RESPONSE OF CHICKEN GENOTYPES TO DIETARY LEVELS OF *Moringa oleifera* (Lamarck) SEED MEAL

By

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ABSTRACT

Moringa oleifera (Lamarck) seed is a potential novel feedstuff that can be incorporated into poultry nutrition in Nigeria. *Moringa oleifera* is a potential cheaper alternative than the current conventional feedstuff. However, the performance response may vary between different chicken genotypes. The objectives of this study are to evaluate: (i) effects of dietary inclusion of *Moringa oleifera* Seed Meal (MOSM) on performance and morphometric body parameters of local and exotic chickens; (ii) effects of dietary inclusion of MOSM on reproductive characteristics of local and exotic chickens; and (iii) correlation and predictive models for growth and reproductive parameters in local and exotic chickens fed MOSM.

Two experiments were conducted. Four experimental diets containing 0, 5, 10 and 15 % MOSM were used. Experiment 1 studied the comparative effects of dietary inclusion of MOSM on the performance and morphometric body parameters of local and exotic chickens. Experiment 2 assessed the comparative influence of dietary MOSM on the spermiogramic and egg characteristics of Yoruba Ecotype Nigerian Local Chickens (YENLC) and Isa Brown chickens. Data obtained were subjected to analysis of variance, correlation, forward-stepwise regression and principal component analysis.

The findings of this study were that;

(i) chickens fed 5% MOSM had the best feed conversion ratio (3.24) and morphometric body parameters ($p<0.05$). Haematology, serum electrolytes and enzymes increased significantly ($p<0.05$) with increasing level of MOSM. Serum total cholesterol significantly decreased ($p<0.05$) from the control to 10% MOSM inclusion;

(ii) dietary inclusion of MOSM affected the reproductive parameters in YENLC and Isa Brown chickens. Egg length, egg width, yolk weight and yolk height decreased significantly ($p<0.05$) with increasing levels of MOSM;

(iii) the association between morphometric parameters and body weights decreased significantly ($p<0.05$) with increasing levels of MOSM (r decreased from 0.72 to 0.52). Late body weight could be predicted for Marshall up to week 7 using body morphometrics (R^2=81.70%);

(iv) diets affected the sperm parameters of the cocks. Body weights predicted semen volume, testes weight, epididymis weight and spermatozoa reserves (R^2=85.30%). There were significant ($p<0.01$) and high positive correlations among egg length, egg width, shell weight, albumen height, albumen weight, yolk height and yolk weight of YENLC ($r\geq0.822$). However, egg length, egg width, shell weight, albumen height, albumen weight, yolk height and yolk weight predicted the egg weight of Isa brown and YENLC with accuracy of 83.90% and 85% respectively; and

(v) the most significant latent determinant of variation in body weight and linear body traits discovered (principal component 1), explained the MOSM effect, and largely reflected the contribution of body weight at weeks 4 and 5 to overall variation (variance explained = 67.41%).

This study concluded that 5% dietary inclusion of MOSM would improve growth performance in Marshall, while 5% level of inclusion of MOSM would improve the reproductive performance of Isa Brown chickens. 10% MOSM dietary inclusion would contribute to optimum growth and reproductive performance in YENLC. The study recommended that up to 5% MOSM can be included in chickens' diet irrespective of the genotype for optimum performance.

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CERTIFICATION

I certify that this research work was carried out by AKINTUNDE, Adeyinka Oye in the Department of Animal Production, University of Ilorin, Ilorin under my supervision.

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Dr. A.A. Toye Date

Department of Animal Production,

University of Ilorin, Ilorin.

DEDICATION

This thesis is dedicated to Almighty God, the author and finisher of my faith. The one that shows the way in the wilderness of this life, He is my all in all.

The thesis is also dedicated to my beloved son – Eniiwaju Ayomide AKINTUNDE. Your coming has been accompanied with a lot of breakthroughs and open-doors.

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CHAPTER 1

1.0 INTRODUCTION

Animal protein is the major source of protein in the food of man. Any food taken by man should be able to supply the essential nutrients that are required. Human population is increasing on daily basis so there is need to find a means to increase livestock production to meet the demand of man.

Poultry production is one of the growing areas of livestock production. It is of great interest to farmers because of its high prolificacy and productivity. Poultry are monogastric animals which cannot utilize fibrous feed efficiently like the ruminant counterpart due to lack microbes that can degrade fibrous based feed. Chickens are sought after because of their very good feed conversion ratio.

In the recent times, there is much emphasis on the production of broilers and layers at the expense of the indigenous chickens which are hardy and adapt well to the harsh climatic conditions of Nigeria. Majority of the rural households raise the Nigerian local chickens. It is also established that phenotypic expression of birds – local and exotic is dependent on genotype and environment in which feed/nutrition is a major constituent. This implies that the response of different genotypes of birds to the same diet under the same environmental condition would differ. There might also be variation within breed. Therefore, in animal breeding, it is imperative to compare different strains/breeds of chickens before generalizing outcomes of research.

The abundance of local fowls had been reported and it was established that their numbers far outweighed the species of other livestock in Nigeria; their number was estimated to be about 123.9 million in 1978, 115.9 million in 2003, and 84 million in 2006 (Afolabi *et al*., 2012). The local hens of Nigeria are predominantly raised on free range however, they are highly valued for their eggs and high level of adaptation to the local climate of Nigeria. The Nigerian local chickens are often given little or no adequate care in term of housing, nutrition, and medication however they serve as a very good source of dietary protein for low-income rural and indigenous dwellers.

In order to improve the performance and productivity of livestock, supplementation of their diet with alternative feedstuff is required. While supplementing livestock's diet with protein, this should be done with

special consideration to the nutritional requirements of the animal to achieve nutrient balance or balanced ration. The main and most widely sources of protein in the convetional livestock feed are fish meal and Soyabean meal.

However, the rate at which the prices of the aforementioned protein sources are increasing arbitrariliy despite the erratic supply in recent times is a thing of concern to livestock especially poultry farmers. The ever-increasing competition between livestock and humans for these protein feed ingredients is another threat to the availability of these feedstuffs to livestock farmers. Odunsi (2003) opined that the need for alternative feedstuff must be swiftly identified and evaluated because the rapid rise in the population of human and livestock has been creating the increased needs for food and feed in the less developed countries.

In Low-Income Food-Deficit Countries (LIFDCs), surplus of cereals is generally not available; therefore, it is not advisable to develop a wholly grain-based feeding system. The recommended policy is to identify and use locally available feed resources to formulate diets that are as balanced as possible (Guèye and Branckaert, 2002). There is the need, therefore, to explore the use of non-conventional feed sources that have the capacity to yield the same output as conventional feeds, and perhaps at cheaper cost.

This strategy could help reduce the cost of production, and ensure cheaper meat production thereby making available the major crops for human consumption. The economization of feed cost using cheaper and unconventional feed resources (Vasanthakumar *et al*., 1999; Bhatt and Sharma, 2001; Muriu *et al*., 2002) is an important aspect of commercial poultry production.

One possible source of cheap protein is the leaf and seed meals of some tropical legume browse plants. Leaf and seed meals do not only provide protein source but also some essential vitamins such as vitamins A and C, minerals and oxycarotenoids. The constraints to enhanced utilization of leaf and seed meals reside chiefly on factors such as fibre content, the presence of anti-nutritive compounds and deficiencies of certain amino acids.

Recently, there has been interest in the utilization of *Moringa oleifera* commonly called horseradish tree or drumstick tree, as a protein source for livestock (Makker and Becker, 1997; Sarwatt *et al*., 2002). *Moringa oleifera* leaves have quality attributes that make it a potential replacement for soyabean meal or fish meal in

non-ruminant diets. *Moringa oleifera* can easily be established in the field, has good coppicing ability, as well as good potential for forage production. Furthermore, there is the possibility of obtaining large amounts of high quality forage from moringa without expensive inputs due to favourable soil and climatic conditions for its growth. Sarwatt *et al*. (2004) reported that *Moringa oleifera* foliages are a potential inexpensive protein source for livestock feeding. The advantages of using *Moringa oleifera* for a protein resource are numerous, and include the fact that it is a perennial plant that can be harvested several times in one growing season and also has the potential to reduce feed cost. *Moringa oleifera* is in the group of high-yielding nutritious browse plants with every part having food value (Duke, 1998).

Moringa oleifera is a rich antioxidant source. The leaves and seeds are outstanding as sources of vitamin A and, when raw, vitamin C. They are a good source of B vitamins and among the best plant sources of minerals. The calcium content is very high for a plant. Phosphorous is low, as it should be. The content of iron is very good (it is reportedly prescribed for anaemia in the Philippines). They are an excellent source of protein and a very low source of fat and carbohydrates. Thus the leaves are one of the best plant foods that can be found. The leaves are good sources of the sulfur-containing amino acids: methionine and cystine, which are often in short supply. (Price, 2007). The crude protein, crude lipids and ash values of 26.4%, 6.5% and 12%, respectively were reported for the unextracted leaves by Gupta *et al*. (1989). Also, higher levels of NDF (28.8%) and ADF (13.9%) were reported (Gupta *et al*., 1989).

Also, the effect of nutrition may differ from different genotypes of birds reared under the same environmental conditions. This means that each environmental factor which may be feeding habit or nutrition has a specific effect on members of the same genotype and different genotypes. If the effects on a genotype are the same for several environmental factors, there is no genotype – environment interaction; but if different and large, then genotype – environment interaction may be implicated. The phenotypic value of an individual in the genotype then becomes: P = G + (E + I G.E.)

Despite the relatively high crude protein content of *Moringa oleifera* seed meal, there is little information available on the use of this unconventional feed resource and the responses of different genotypes of

chickens to this non-conventional feed ingredient. It is also ascertained that the responses of different genotypes of chickens vary. There are even variations in the responses of birds within genotype.

1.1. OBJECTIVES

The general objective is to examine the effect of two genotypes of chickens as it relates to the inclusion of graded levels of *Moringa oleifera* Seed Meal in their diets.

The specific objectives are:

- To determine the proximate/ chemical composition of *Moringa oleifera* seed meal obtained from the Kaduna area of Nigeria.
- To determine the genotype effect, interaction and diet effect (MOSM) on the performance, efficiency of nutrients utilization, haematological and serum biochemical parameters of local and exotic chickens.
- To determine the genotype effect, interaction and diet effect (MOSM) on the sperm and egg parameters of local and exotic chickens.
- To determine the effect of genotype and MOSM inclusion on the association and predictive abilities of body parameters, haematological and serum biochemical parameters.
- To determine the level of prediction of body weight, sperm parameters and egg weight, phenotypic correlation and principal component analyses using spermiogramic and egg parameters of birds at early life as it relates to genotypes and MOSM inclusion.

CHAPTER 2

2.0. LITERATURE REVIEW

2.1. Origin and distribution of *Moringa oleifera*

Moringa (*Moringa oleifera Lam*) had its origin from North-West region of India, South of the Himalayan Mountains and it belongs to the family moringaceae (Makkar and Becker, 1997). *Moringa oleifera* is now widely grown and cultivated in many locations/parts in the tropics including Nigeria. (Fahey *et al*., 2001). Kristin (2000) reported that out of the known and identified thirteen specie of the family *Moringaceae, Moringa oleifera* is the most widely cultivated and grown even by the peasant farmers/ low income earners.

2.2. Uses of *Moringa oleifera*

Human beings can consume all the parts of *Moringa oleifera* tree. Fuglie (1999) reported the many uses of *Moringa oleifera* as follows: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannins for tanning hides (bark and gum), and water purification (Powdered seeds).

Moringa oleifera powdered seeds have been widely used to flocculate contaminants and purifying drinking water (Berger *et al*., 1984; GassenSchmidt *et al*., 1995; Olsen, 1987). Also, the seeds of *Moringa oleifera* can be eaten green, roasted, powdered and steeped for tea or used in curries (GassenSchmidt *et al*., 1995). *Moringa oleifera* seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. The tree of *Moringa oleifera* is being advocated in the recent time as a remarkable source of highly digestible protein, calcium, iron, vitamin C, and carotenoids suitable for

utilization in many of the so-called “developing” regions of the world where undernourishment is a major concern (Fahey *et al.,* 2001).

The seeds of *Moringa oleifera* are widely known to be antipyretic, acrid and bitter (Sutherland *et al.,* 1994). The cytokinine-type hormones extracts of moringa leaves in 80% ethanol as a foliar spray can be used according to Foidl *et al*. (2001) to accelerate the growth of young plants such as soyabean, blackbean, maize, onion, sorghum, tomato, coffee, and sugar cane. *Moringa oleifera* leaves have also been shown to increase breast milk production (Estrella *et al*., 2000). Fuglie (2001) reported that in many Asian and African countries, breat milk production is being enhanced through the consumption of *Moringa oleifera* leaves by women.

Moringa oleifera leaves have very strong antioxidant activity (Siddhuraju and Becker, 2003; Yang *et al*., 2006). The leaves and seeds of *Moringa oleifera* serve as an excellent source of vitamin A and, when raw, vitamin C especially the leaves. *Moringa oleifera* is equally rich in Vitamin B and one of the plants that are excellent sources of minerals. The plant is also outstanding in its supply of calcium. Phosphorous is low, as it should be. The content of iron is very good (it is reportedly prescribed for anemia in the Philippines). They are an excellent source of protein and a very low source of fat and carbohydrates hence it could be assumed that the plant will be good for fat reduction in the body system. This has thus made *Moringa oleifera* to be one of the best plant foods that can be found. It was also reported that the leaves are good sources of the sulfur-containing amino acids: methionine and cystine, which are often in short supply (Price, 2007)

It was reported that the flowers, leaves and roots could be used for the treatment of ascites, rheumatism and venomous bites and as cardiac and circulatory stimulants in folk remedies (Dahot, 1988; Hartwell, 1995). The roots of the young tree and also root bark are rubefacient and vesicant. The root decoction is used in Nicaragua for dropsy and the flower decoction is used as a cold remedy (Hartwell, 1995).

Though some nutrients in vegetables are lost as a result of cooking, Price (2007) reported that boiled *Moringa oleifera* leaves or leaf powder provided at least three times more bio-available iron than raw *Moringa oleifera* leaves. The antioxidant activity of moringa leaves can be enhanced through boiling. The matured leaves of *Moringa oleifera* was reported to contain higher contents of nutrient when compared to

the young leaves of the same plant. Vitamin A was highest during the hot-wet season, whereas iron and vitamin C were highest during the cool-dry season (Price, 2007).

In the experiments conducted at the University of Baroda in India, it was observed that the cooking of *Moringa oleifera* leaves with oil would help in the retention of beta-carotene and the conversion of beta carotene to vitamin A was highly enhanced in the body. These studies also revealed that when the leaves of moringa are cooked with any tomato products, beta carotene would be reduced. This is due to the fact that vitamin A is unstable under acidic conditions (Price, 2007).

The leaves and seeds of *Moringa oleifera* can be dried with much ease. Leaves of *Moringa oleifera* are expected to be dried in the shade, this is to avoid excessive loss of vitamins, especially vitamin A. AVRDC research reported by Price (2007) showed that when *Moringa oleifera* leaves were dried at 50°C (122°F) for 16 hours there was retention of most of the nutrients. The brittle leaves were then pounded and sifted to remove leaf stems. Leaves can also be rubbed over a wire screen to make a powder, which should be stored in a sealed, dark container. (Price, 2007).

"Nutrient value of *Moringa oleifera* leaves can be increased (for poultry and swine) through the addition of an enzyme (phytase) to break down the phytates, leading to increased absorption of the phosphorus found in *Moringa oleifera*. The enzyme should be simply mixed in with the leaves without heating" (Price, 2007).

When 40-50% of *Moringa oleifera* was included in the feed of local Jersey cattle, it was observed that the average birth weight of the cattle which was usually in the average of 22 kg increased by 3-5 kg. Also, incidence of twin births increased drastically with *Moringa oleifera* feed: 3 per 20 births as against the usual average of 1:1000 (Price, 2007).

Moringa oleifera leaf concentrate may sometimes be preferable to fresh leaves for use in livestock feed. "Chickens will not voluntarily consume *Moringa oleifera* leaves or *Moringa oleifera* leaf powder. However, about half the protein content can be extracted from the leaves in the form of a concentrate which can then be added to chicken feed (or used in many other ways). (Price, 2007).

Moringa oleifera seeds can be extracted and eaten as "peas" (boiled or fried) when still green. The dry seeds are apparently not used for human consumption, perhaps because the bitter coating becomes hardened.

The mature seed is about 40% oil. *Moringa oleifera* oil is of excellent quality (73% oleic acid, similar to olive oil) for cooking. It was sold for many years as "ben oil," it is used in cooking and perfumes and has been used as watch lubrication, but was replaced long ago by sperm oil. It can be used for making soap and is also excellent to burn for light. The oil is slow to become rancid. The species, *Moringa peregrina*, from the Red Sea area reportedly produced very good oil.

Oil can be extracted from *Moringa oleifera* seed. Seed from mature pods-which can be 60 cm (24 in) long are roasted, mashed and placed in boiling water for 5 minutes. After straining and sitting overnight, the *Moringa oleifera* oil floats to the surface.

In addition to their usefulness as a source of oil, *Moringa oleifera* seeds can be used for water treatment **(**Price, 2007). Price (2007) also reported that the root bark of *Moringa oleifera* contains several alkaloids including the toxic and physiologically active moringinine. Eating large amounts of the root at once or too often should be avoided, because roots also contain pterygospermin and an alkaloid called spirachin, a nerve-paralyzing agent **(**Price, 2007).

2.3. Use as an antibiotic

Price (2007) noted that Pterygospermin and/or related compounds (isothiocyanates), found in various parts of the *Moringa oleifera* plant, have been shown to have antibiotic and fungicidal properties.

2.4. Nutritive value of *Moringa oleifera* plant

Grubben and Denton (2004) reported that the leafy tips of *Moringa oleifera* contain per 100 g edible portion: water 78.7 g, energy 268 kJ (64 kcal), protein 9.4 g, fat 1.4 g, carbohydrates 8.3 g, total dietary fibre 2.0 g, Ca 185 mg, Mg 147 mg, P 112 mg, Fe 4.0 mg, Zn 0.6 mg, vitamin A 7564 IU, thiamine 0.3 mg, riboflavin 0.7 mg, niacin 2.2 mg, folate 40 µg, and ascorbic acid 51.7 mg.

The raw fruits of the plant, according to Bosch (2004), contain per 100 g edible portion: water 88.2 g, energy 155 kJ (37 kcal), protein 2.1 g, fat 0.2 g, Carbohydrates 8.5 g, total dietary fibre 3.2 g, Ca 30 mg, Mg

45 mg, P 50 mg, Fe 0.4 mg, Zn 0.4 mg, vitamin A 74 IU, thiamin 0.05 mg, riboflavin 0.07 mg, niacin 0.6 mg, folate 44 μg, and ascorbic acid 141.0 mg. The analysis of nutritional value of *Moringa oleifera* is presented in Table 2.1.

Table 2.1: Analysis of nutritional value of Moringa pods, fresh (raw) leaves and dried leafy powder per 100g of edible portion

Components	Pods	Leaves	Leaf Powder
Moisture (%)	86.9	75.0	7.5
Calories	26	92	205
Protein (g)	2.5	6.7	27.1
Fat (g)	0.1	1.7	2.3
Carbohydrates (g)	3.7	13.4	38.2
Fibre (g)	4.8	0.9	19.2
Minerals (g)	2.0	2.3	-
Ca Calcium (mg)	30	440	2003
Cu Copper (mg)	3.1	1.1	0.57
Fe Iron (mg)	5.3	7.0	28.2
K Potassium (mg)	259	259	1324
Mg Magnesium (mg)	24	24	368
P Phosphorus (mg)	110	70	204
S Sulphur (mg)	137	137	870
Se Selenium (mg)	-	-	0.09
Zn Zinc (mg)	-	-	3.29
Oxalic acid (mg)	10	101	1600

Vitamin A (mg)	0.11	6.8	18.9
Vitamin B (mg)	423	423	-
Vitamin B1(mg)	0.05	0.21	2.64
Vitamin B2 (mg)	0.07	0.05	20.5
Vitamin B3 (mg)	0.2	0.8	8.2

Table 2.1: Analysis of nutritional value of Moringa pods, fresh (raw) leaves and dried leafy powder per 100g of edible portion (*contd*)

Components	**Pods**	**Leaves**	**Leaf Powder**
Vitamin C (mg)	120	220	17.3
2.5. AMINO ACIDS			
Arginine (mg)	90	402	1325
Histidine (mg)	27.5	141	613
Isoleucine (mg)	110	422	825
Leucine (mg)	163	623	1950
Lysine (mg)	37.5	288	1325
Methionine (mg)	35	134	350
Phenylanaline (mg)	108	429	1388
Threonine (mg)	98	328	1188
Tryptophan (mg)	20	127	425
Valine (mg)	135	476	1063

Source: Booth and Wickens (1988)

Moringa oleifera leaves could serve as a valuable source of nutrients for all age groups. For example, in Haiti and Senegal, health workers have been treating malnutrition in small children, pregnant and nursing women with *Moringa oleifera* leaf powder (Price, 1985). The leaves are known to be great source of vitamins and minerals being served raw, cooked or dried.

Fuglie (2005) reported that 8 g serving of dried leaf powder will satisfy a child within ages 1-3 years with 14% of the protein, 40% of the calcium, 23% of the iron, and nearly all vitamin A that the child needs in a day.

One 100 g portion of leaves could provide a woman with over a third of her daily need of calcium and give her important quantities of iron, protein, copper, sulphur, and B-vitamins. It is estimated that only 20-40% of vitamin A content will be retained if leaves are dried under direct sunlight, but that 50-70% will be retained if leaves are dried in the shade (Subadra and Monica, 1997).

The nutritional characteristics of the *Moringa oleifera* tree are excellent so it can easily be used as a fresh forage material for animals. The leaves are rich in protein, carotene, iron and ascorbic acid and the pod is rich in the amino acid lysine (CSIR, 1962). In an experiment where extracted and unextracted leaves of *Moringa oleifera* were used as a component of animal feed, Makker and Becker (1996) analyzed these samples for nutrients and antinutrients.

Table 2.2 presents the chemical composition of both the extracted and unextracted *Moringa oleifera* leaves. The extracted and unextracted *Moringa oleifera* leaves gave crude protein values of 43.5 and 25.1% respectively, suggesting that both the extracted and unextracted leaves are good sources of protein for livestock. The crude protein and fibre contents of the extracted leaves were higher than those of the unextracted leaves due to the loss of some cell solubles and lipids during the treatment with 80% ethanol.

The crude protein, crude lipids and ash values of 26.4%, 6.5% and 12%, respectively were reported for the unextracted leaves by Gupta *et al*. (1989). Also, higher levels of NDF (28.8%) and ADF (13.9%) were reported (Gupta *et al*., 1989).

Table 2.2: Chemical composition of extracted and unextracted *Moringa oleifera* leaves

Type of leaf	Crude Protein	Lipid	Ash	NDF	ADF	ADL	Gross energy ($MJkg^{-1}$)
Extracted leaves	43.5	1.4	10.0	47.4	16.3	2.2	17.7
Unextracted leaves	25.1	5.4	11.5	21.9	11.4	1.8	18.7

All values except gross energy are expressed as percentage dry matter. NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, ADL = Acid Detergent Lignin

Source: Fuglie (1999).

2.5. Phytochemicals of *Moringa oleifera* and their uses

An examination of the phytochemicals of *Moringa oleifera* affords the opportunity to examine a range of fairly unique compounds (Fahey *et al*., 2001). In particular, this plant family is rich in compounds containing the simple sugar, rahmnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates (Bennett *et al*., 2003; Fahey *et al*., 2001).

Some of the compounds that have been isolated from *Moringa oleifera* preparations which are reported to have hypotensive, anticancer and antibacterial activity include 4-(4'-*O*-acetyl-a-L-rhamnopyranosyloxy)benzyl isothiocyanate**,** 4-(a-L-rhamnopyranosyloxy)benzyl isothiocyanate**,** niazimicin, pterygospermin**,** benzyl isothiocyanate**,**and 4-(a-L-rhamnopyranosyloxy) benzyl glucosinolate (Daxenbichler *et al*., 1991; Fahey *et al*., 2001; Bennett *et al*., 2003; Mekonnen and Dräger, 2003). Antioxidant activity of these compounds has also been reported (Win and Jongen, 1996).

Flavonoid pigments such as quercetin, kaempferol, rhamnetin, isoquercitrin and kaempferitrin were reported to be present in the flowers of *Moringa oleifera* as reported by Nair and Subramanian (1962). According to Foidl *et al*. (2001) extracts of *Moringa oleifera* leaves in 80% ethanol contain cytokinine-type hormones.

The flavonoids such as quercetin and kaempferol were identified as the most potent antioxidants in *Moringa oleifera* leaves. Their antioxidant activity was higher than the conventional antioxidants such as ascorbic acid, which is also present in large amounts in *Moringa oleifera* leaves (Siddhuraju and Becker, 2003).

2.6. Nutritional evaluation of alternative feed ingredients on the performance of animals

Some non-conventional feed ingredients have been used as feedstuffs for animals as a partial substitute for the conventional grains and forages. *Leucaena leucocephala* has been successfully used in rabbit diets when incorporated in low levels.

The presence of mimosine, a toxic amino acid can cause growth depression at higher incorporation levels (Parigi-Bini and Xiccato, 1998).

In an experiment carried out by Odeyinka *et al*. (2008), a 20-week feeding trial was conducted by to evaluate the reproductive performance of rabbits fed *Moringa oleifera* as a replacement for *Centrosema pubescens*. *C. pubescens* and *M. oleifera* leaves that were harvested freshly was included in the diets of the animals at 20% of their liveweight at the ratios of 100:0 (MO), 75:25 (M25), 50:50 (M50), 25:75 (M75), and 0:100 (M100), in addition to the concentrate feed offered to the animals. There were significant differences in the total dry matter intake, litter size at weaning, average daily weight gain per kid and milk yield of does, on the different treatments ($p<0.05$) . However, no significant difference was observed in crude protein intake, initial average body weight, and gestation length as well as litter weight at birth. They however concluded that *Moringa oleifera* can be used to replace *Centrosema pubescens* without adverse effects on the reproductive performance of rabbits.

In another experiment by Oduro *et al*. (2008) to determine the nutritional potential of two leafy vegetables (*Moringa oleifera* and *Ipomoea batatas)*, it was concluded from their studies that *Moringa oleifera* leaves could contribute to the nutrient requirements of humans and should be strongly recommended in Ghana.

Ghasi *et al*. (1999) reported that juice extracted from *Moringa oleifera* leaves was a potent hypocholesterolemic agent. In their research using Wister rat, they concluded that even when given at the relatively low dose of 1 mg/g, co-administered with a high fat diet daily over a period of 30 days, cholesterol was reduced in serum, liver and kidney.

2.9. Effects of Moringa oleifera inclusion on chickens

Several studies showed that animal performance could be improved by dietary supplementation of *Moringa oleifera*. An improvement in egg production, yolk colour and feed conversion ratio were observed in Rhode Island Red hens supplemented with *Moringa oleifera* (Mohammed *et al.* 2012). The addition of *Moringa oleifera* leaves powder to the diets was associated with increased weight in broilers (Donkor *et al.* 2013).

In another study by Kholif *et al.* (2015), it was observed that goats fed diets containing *Moringa oleifera* leaves had an increased feed intake, nutrient digestibility and milk yield. The effect of *Moringa oleifera*

leaves was proven to be dosage-related and a higher supplementation level could lower animal performance due to the increased concentration of anti-nutrient factors (such as saponins and phenols) (Worku, 2016).

Wei *et al*. (2016) also conducted a research on the evaluation of *Moringa oleifera* leaf in laying hens: effects on laying performance, egg quality, plasma biochemistry and organ histopathological indices. They reported that there was no significant differences in egg weight or feed intake among all groups ($p > .05$). The birds fed 15% dietary levels of *Moringa oleifera* leaf had higher feed conversation ratio and lower egg production compared with those in control group ($p < .05$). Layers in 5% *Moringa oleifera* leaf diet group had a deeper yolk colour than those in control group ($p < .05$). The albumen height and Haugh unit increased with increasing level of *Moringa oleifera* leaf when eggs were stored at 4 °C and 28 °C for 4 weeks ($p < .05$). The birds fed 15% dietary levels of *Moringa oleifera* leaf had higher aspartate aminotransferase activity and lower uric acid concentration than other groups ($p < .05$). Layers fed 10% and 15% inclusion levels of *Moringa oleifera* leaf had higher malondialdehyde content than those in control group ($p < .05$).

The effects of *Moringa oleifera* Lam seeds on the performance and carcass characteristics of broiler chickens was also studied by Ochi et al. (2015). Three experimental diets containing 0.5, 1.0 and 2.0 % *Moringa oleifera* seed powder (MOSP) and a control MOSP-free diet were used. Feed consumption, weight gain, feed conversion ratio and carcass quality characteristics were recorded for the individual replicate of each dietary treatment. Addition of MOSP up to 1.5% to broiler chicks diet significantly ($p<0.05$) showed low weight gain, feed efficiency and body weight during starter period. During finisher and the whole period supplying broiler chicks diet with 0.5% MOSP resulted in significant increase ($p<0.05$) in feed consumption, but addition of different levels of MOSP showed no significant effects($p>0.05$) on weight gain, feed efficiency, final live body weight, dressing percentage, liver weight and heart weight. They however opined that the reduction in weight gain, feed efficiency and body weight could be due to addition of 2.0% MOSP to broilers' diet during starter period which may be as a result of the presence of phytate which acts as an anti-nutritional factor.

Hence, incorporation of various parts of this plant in poultry feed formulation is imperative for cost reduction and enhancing the performance and quality chicken carcasses when consumed within chickens' safety limit taking cognizance of the phytochemicals.

2.10. Evaluation of chicken flock for optimum performance

Jesuyon (2011) opined that the quality of a flock of pullets at point-of-lay may be measured using:

- Body weight
- Age
- Feed intake capacity
- Beak trimming quality
- Body weight uniformity
- Health status

He further stated that while in production, a flock may be evaluated using:

- Peak egg production
- Persistency in lay (HDP and length of time)
- Percent fertility (mean and peak)
- Maximum hatching eggs / HH / week
- Optimum egg weight and shell quality
- Body weight uniformity of flock (>85 %)
- Livability (high)
- Attainment of target body weight for genotype.

2.11. Genotype sensitivity

Graphically, the slope of the phenotypic values (y) of a genotype, G, against the environmental values of all the genotypes (x) in the environment will give the environmental sensitivity coefficient, b, of the genotype in the environment.

$$\text{Sensitivity of G} = (b) = \frac{\Delta y}{\Delta x}$$

$$\text{So, Sensitivity} = \frac{\text{Phenotypic values of a genotype in an environment}}{\text{Mean of all Genotypic values in the environment}}$$

But statistically, environmental sensitivity is the regression of a genotype's phenotypic values on the phenotypic mean values of all genotypes in that environment (environmental values) (Falconer and Mackay, 1996).

$$Y = a + b\,X$$

Where Y = genotype's response in season

a = intercept or genotypic constant for the season

b = sensitivity / power / slope / response coefficient

X = Mean value of all genotypes, from all seasons, in the environment.

Thus, the amount of variance due to feeding various levels of diets is obtainable from the heterogeneity of regression slopes, that is, the slope of the regression line measures the seasonal sensitivity of a genotype. Large differences in sensitivity among genotypes in various environments may lead to a reversal of the order of merit (Falconer and Mackay, 1996) among the genotypes. Part of the genotype–environment interaction variance can be ascribed to differences in sensitivity of different genotypes to different environments (nutrition inclusive) (Falconer and Mackay, 1996; Horst, 1981).

Therefore, genotypic sensitivity is a component of the genotype by environment interaction (G-E); and the variance due to sensitivity can be estimated by regression and mathematical procedures.

Sensitivity indices help breeders to rank genotypes according to its magnitude, and also to decide which genotype shall be selected and the appropriate diet selection and combination for optimum performance. Nutritional sensitivity helps to understand responses of genotypes to uniform environmental and seasonal conditions, since a low genetic correlation means that allgenotypes react differently and have regression lines with different slopes that is, individuals have different nutritional sensitivities.

According to Falconer and Mackay (1996), when an environment increases character or trait, it is termed 'good' but when it decreases character, it is termed 'bad'. In good environments with appropriate diet combination, high sensitivity brings high performance while in bad environments with inappropriate nutrition; low sensitivity brings about poor performance.

2.12. Genotype - Environment interaction

Genotype – Environment interaction (G-E) has been defined as a change in the relative performance of a character of two or more genotypes measured in two or more environments (Bowman, 1974). When a genotype is reared under two specific environments, for example temperate and tropical, its response (body weight) may differ in the two environments. The differences could be due to management, feeding, crowding, weather, equipment, farms, nutrition, season, or geographical locations etc. Also, the effect of nutrition may differ from different genotypes of birds reared under the same environmental conditions. This means that each environmental factor which may be feeding habit or nutrition has a specific effect on members of the same genotype and different genotypes. If the effects on a genotype are the same for several environmental factors, there is no genotype–environment (G-E) interaction; but if different and large, then genotype–environment interaction may be implicated. The phenotypic value of an individual in the genotype then becomes:

$P = G + (E + I\ G.E.)$

Since a single genotype is a genetically uniform group, the variance observed will be due entirely to environmental differences (that is, different feeding regimes) among individuals within the genotype. This means that the variance depends on the way in which the particular genotype responds to the nutritional differences. It is usually observed that, one genotype may be more sensitive than the other to environmental differences; that is, a specific difference of environment may have a greater effect on one genotype than the other (Falconer and Mackay, 1996).

Interaction may involve:

- A greater effect of an environment on some genotypes than on others, leading to differences in genotype sensitivity to the environment.
- Changes in Rank order for genotypes between environments. The environments have to differ considerably for rank order changes to be important (significant).
- Changes in absolute and relative magnitude of the genetic, environmental and phenotypic variances between environments, so changing heritability.

The variance due to interaction can be estimated by factorial analysis of variance (ANOVA) procedure of most statistical softwares. Therefore the existence of G-E interaction is a pointer to the adaptability potential of a new genotype or an exotic strain to the local condition. When there is no interaction, the best genotype in an environment will be the best in all. The presence of much interaction means that particular genotypes must be sought for particular environments (Falconer and Mackay, 1996).

2.13. The Nigerian Local Chicken

Nigeria is richly endowed with a large population of local chickens. According to RIM (1992) the local chicken population in Nigeria is about 103 million, 85% of which are found in the north and the rest in the southern part of the country. Local chickens are kept for various purposes, which include the provision of meat and eggs for home consumption, religious ceremonies and barter, as such they play a big role in rural as well as national economy (FAO, 2004).

However, the local chickens in Nigeria are a pool of heterogeneous individuals, which differ, in adult size, body weight, feather and plumage pattern (Fayeye *et al*., 2005). There were several reports on the unique adaptation features of the Nigerian local chicken (Adebambo *et al.*, 1999; Ibe, 1993). These include their relatively small adult size, generally flighty nature, relatively thick eggshell, high tolerance to some tropical diseases and parasites and the presence of some major genes affecting feather structure and feather distribution for example naked neck and frizzle feathers. Peters *et al.* (2004) noted that the major genes of frizzling and naked neck are important as they enhance the themo-regulatory activities of the birds.

There have been various genetic studies on the Nigerian local chicken round the ecological zones of the country – in the east by Nwosu and Omeje (1985), Udeh and Omeje (2001) and Momoh *et al.* (2007), in the west by Adebambo *et al.* (1999) and Peters *et al.* (2004) and in the north by Fayeye *et al.* (2005). Their main aims were mainly to characterize the Nigerian local chicken using its physical features and crossbreeding to monitor the performance of the progenies. Two major strategies have been offered to achieve new breed development: intense selection within the population followed by crossing (Osman and Robertson, 1968), and crossbreeding to create a heterogeneous broad-based population followed by intense selection (Pirchner, 1983).

The findings of Oluyemi (1979) tend to suggest that the Nigerian local chicken would not be suitable for development as a broiler breed. Incidentally, several works by researchers on the Nigerian local chicken have shown that breeding and developing this chicken into a layer stock would be more efficient and highly achievable. For instance, Nwosu (1990) reported that the local chicken have potential for egg production when he recorded an annual egg number of 146 eggs for the local chicken under battery cage system of management. This was better than the 80-112 eggs per hen per year reported by Sonaiya *et al*. (1998) for the Nigerian local chicken, although this was the local chicken under semi- intensive system of management.

2.14. Egg Production in Chickens

The egg production of a chicken is a result of many genes acting on a large number of biochemical processes, which in turn control a range of anatomical and physiological traits. With appropriate environmental conditions (nutrition, light, ambient temperature, water, sound health, etc.), the many genes controlling all the processes associated with egg production can act to allow the chicken to express fully its genetic potentials (Fairfull and Gowe, 1990).

2.20. Effects of genotypes on the performance of chickens

The biological responses of different genotypes of chickens raised under the same environmental conditions should be evaluated before making generalizations of findings for optimum performance in poultry production.

Fanatico *et al. (*2005) and Takahashi *et al.* (2006) evaluated the effect of freerange genotypes of chickens on their production performances, it was reported that there was no significant interaction between genotype and production system. They however concluded that if the birds were raised intensively, the chickens would be able to express their maximum growth potential, and thus the genotypes can be better differentiated

In a similar study by Del Castilho *et al.* (2013) on the effects of sex and genotype on performance and yield characteristics of free range broilers, there was no significant effect ($p<0.05$) of interaction between sex and genotype in all variables measured for performance and yield characteristics.

It was observed by Del Castilho *et al.* (2013) that despite the fact that the chickens were of different lines and origins, the initial body weight was not affected by the genetics or sex but body weight gain for males was significantly higher than females in all their further determinations. Lana *et al.* (2000) and Viana *et al.* (2000) found similar results, with higher average body weight for males of broiler strains at 42 days old.

For feed conversion ratio, it was observed that there was no significant effect of genotype on this feature in any of the ages (Del Castilho *et al.,* 2013). Barbosa Filho *et al.* (2005) found similar results, obtaining no

significant differences between the average feed conversions between different genotypes of freerange chickens at 75 days of age. Different results were reported by Hellmeister Filho *et al.* (2003) who observed genotype effect, getting the best averages of feed conversion for free-range broiler chickens with fast and slow growth comparison.

Savino *et al.* (2007) evaluated eight genotypes of free-range chickens and found no effect of genotype on feed conversion only at 28 days and not at 56 and 84 days of age. The livability values did not suffer significant effect of genotype. It was also observed that livability had very high values, according to the results of Hellmeister Filho *et al*. (2003), who found low levels of mortality, suggesting high livability of different genotypes, which is an important factor, since this system requires greater resistance of birds. The similar livability between genotypes indicates that the selection practiced in the genotypes of intermediate growth did not change the resistance of these birds, which continue with the good livability characteristic of the slow growth birds.

Fanatico *et al*. (2005) reported a genotype effect on the yield of the birds. In their study, higher carcass and breast yields were observed for a fast growing genotype in comparison to a slow growing genotype, both raised with access to pasture area. The leg yield, however, was higher for the slow growth genotype. Takahashi *et al.* (2006) found no effect of genotype in free-range birds only in carcass yield at 63 and 84 days of age. The values of breast and leg yields in all the evaluated ages (56, 63, 70, 77 and 84 days) showed no significant difference between genotypes.

However, in a study by Lewis *et al.* (1997) on responses of two genotypes of chickens to diets and stocking densities, ISA birds were grown to 83 days, and compared with Ross birds grown to 48 days; ISA birds grown to 83 days had significantly similar ($p>0.05$) body weights to Ross birds grown to 48 days. Ross birds had a faster body weight gain, a larger feed intake, but more efficient food conversion ratio and higher incidence of mortality.

Also, in a similar study on the effect of genotype on production traits in broiler chickens by Hristakieva *et al.* (2014), it was observed that there were a number of variations in meat and slaughter traits between

studied broiler chicken hybrids. Coob 500 broilers had higher productive performance when compared with Ross 308 and they were raised under the same growing conditions however, the weight of hatchlings differed significantly according to the genotype. One-day-old Cobb 500 broilers were heavier than Ross 308 broilers. At the end of the experiment which lasted for 49 days, Cobb 500 broilers attained a higher live weight, and were heavier than Ross 308 birds by 6.29 %.

Benyi *et al.,* (2015) also studied the effect of genotype and sex on the growth performance and carcass characteristics of broiler chickens (Cobb and Ross strains of broilers were used for the study), it was reported that genotype had a significant effect only on feed conversion ratio, Cobb was more efficient in converting feed than Ross.

CHAPTER 3

3.0 EFFECT OF GRADED LEVELS OF *Moringa oleifera* SEED MEAL ON PERFORMANCE CHARACTERISTICS AND NUTRIENT RETENTION IN LOCAL AND EXOTIC CHICKENS

3.1. Introduction

Moringa oleifera is rich in nutrient (Price 2007) and the dry leaf and seed may be considered a protein feedstuff based on the concentration (Ogbe and Afiku, 2011).

It is also rich in active chemicals which are not in themselves nutrients that may modulate the responses of birds including: tannin, saponin, alkaloids, glucosinolates, phenols, phytates and trypsin inhibitor (Ogbe and Afiku, 2012).

Poultry production is gaining much prominence in Nigeria and it holds much potential in solving the needs for animal proteins for humans. Due to the fact that resource poor farmers raise Yoruba Ecotype Nigerian Local Chickens (YENLC) for livelihood and feed them with available feed ingredients. Also, the prolificity of YENLC also contributed to the need for its study and the short generation interval of the broiler chickens coupled with the fact that most broiler farmers are looking for alternative source of feed ingredients that is cheaper and readily available, it is therefore essential to study the efficiency of nutrient utilization in both genotypes.

Recent studies have examined the effect of *Moringa oleifera* leaves and seeds but the effect of the genotype has not been studied. Also, the scope of the work was wider than what has been reported in literatures.

This study also showed that the effect of MOSM on growth was not universal across the genotypes of chickens but exhibited a genotype effect on the chicken. This study was aimed at determining the level at which MOSM can be used for different genotypes of chickens.

Previous studies had shown that *Moringa oleifera* leaves significantly affected linear body measurements in chickens (Oludoyi and Toye, 2013). The proportionate contributions of body parts to body weight influence the sale value and profit of chickens sold for meat especially in the market.

The study examined the effect of seed on body parts – body weight, keel length, body length, shank length, thigh length, body girth and wing length, whether and to what extent they affect the growth rate and yields of chickens and its importance for long term experience in animal breeding.

Previous studies had shown that different genotypes of birds respond differently to nutrient utilization especially when using the alternative feedstuffs which contain a high level of fibres and phytochemicals. Some phytochemicals lock up proteins thus making the high protein content in the alternative feedstuff unavailable for the animals. The toxicity and presence of phytochemicals in such diets may hinder the growth of the livestock but Yoruba Ecotype Nigerian Local Chickens were naturally scavengers and raised mainly on free range when compared with the exotic chickens. The study is aimed to compare the biological response of the two genotypes of chickens to the nutrient utilization. The study also examined the levels of interaction between the inclusion of MOSM and the genotypes of chickens.

The possible effects of MOSM on some blood parameters were determined in this trial. Many researchers have reported negative effects of the use of unusual ingredients on some blood parameters as a result of factors such as nutrient imbalance, improper metabolism, presence of anti-nutritional factors and toxic elements in the diets offered to livestock. In a study conducted in southern part of Kaduna State, Nigeria on the economics of animal production, cost of feed was found to be the major constraint followed by purchase of the animal and cost of labour (Ajala, 2003). The use of non-conventional feedstuffs to bring down this

cost was suggested as a possible short-term method to improve poultry production in the study area. This emerging fact makes it necessary to investigate the effect of the inclusion of ingredients with established nutriceuticals on the health status of chickens via the study of the animals' blood profile. The study was also aimed at determining the effect of genotypes on blood parameters as these are pointers to the health status of the animal.

Blood parametes will also help to predict the safety limits of MOSM and the comparism of the effects on the genotypes of chickens.

3.1.1. Objectives:

- To determine the chemical composition of *Moringa oleifera* seed meal obtained from the Nigerian Guinea Savannah specifically, Kaduna Metropolis.
- To determine the performance of different genotypes of chickens to the varying levels of MOSM inclusion.
- To determine the genotype effect, interaction and diet effect (MOSM) on the performance of local and exotic chickens.
- To determine the effect of genotype and MOSM inclusion on the modulation of body parameters.
- To determine the level of prediction of late body weight using linear body parameters of birds at early life as it relates to genotypes and MOSM inclusion.

3.1.2. Justification:

This is necessary because geographical locations, soil type and nutrient content of the soil of *Moringa oleifera* may have effect on the nutrient/chemical composition of the seed and this may produce different animal responses and may influence different genotypes in diverse ways.

Good experimental practices demand that the composition of MOSM available in the area and used in the present study should be determined prior to the animal study and there was no record of such before the

commencement of the experiment. This will make the recommended outcome of this study relevant. Also, the chemical composition were determined to raise the level of confidence on the inclusion of MOSM. The data obtained from this analysis was used to compare the data obtained in literature to ascertain the level of nutrients to be incorporated in the diets of the local and exotic chickens.

The primary objective of poultry production is to produce egg and meat in a cost effective and sustainable manner. From a nutritional perspective, protein is perhaps the most critical nutrient, because it is the most expensive to provide in the diet and because gut capacity may limit the ability of the animal to consume sufficient quantities to achieve their full genetic potential for growth. Feeding birds a balanced diet is an essential part of the poultry profit equation. Since feed accounts for 55 to 75 % of total costs, feeding and nutrition can make a huge difference to poultry farm profits. It therefore becomes imperative to investigate the effect of the utilization of unconventional feedstuffs like *Moringa oleifera* seed meal in local and broiler chickens feed formulation. MOSM holds some promise because of its potential as a high energy, protein and vitamin source for poultry feeding with the possibility of replacing some quantity of maize and soybean that are the chief sources of energy in livestock production in Nigeria.

Blood is an important index of physiological and pathological changes in an organism, and it is also used in assessing the body's ability to respond to haematological upset. Harper *et al* (1979) established that blood constituents are affected by feed components: assessment of blood metabolites therefore provides a mileu for chemical studies of animal nutritional and health status. Blood contains a myriad of metabolites and other constituents, which provide a valuable medium for clinical investigation and assessment of the nutritional status of animals. It is generally believed that *Moringa oleifera* is well tolerated, and has low levels of toxicity in humans and rodents, but there are no clear-cut systematic studies of the biological response of chickens when fed graded levels. This knowledge is important for sensitive assessment of levels of safe use, and specifically the nature of its effect (beneficial, neutral or harmful) as measured at the level of haematology. Also, because environment affects the level of antinutrients in crops, the *Moringa oleifera* produced in the Nigerian Guinea Savannah. Hence, the use of blood parameters in nutritional assessment of chickens fed MOSM diets.

The influence of the inclusion of MOSM on serum proteins, chemical components, enzyme activities, and some selected organs of local and broiler chickens were investigated in this trial. Serum biochemical parameters in nutritional assessment help in the determination of the health status of the animal as well as the efficiency of the nutrients utilization. Organ morphology also predicts the health implication of feeding the birds with MOSM diets.Reports on the effects of MOSM on these parameters in livestock are presently scanty, and therefore required to increase the confidence of use of MOSM at appropriate levels in diet formulation.

3.2. Materials and Methods

3.2.1 Sources of MOSM

The plant material, *Moringa oleifera*, was sourced from Kaduna metropolis. The seeds of Moringa were ground.

3.2.2 Chemical composition determination for MOSM

The ground samples were taken to the laboratory for proximate analysis using the analytical methods of A.O.A.C. (1990). The anti-nutritional properties of the *Moringa oleifera* seed meal were determined. Phenolics and tannin composition were determined from a 200 mg sample extracted with 10 ml 70% acetone in water bath maintained at 130 cycles per second for 90 minutes (Makkar, 2000) to let phenolics present in plant materials dissolve to liquid phase. Then centrifuged at 3 000 revolutions for 20 minutes at 4°C to recover phenolics and tannins in the supernatant. The collected supernatant was used for various assays. Total extractable phenolics was assayed calorimetrically by Folin-Ciocalteau assay (Jolkumen-Tiito, 1985). Folin-Ciocalteu assay coupled with tannin binding agent, polyvinyl polypyrolidone was used to estimate total extractable tannins gravimetrically (Makkar *et al*., 1993).

3.2.3. Experimental Site

The experiment was carried out at the Livestock Farm Section of the Federal College of Animal Health and Production Technology, Moore Plantation, Ibadan. The city has coordinates of 70 24' 7.0632'' N and 30 55'

2.3268'' E. It has a tropical wet and dry climate with a lengthy wet season and relatively constant temperature throughout the course of the years. The mean total rainfall for Ibadan is 1420.06 mm while the mean maximum temperature is 26.46^{0}C, minimum 21.42^{0}C and the relative humidity is 74.55%.

3.2.4. Experimental Birds

The eggs of Yoruba Ecotype Nigeria Local Chickens were sourced from Ayede and Erunmu environments in Egbeda Local Government, Oyo State and hatched at Bronco Hatchery, Oluyole Extension, Ibadan.
Marshall broilers were sourced from Obasanjo Farm, Ibadan, Oyo State.

3.2.5. Experimental animals, diets and design

Ninety-six broiler chicks and ninety-six local chicks of mixed sexes were randomly allotted to four dietary treatments containing graded levels of MOSM: 0% (diet 1), 5% (diet 2), 10% (diet 3), 15% (diet 4) fed independently to the broiler chicks and local chickens such that each treatment comprised of three replicates of eight birds each in a 2 x 4 factorial design. The experimental animals were weighed before feeding at the commencement of the feeding trial and every 7 days thereafter until the end.

The experimental birds were housed individually in digestibility crates. A digestibility trial where feed intake and faecal output were recorded for 7 days then followed. The diets were thoroughly mixed to obtain uniform composition before being offered to the birds. The same quantities of feed were offered to the experimental birds each day of the digestibility trial and refused feed were measured for individual bird. Faecal outputs were also measured. A delay of 24 hours was allowed before the first collection of faeces and this collection continued 24 hours after the last day of feeding. Samples of experimental diets and oven-dried faeces was analysed for proximate composition for the determination of apparent digestibility coefficients (ADC), apparent digestible nutrients (ADN), total digestible nutrients (TDN) and feed conversion efficiency (FCE) using the appropriate formulae (McDonald *et al.,* 1999).

3.2.6. Housing and Management of the Experimental Birds

The experimental birds were all subjected to the same management and treatment throughout the duration of the experiment. The only exception was the different dietary feed offered to the experimental birds. Routine medication, vaccination and management were also carried out.

Table 3.1. COMPOSITION OF EXPERIMENTAL DIET

INGREDIENT	**A**	**B**	**C**	**D**
Maize	37	37	37	37
Full Fat Soybean	20	20	20	20
GNC	18	15.5	13	10.5
***Moringa oleifera* Seed Meal (MOSM)**	0	5	10	15
Fish Meal	3	3	3	3
Wheat Offal	10	10	10	10
Corn Bran	8	5.5	3	0.5
Bone Meal	1.5	1.5	1.5	1.5
Oyster Shell	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25

Total	100	100	100	100
%CP (calculated)	23.40	23.28	23.15	23.03
ME (Kcal/Kg) – Calculated	**2,851.54**	**2,867.64**	**2,883.74**	**2,899.84**

3.2.7. Body Weights and Morphometric characteristics of chickens fed MOSM diet

The morphometric indices were determined to enable the comparative studies between the exotic and the local chickens.

Linear body measurements - shank length (SL), thigh length (TL), keel length (KL), body girth (BG), wing length (WL) and body length (BL) were determined.

Body Weight (BW): Body weight in gram (g) was recorded to two decimal places weekly using a sensitive weighing scale.

Body Length (BL): This was taken as the nostril to the pygostyle distance measured in centimeter (cm) units when a tape is stretched from the bird's nasal opening along its stretched neck and along its back to the tip of pygostyle.

Body Girth (BG): This was measured in centimeter (cm) as the distance covered when a tape is looped round the region of the breast, care was taken to ensure that the tape was run under (rather than over) the wing.

Shank Length (SL): This was taken as the distance in centimeter (cm) between the foot pad and the hock joint, measured by use of a set of Venier Calliper.

Thigh Length (TL): This was taken as distance between the tip of the tarsus and the ball joint, measured in centimeter (cm) by use of a tape measure.

Keel Length (KL): This was taken as the distance between the cranial and caudal termini of the keel bone, measured in centimeter (cm) by use of a tape measure.

Wing Length (WL): This was taken as the distance from the humerus-coracoid junction to the distal tip of the phalange digits and was measured in centimeter (cm) unit using a tape measure.

Obesity or Fatness: This was estimated through Body Mass Index (BMI) as:

$$\text{BMI} = \frac{Body\ Weight\ (g)}{Body\ Length\ of\ birds\ (cm^2)}$$

3.2.8. Feed Intake, Weight Gain and Feed Conversion Ratio

During the feeding trials, feed intake and weight changes were monitored for individual bird for the determination of weight gain and feed conversion ratio (FCR) of the chickens on each diet. The experimental birds were sacrificed at the end of the feeding trial for dressing percentage determination.

Growth performance: Data were collected on the initial weight of birds, final weight, feed intake and weight gain.

Feed intake (g) = feed offered (g) - left over (g)

Weight gain (g) = final body weight (g) - initial weight (g)

Feed conversion ratio (FCR): This was obtained by dividing the quantity of feed consumed by the weight gained. All the values obtained for the feed intake and live weight gain were converted to grams and these values represent the amount of feed (g) needed to grow one gram of body weight.

$$\text{FCR} = \frac{\text{Total Feed consumed (g)}}{\text{Weight gain (g)}}$$

3.2.9 Apparent digestibility coefficients and total digestible nutrients

The values obtained in digestibility trials were referred to as apparent digestibility coefficients to distinguish them from the coefficients of true digestibility since the excretion in faeces of substances not arising directly

from the diets offered the experimental animal leads to underestimation of the proportion of the diet actually absorbed by the animal. Total digestible nutrients (TDN) content of feeds provide a measure of the energy value of such feeds and is calculated as the combined weight in 100 kg of the feed, of digestible crude protein, and digestible carbohydrates (crude fibre and nitrogen free extractives), plus 2.25 times the weight of digestible ether extract.

3.2.10. Collection of blood samples

To elucidate the effect of MOSM on haematological responses by the birds, blood was sampled at week eight from the experimental birds. Blood samples were collected from the wing web of the birds (that were previously confined without feed for 12 hours but were allowed access to water) into sterilized glass tubes containing EDTA (ethylene diamine tetra acetic acid) for immediate analysis of haematological parameters in the laboratory.

Blood samples were also collected for the serum biochemical analyses from the wing web of the experimental birds at age 8 weeks into a set of sterilized dry glass tubes containing no traces of anticoagulant for serum separation within 45 minutes of blood collection. Serum samples thus collected was analysed for chemical components; sodium (Na^+), potassium (K^+), chloride (Cl^-)y7, bicarbonate (HCO_3^-), calcium (Ca^{2+}), phosphorus, urea, creatinine, cholesterol, serum proteins; total serum protein, albumin and globulin, and serum enzyme activities; alanine transaminase (ALT), aspartate transaminase (AST) and alkaline Phosphatase (ALP).

3.2.11. Haematology

The packed cell volume (PCV) and haemoglobin (Hb) were determined using the micro haematocrit method and cyanmethehemoglobin method respectively as described by Mitruka and Rawnsley (1977). Erythrocyte count (RBC) and Leukocyte count (WBC) were determined using the improved Neubauer haemocytometer after the appropriate dilution (Schalm *et al*., 1975). Differential leukocyte counts were determined by scanning Giemsa's stained slides in the classic manner (Schalm *et al*., 1975). Blood indices and corpuscular

constants; mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined using the appropriate formulae (Jain, 1986).

3.2.12. Serum biochemistry

Na^+ and K^+ were determined using flame photometry, and Cl^-, HCO_3^-, Ca^+ and P were determined according to AOAC (1990). Urea was determined by urease method and creatinine by Folin-Wu filtrate methods as described by Toro and Ackermann (1975). Total serum protein was determined using the Buiret method as described by Reinhold (1953) while albumin was determined using the BCG (Bromocresol green) method as described by Peters, Biamonte and Doumas (1982). Alanine transaminase (ALT), aspartate transaminase (AST), and alkaline phosphatase (ALP) activities was determined using spectrophotometric methods as described by Rej and Hoder (1983), Hoder and Rej (1983) and McComb, Bowers and Rosen (1983), respectively.

3.2.13. Organs' absolute and relative weight determination

After the experimental birds were slaughtered, the carcasses were then immediately cut open and the liver, kidneys, lungs, spleen, heart, adrenal and thyroid glands were dissected out, blotted free of blood and adhering membranes and weighed. The organ weights were converted into relative weights by the simple formula:

$$\text{Relative organ weight} = \frac{\text{Fresh organ weight x 100}}{\text{Live weight}}$$

3.3. Statistical Analysis

3.3.1. Mean Count and Standard Errors of Means

Least squares means and standard error values for each treatment group were determined by the use of Microsoft Office Excel 2007 (Microsoft Corp.) and all data from this study were further subjected to a two-way analysis of variance for the effect of breed and treatment and their interactions. Means were separated by the use of Duncan New Multiple Range Test at 95% confidence interval.

3.3.2. Test of Significance

Data were analyzed using the General Linear Model procedure of the SPSS Version 22 (IBM, SPSS). The appropriate statistical model used was:

$Yijk = \mu + Gi + Mj + (GM)ijk + \varepsilon ijk$

Yijk = observation on kth population, of ith genotype and jth MOSM inclusion

μ = common mean

Gi = fixed effect of genotype (i=2)

Mj =fixed effect of MOSM inclusion (j=4)

(GM)ijk = interaction effect of genotype and MOSM

εijk = error term associated with each record (normally, independently and identically distributed with zero mean and constant variance)

3.4. Results

The chemical composition of MOSM obtained from Kaduna Metropolis in the Nigerian Guinea Savannah showed that it had a crude protein of 21.67% and energy of 14.39MJ/Kg. The values for crude fat, crude fibre and total ash were 36.5%, 17.88% and 3.67% respectively. The seed also contained some phytochemicals – phenols, tannin, alkaloid, saponin, cyanide and glucosinolate.

Table 3.2: Proximate Analysis of MOSM

PARAMETERS	
Dry Matter (%)	89.05±1.73
Crude Protein (%)	21.67±1.73
Crude Fat (%)	36.50±1.73
Crude Fibre (%)	17.88±1.73
Total Ash (%)	3.67±1.73
NFE (%)	53.13±1.73
Energy (MJ/Kg)	14.39±1.73
Phenols (%)	0.11±1.73
Tannin (%)	0.09±1.73
Alkaloid (%)	1.16±1.73

Saponin (%)	0.90±1.73
Cyanide (Mg/Kg)	22.67±1.73
Glucosinolate (0%)	0.07±1.73

*NFE: Nitrogen Free Extracts

3.5. Effect of MOSM and Genotype on Body Weight

3.5.1. Effect of Genotype on body weight: A significant difference ($p < 0.05$) was observed in the body weight throughout the experiment with the Marshall broilers being heavier than the local chickens throughout the experiment (Table 3.3)

3.5.2. Effects of MOSM on Body weight: In week 1, birds fed 10% and 15% MOSM had significantly ($p<0.05$) lower body weight than the control but 5% did not differ significantly ($p>0.05$) from the control (0% MOSM).

In week 2, the weights of the birds decreased significantly ($p<0.05$) with increasing levels of MOSM. However, in the late starter and throughout the finisher period, birds fed 5% MOSM was not significantly ($p>0.05$) different from the control (0% MOSM) but birds fed 10 and 15% MOSM had significantly lower body weight ($p<0.05$) – 0% MOSM=5% MOSM>10% MOSM (Table 3.3).

3.5.3. Genotype X Diet (Graded levels of MOSM) interactive effect on Bodyweight. The interaction of genotype and diet had significant effect on bodyweight as shown in Table 3.3.

3.5.4. Effect of Graded levels of MOSM on Body weight within genotype (breed). Within the Yoruba Nigeria Local chickens, in weeks 2, 3 and 4, 0%, 5% and 10% MOSM was not significantly different but

15% MOSM was significantly ($p<0.05$) . MOSM did not significantly ($p>0.05$) affect the body weight at weeks 7 and 8. This implies that MOSM had no effect on the later stage of YENLC after 6 weeks (Table 3.4).

However, within the broiler genotype treatment group at the end of the starter phase, birds fed 5% MOSM was not significantly different ($p>0.05$) from the control (0% MOSM) but with significantly higher ($p<0.05$) body weight compared to birds fed 10% MOSM and 15% MOSM. From week 6 to week 8, birds fed 5% MOSM was similar to the control (0% MOSM) but were significantly ($p<0.05$) heavier than birds fed 10% and 15% MOSM (Table 3.4).

Table 3.3. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Weights of Chicks

	Genotype		Diet				
Body Weight (g)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	GXD
Week 0	23.00 ± 0.38	33.85 ± 0.34 *	29.29 ± 0.93[a]	28.17 ± 0.94 [a]	28.02 ± 0.94 [a]	28.23 ± 0.95 [a]	
Week 1	29.60 ± 0.40	62.89 ± 0.33 *	47.56 ± 2.36 [c]	47.08 ± 2.60 [bc]	46.00 ± 2.47 [b]	44.33 ± 2.47 [a]	*
Week 2	48.62 ± 0.86	101.51 ± 2.24 *	90.33 ± 5.52 [d]	84.88 ± 5.43 [c]	75.95 ± 3.66 [b]	60.77 ± 3.24 [a]	*
Week 3	74.10 ± 1.23	156.58 ± 4.28 *	138.24 ± 8.23 [c]	141.79 ± 11.03 [c]	112.46 ± 5.54 [b]	88.92 ± 4.14 [a]	*
Week 4	103.16 ± 1.62	238.20 ± 7.23 *	211.37 ± 14.15 [c]	209.42 ± 17.69 [c]	162.92 ± 8.99 [b]	128.62 ± 6.32 [a]	*
Week 5	145.13 ± 1.94	339.44 ± 11.71 *	300.39 ± 21.47 [c]	307.55 ± 26.5 [c]	233.71 ± 12.89 [b]	171.72 ± 7.94[a]	*
Week 6	214.00 ± 2.31	473.59 ± 14.18 *	396.48 ± 28.54[c]	417.27 ± 32.39 [c]	364.50 ± 20.44 [b]	259.21 ± 10.88 [a]	*
Week 7	238.74 ± 2.53	638.55 ± 21.60 *	525.04 ± 44.69 [c]	542.30 ± 48.58 [c]	445.97 ± 31.35 [b]	326.13 ± 17.78[a]	*
Week 8	296.03 ± 5.82	771.35 ± 27.01 *	640.52 ± 55.83 [c]	646.30 ± 57.08 [c]	541.95 ± 35.07 [b]	404.63 ± 27.29[a]	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x ± sem (n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

Table 3.4. Body Weights of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler				
Body Weight (g)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**LEVEL OF SIGNIFICANCE**
Week 0	24.71 ± 1.01^{b}	22.79 ± 0.65^{ab}	22.25 ± 0.61^{a}	22.25 ± 0.65^{a}	33.88 ± 0.81^{c}	33.54 ± 0.83^{c}	33.79 ± 0.58^{c}	34.21 ± 0.43^{c}	*
Week 1	31.92 ± 0.98^{b}	29.50 ± 0.68^{a}	29.33 ± 0.65^{a}	27.67 ± 0.61^{a}	63.21 ± 0.71^{d}	64.67 ± 0.57^{d}	62.67 ± 0.54^{cd}	61 ± 0.61^{c}	*
Week 2	53.64 ± 1.06^{b}	51.67 ± 0.87^{b}	49.50 ± 0.74^{b}	38.00 ± 0.80^{a}	123.96 ± 3.27^{f}	112.56 ± 1.47^{e}	94.35 ± 1.18^{d}	76.61 ± 1.64^{c}	*
Week 3	82.45 ± 1.60^{b}	79.33 ± 0.93^{b}	72.31 ± 0.94^{b}	59.50 ± 0.81^{a}	189.38 ± 3.74^{c}	193.83 ± 8.28^{c}	140.39 ± 1.70^{c}	109.39 ± 1.90^{c}	*
Week 4	114.82 ± 1.31^{b}	108.27 ± 1.67^{b}	102.13 ± 1.40^{b}	83.38 ± 1.79^{a}	299.88 ± 6.07^{e}	293.72 ± 12.59^{e}	207.14 ± 4.87^{d}	160.09 ± 2.40^{c}	*
Week 5	156.73 ± 1.44^{b}	151.6 ± 1.66b	149.56 ± 1.37^{b}	118.69 ± 1.54^{a}	432.08 ± 12.24^{e}	437.5 ± 15.34^{f}	294.91 ± 9.01^{d}	208.61 ± 5.72^{c}	*
Week 6	215.36 ± 1.82^{ab}	231.33 ± 1.57^{b}	225.06 ± 1.91^{ab}	184.81 ± 2.84^{a}	562.5 ± 23.37^{e}	572.22 ± 22.61^{e}	465.91 ± 10.32^{d}	310.96 ± 6.79^{c}	*
Week 7	232.59 ± 2.32^{a}	268.73 ± 1.46^{a}	236.5 ± 2.31^{a}	221.31 ± 5.21^{a}	793.13 ± 30.84^{d}	770.28 ± 37.63^{d}	598.32 ± 19.05^{c}	402.36 ± 17.06^{b}	*
Week 8	289.68 ± 7.32^{a}	328.53 ± 7.26^{a}	323 ± 13.44^{a}	247.31 ± 7.50^{a}	962.13 ± 47.34^{d}	911.11 ± 46.19^{d}	701.18 ± 27.94^{c}	519.05 ± 27.51^{b}	*

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x ± sem (n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal diet*

3.6. Effect of MOSM and Genotype on Shank Length

3.6.1. Effect of Genotype on shank length: A significant difference ($p < 0.05$) was observed in the shank length throughout the experiment with the Marshall broilers having higher shank lengths than the local chickens throughout the experiment (Table 3.6).

*3.6.2. Effects of Diet (graded levels of MOSM) on shank length: W*hen all birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced the shank length. From week 6 to week 8, shank lengths decreased significantly ($p<0.05$) across the group but birds fed 10% MOSM was significantly similar ($p>0.05$) to birds fed 15% MOSM (Table 3.6).

3.6.3. Genotype X Diet (Graded levels of MOSM) factor interactive effect on Shank length. The interaction of genotype and diet had significant effect ($p<0.05$) on shank lengths as shown in Table 3.6.

3.6.4. Effect of Graded levels of MOSM on Shank length within genotype (breed). From week 4 to week 8, YENLC fed 0% MOSM, 5% MOSM and 10% MOSM were significantly not different ($p>0.05$) and longer than the shank lengths of birds fed 15% MOSM.

Also, for the Marshall broilers, at week 4, birds in the control (0% MOSM), 5% MOSM and 15% MOSM were similar ($P>0.0.5$). Birds fed 10% MOSM had the least shank lengths. From weeks 6 to week 8, birds fed 0% MOSM and 5% MOSM were similar ($p>0.05$) but the values decreased significantly ($p<0.05$) from 10% MOSM to 15% MOSM (Table 3.5).

Table 3.5. Shank Lengths of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler				
Shank Length (cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**SIGNIFICANCE**
Week 1	2.60±0.08 (24)^{c}	2.44±0.1 (24)^{bc}	2.27±0.08 (24)^{b}	1.98±0.08 (24)^{a}	2.92±0.07 (24)^{d}	2.91 ± 0.06 (24)^{d}	2.47±0.07(24)^{bc}	2.38± 0.08 (24)^{bc}	*
Week 2	3.57±0.08 (22)^{c}	3.41±0.08 (15)^{bc}	3.23±0.12 (16)^{b}	2.74±0.11 (16)^{a}	4.04±0.11 (24)^{d}	4.18 ± 0.1 (18)^{d}	3.93±0.09 (23)^{d}	4 ± 0.1 (23)^{d}	*
Weeek 3	4.02±0.08 (22)^{c}	3.8±0.07 (15)^{bc}	3.65±0.1 (16)^{ab}	3.39±0.14 (16)^{a}	5.08±0.09 (24)^{de}	5.17 ± 0.14 (18)^{e}	4.77±0.14 (23)^{d}	4.89±0.07 (23)^{de}	*
Week 4	4.80±0.14 (22)^{b}	4.71±0.15 (15)^{b}	4.72±0.19 (16)^{b}	4.13±0.18 (16)^{a}	6.34±0.17 (24)^{d}	6.72 ± 0.13 (18)^{d}	5.86 ± 0.2 (22)^{c}	6.36±0.1 (23)^{d}	-
Week 5	5.46±0.14 (22)^{b}	5.54±0.17 (15)^{b}	5.58±0.2 (16)^{b}	4.74±0.18 (16)^{a}	7.49±0.18 (24)^{de}	7.80 ± 0.18 (18)^{e}	6.73± 0.24 (22)^{c}	7.15±0.1 (23)^{cd}	*
Week 6	6.24±0.12 (22)^{b}	6.25±0.21 (15)^{b}	6.38±0.2 (16)^{b}	5.58±0.19 (16)^{a}	9.38±0.13 (24)^{d}	8.88 ± 0.24 (18)^{d}	8.16 ±0.21 (22)^{c}	8.37±0.14 (23)^{c}	-
Week 7	7±0.10 (22)^{b}	6.81±0.20 (15)^{ab}	6.87±0.20 (16)^{ab}	6.47±0.21 (16)^{a}	11.10±0.16 (24)^{e}	10.05 ± 0.2 (18)^{d}	8.98± 0.17 (22)^{c}	8.91±0.09 (22)^{c}	*
Week 8	7.94±0.17 (22)^{b}	7.85±0.3 (15)^{b}	7.83±0.24 (16)^{b}	7.20±0.21 (16)^{a}	12.25±0.18 (24)^{e}	11.91±0.17 (18)^{e}	10.64±0.2 (22)^{d}	10.00±0.17 (22)^{c}	*

a, b, c,d means with different superscript within genotype are significantly different
Group mean, standard error and number count of samples (x ± sem (n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.6. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Shank Lengths of Chicks

	Genotype		Diet				
Shank Length (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**G x D**
Week 1	2.32 ± 0.05 (96)	2.67 ± 0.04 (96) *	2.76 ± 0.06 (48) c	2.68 ± 0.07 (48) c	2.37 ± 0.06 (48) b	2.18 ± 0.06 (48) a	*
Week 2	3.26 ± 0.06 (69)	4.03 ± 0.05 (88) *	3.82 ± 0.08 (46) b	3.83 ± 0.09 (33) b	3.64 ± 0.09 (39) ab	3.48 ± 0.13 (39) a	*
Week 3	3.74 ± 0.06 (69)	4.97 ± 0.06 (88) *	4.57 ± 0.1 (46) b	4.55 ± 0.14 (33) b	4.31 ± 0.13 (39) a	4.27 ± 0.14 (39) a	*
Week 4	4.61 ± 0.09 (69)	6.30 ± 0.08 (87) *	5.60 ± 0.16 (46) ab	5.81 ± 0.20 (33) b	5.38 ± 0.17 (38) a	5.44 ± 0.2 (39) a	-
Week 5	5.34 ± 0.09 (69)	7.27 ± 0.10 (87) *	6.52 ± 0.19 (46) ab	6.77 ± 0.23 (33) b	6.24 ± 0.18 (38) a	6.16 ± 0.21 (39) a	*
Week 6	6.12 ± 0.09 (69)	8.70 ± 0.10 (87) *	7.87 ± 0.25 (46) c	7.69 ± 0.28 (33) bc	7.41 ± 0.2 (38) ab	7.23 ± 0.25 (39) a	-
Week 7	6.81 ± 0.09 (69)	9.78 ± 0.13 (86) *	9.14 ± 0.32 (46) c	8.58 ± 0.32 (33) b	8.09 ± 0.21 (38) a	7.88 ± 0.22 (38) a	*
Week 8	7.72 ± 0.12 (69)	11.19 ± 0.13 (86) *	10.18 ± 0.34 (46) c	10.07 ± 0.39 (33) c	9.46 ± 0.27 (38) b	8.82 ± 0.26 (38) a	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.7. Effect of MOSM and Genotype on Thigh Length

3.7.1. Effect of Graded levels of MOSM on Thigh length within genotype (breed). For thigh lengths, there were significant differences ($p<0.05$) for all the 8 weeks for the YENLC and the Marshall broilers as shown in Table 3.7.

At week 1, YENLC fed 15% MOSM were not significantly different from the Marshall broilers fed 5% MOSM. Also, the YENLC fed 5% and 10% MOSM were not significantly different from the Marshall broilers fed 0%, 5%, 10% and 15% MOSM while the YENLC fed 0% and 5% MOSM were not significantly different from the Marshall broilers fed 0% and 10% MOSM. For both genotypes, birds fed 0% MOSM had the highest thigh lengths (2.05±0.05 and 1.93±0.05 for YENLC and Marshall broilers respectively) while the least thigh length was recorded for YENLC fed 15% MOSM and Marshall broilers fed 5% MOSM (1.65±0.07 and 1.78±0.08 for the YENLC and Marshall broiler chickens respectively)

Also, for the YENLC at week 4, thigh legths of the birds fed 0% MOSM, 5% MOSM and 10% MOSM were not significantly different ($p>0.05$) while birds fed 10% MOSM and 15% MOSM were also similar ($p>0.05$)

For the Marshall broilers, all the birds in the 4 dietary groups were not significantly different ($p>0.05$) but at weeks 7 and 8, birds fed 5% MOSM were similar to birds in the control (0% MOSM) and significantly ($p<0.05$) had higher thigh lengths when compared to birds fed 10% MOSM and 15% MOSM.

3.7.2. Effect of Genotype on thigh length. A significant difference ($p < 0.05$) was observed in the shank length throughout the experiment with the Marshall broilers having higher thigh lengths than the local chickens throughout the experiment (Table 3.8).

*3.7.3. Effects of Diet (graded levels of MOSM) on thigh length: W*hen all birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced the thigh length. From week 7 to week 8, birds fed 5% MOSM was similar to birds in the control (0% MOSM) and significantly higher than the thigh lengths of birds fed 10% MOSM and 15% MOSM (Table 3.8).

3.7.4. Genotype X Diet (Graded levels of MOSM) interactive effect on thigh length. The interaction of genotype and diet had significant effect on thigh lengths from week 1 to week 8 as shown in Table 3.8.

Table 3.7. Thigh Lengths of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Thigh Length (cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Week 1	2.05±0.05 (24)^{c}	1.96 ±0.03 (24)^{bc}	1.85 ± 0.05 (24)^{b}	1.65± 0.07 (24)^{a}	1.93±0.05 (24)^{bc}	1.78 ±0.08 (24)^{ab}	1.88 ±0.05 (24)^{bc}	1.84 ± 0.06 (24)^{b}
Week 2	2.68±0.05 (22)^{bc}	2.83 ±0.07 (15)^{cd}	2.52 ± 0.08 (16)^{b}	2.10 ± 0.09 (16)^{a}	2.79±0.07 (24)^{cd}	2.71 ±0.15 (18)^{bc}	2.88 ±0.06 (23)^{cd}	2.97 ± 0.07 (23)^{d}
Week 3	3.20± 0.08 (22)^{b}	3.41 ± 0.1 (15)^{b}	3.15 ± 0.09 (16)^{b}	2.78± 0.14 (16)^{a}	3.92± 0.15 (24)^{c}	4.19 ± 0.16 (18)^{c}	4.01 ± 0.1 (23)^{c}	4.09 ± 0.11 (23)^{c}
Week 4	4.48 ±0.18 (22)^{b}	4.45 ± 0.17 (15)^{b}	4.06 ±0.16 (16)^{ab}	3.59± 0.16 (16)^{a}	5.55± 0.27 (24)^{c}	5.96 ± 0.25 (18)^{c}	5.51 ± 0.19 (22)^{c}	5.33 ± 0.14 (23)^{c}
Week 5	5.23± 0.14 (22)^{b}	5.21 ± 0.15 (15)^{b}	4.81 ± 0.21 (16)^{b}	4.21± 0.18 (16)^{a}	6.75±0.19 (24)^{cd}	6.95 ± 0.26 (18)^{d}	6.32 ± 0.2 (22)^{c}	6.55 ± 0.14 (23)^{cd}
Week 6	5.67 ± 0.14 (22)	5.80 ± 0.13 (15)	5.78 ± 0.2 (16)	5.05± 0.26 (16)	8.41 ± 0.23 (24)	8.50 ± 0.33 (18)	7.36 ± 0.24 (22)	7.89 ± 0.18 (23)
Week 7	6.49 ±0.13 (22)^{b}	6.95 ± 0.18 (15)^{b}	6.36 ± 0.18 (16)^{b}	5.66± 0.21 (16)^{a}	9.61± 0.26 (24)^{d}	9.51 ±0.21 (18)^{d}	8.10 ± 0.21 (22)^{c}	8.07 ± 0.16 (22)^{c}
Week 8	7.51 ±0.24 (22)^{b}	7.77 ± 0.27 (15)^{b}	7.14 ±0.18 (16)^{ab}	6.54± 0.26 (16)^{a}	11.10±0.23(24)^{d}	11.03±0.25 (18)^{d}	9.63 ± 0.29 (22)^{c}	9.63 ± 0.18 (22)^{c}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.8. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Thigh Lengths of Chicks

	Genotype		Diet				
Thigh Length (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Week 1	1.88 ± 0.03 (96)	1.96 ± 0.03 (96) *	1.99 ± 0.03 (48) c	1.87 ± 0.04 (48) b	1.87 ± 0.04 (48) b	1.74 ± 0.05 (48) a	*
Week 2	2.54 ± 0.05 (69)	2.84 ± 0.04 (88) *	2.74 ± 0.05 (46) a	2.76 ± 0.09 (33) a	2.73 ± 0.06 (39) a	2.62 ± 0.09 (39) a	*
Week 3	3.14 ± 0.06 (69)	4.04 ± 0.06 (88) *	3.57 ± 0.1 (46) a	3.84 ± 0.12 (33) b	3.66 ± 0.1 (39) ab	3.55 ± 0.13 (39) a	*
Week 4	4.17 ± 0.1 (69)	5.57 ± 0.11 (87) *	5.04 ± 0.18 (46) ab	5.27 ± 0.21 (33) b	4.9 ± 0.17 (38) ab	4.61 ± 0.17 (39) a	*
Week 5	4.89 ± 0.1 (69)	6.63 ± 0.1 (87) *	6.03 ± 0.16 (46) bc	6.16 ± 0.22 (33) c	5.68 ± 0.19 (38) ab	5.59 ± 0.22 (39) a	*
Week 6	5.58 ± 0.1 (69)	8.03 ± 0.13 (87) *	7.1 ± 0.24 (46) ab	7.27 ± 0.3 (33) b	6.69 ± 0.2 (38) a	6.73 ± 0.27 (39) a	
Week 7	6.36 ± 0.1 (69)	8.81 ± 0.13 (86) *	8.12 ± 0.28 (46) b	8.35 ± 0.26 (33) b	7.37 ± 0.2 (38) a	7.06 ± 0.23 (38) a	*
Week 8	7.25 ± 0.13 (69)	10.33 ± 0.14 (86) *	9.38 ± 0.31 (46) b	9.55 ± 0.34 (33) b	8.58 ± 0.27 (38) a	8.33 ± 0.29 (38) a	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x ± sem (n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.8. Effect of MOSM and Genotype on Keel Length

3.8.1. Effect of Keel length on Graded levels of MOSM within genotype (breed). A significant difference ($P < 0.05$) was observed in the keel length throughout the experiment with the Marshall broilers having longer keel lengths than the local chickens from week 2 to week 8 (Table 3.9).

For YENLC at the end of week 4, birds fed 0%, 5% and 10% MOSM were not significantly different ($p>0.05$) while birds fed 15% MOSM had significantly least keel length ($p<0.05$).

For Marshall broilers at week 4, birds fed 5% MOSM had significantly higher ($p<0.05$) higher keel length than the control (0% MOSM) while birds fed 10% and 15% MOSM were similar ($p>0.05$) . However, at week 8, birds fed 5% and 10% MOSM were similar ($p>0.05$) and significantly lower ($p<0.05$) than the control (0% MOSM) but birds fed 15% MOSM had the least keel length.

3.8.2. Effect of Genotype on keel length. A significant difference ($P < 0.05$) was observed in the keel length throughout the experiment with the Marshall broilers having higher keel lengths than the local chickens throughout the experiment (Table 3.10).

*3.8.3. Effects of Diet (graded levels of MOSM) on keel length: W*hen all the birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced the keel length. At week 4, birds in the control (0% MOSM) were similar to the ones fed 10% MOSM and significantly lower than the keel lengths of birds fed 5% MOSM. However, from week 7 to week 8, keel lengths of birds fed 5% and 10% MOSM were significantly lower ($p<0.05$) than the control (0% MOSM) but the least keel length was observed with birds fed 15% MOSM (Table 3.10).

3.8.4. Genotype X Diet (Graded levels of MOSM) factor interactive effect on keel length. The interaction of genotype and diet had significant effect on keel lengths. However, Marshall broilers had significantly higher ($p<0.05$) keel lengths than the YENLC as shown in Table 3.10.

Table 3.9. Keel Lengths of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Keel Length(cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Week 1	2.90 ± 0.07 (24)^{c}	2.56 ± 0.12 (24)^{b}	2.48 ± 0.09 (24)^{b}	2.1 ± 0.09 (24)^{a}	3.09 ± 0.06 (24)^{c}	2.39 ± 0.08 (24)^{b}	2.50 ± 0.08 (24)^{b}	2.60 ± 0.08 (24)^{b}
Week 2	3.65 ±0.08 (22)^{bc}	3.69 ±0.14 (15)^{bc}	3.46 ± 0.11 (16)^{b}	2.96 ±0.15 (16)^{a}	4.09 ±0.14 (24)^{de}	3.77±0.09(18)^{bcd}	3.86±0.11(23)^{cde}	4.12 ± 0.07 (23)^{e}
Week 3	3.94 ± 0.06 (22)^{b}	3.89 ± 0.14 (15)^{b}	3.71 ± 0.12 (16)^{b}	3.3 ± 0.1 (16)^{a}	4.77 ± 0.12 (24)^{d}	4.64± 0.08 (18)^{cd}	4.38 ± 0.07 (23)^{c}	4.55 ±0.07 (23)^{cd}
Week 4	4.48 ± 0.08 (22)^{b}	4.56 ± 0.1 (15)^{b}	4.34 ± 0.09 (16)^{b}	3.76 ±0.09 (16)^{a}	5.75 ± 0.19 (24)^{d}	6.27 ± 0.14 (18)^{e}	5.37 ± 0.14 (22)^{c}	5.21 ± 0.08 (23)^{c}
Week 5	5.28 ± 0.14 (22)^{c}	5.15 ±0.15 (15)^{bc}	4.87 ± 0.11 (16)^{b}	4.36 ± 0.10 (16)^{a}	6.44 ± 0.15 (24)^{e}	6.97 ± 0.11 (18)^{f}	6.20 ± 0.12 (22)^{e}	5.85 ± 0.07 (23)^{d}
Week 6	5.88 ± 0.12 (22)^{c}	5.54 ±0.16 (15)^{bc}	5.43 ± 0.15 (16)^{b}	4.94 ±0.11 (16)^{a}	7.49 ± 0.11 (24)^{e}	7.64 ± 0.10 (18)^{e}	7.05 ± 0.12 (22)^{d}	6.80 ± 0.11 (23)^{d}
Week 7	6.51 ± 0.11 (22)^{b}	6.35 ±0.15 (15)^{ab}	6.00 ± 0.15 (16)^{a}	5.89 ± 0.10 (16)^{a}	9.03 ± 0.18 (24)^{e}	8.32 ± 0.17 (18)^{d}	8.09 ± 0.18 (22)^{d}	7.42 ± 0.15 (22)^{c}
Week 8	7.28 ± 0.11 (22)^{c}	7.05 ±0.16 (15)^{bc}	6.59 ± 0.13 (16)^{ab}	6.40 ± 0.14 (16)^{a}	10.46±0.21 (24)^{f}	9.79 ± 0.21 (18)^{e}	9.55 ± 0.21 (22)^{e}	8.94 ± 0.17 (22)^{d}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.10. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Keel Lengths of Chicks

	Genotype		Diet				
Keel Length (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**G X D**
Week 1	2.51 ± 0.05 (96)	2.64 ± 0.05 (96) *	2.99 ± 0.05 (48) b	2.48 ± 0.07 (48) a	2.49 ± 0.06 (48) a	2.35 ± 0.07 (48) a	*
Week 2	3.46 ± 0.07 (69)	3.97 ± 0.06 (88) *	3.88 ± 0.09 (46) a	3.73 ± 0.08 (33) a	3.7 ± 0.09 (39) a	3.64 ± 0.12 (39) a	*
Week 3	3.73 ± 0.06 (69)	4.58 ± 0.05 (88) *	4.37 ± 0.09 (46) b	4.3 ± 0.10 (33) b	4.11 ± 0.08 (39) a	4.04 ± 0.12 (39) a	*
Week 4	4.30 ± 0.06 (69)	5.62 ± 0.08 (87) *	5.15 ± 0.14 (46) b	5.49 ± 0.18 (33) c	4.93 ± 0.12 (38) b	4.62 ± 0.13 (39) a	*
Week 5	4.94 ± 0.08 (69)	6.33 ± 0.07 (87) *	5.88 ± 0.14 (46) b	6.14 ± 0.18 (33) c	5.64 ± 0.14 (38) b	5.24 ± 0.13 (39) a	*
Week 6	5.48 ± 0.08 (69)	7.23 ± 0.07 (87) *	6.72 ± 0.14 (46) c	6.69 ± 0.21 (33) c	6.37 ± 0.16 (38) b	6.04 ± 0.17 (39) a	*
Week 7	6.21 ± 0.07 (69)	8.23 ± 0.11 (86) *	7.83 ± 0.22 (46) c	7.42 ± 0.21 (33) b	7.21 ± 0.21 (38) b	6.78 ± 0.16 (38) a	*
Week 8	6.87 ± 0.08 (69)	9.70 ± 0.12 (86) *	8.94 ± 0.27 (46) c	8.55 ± 0.27 (33) b	8.31 ± 0.27 (38) b	7.87 ± 0.24 (38) a	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.9. Effect of MOSM and Genotype on Body Girth

3.9.1. Effect of Graded levels of MOSM on Body girth within genotype (breed). A significant difference ($p<0.05$) was observed in the body girths throughout the experiment with the Marshall broilers having longer body girths than the local chickens. At week 4, body girths of Marshall broilers fed 5% MOSM had significantly higher ($p<0.05$) value when compared with the control (0% MOSM) but the value decreased significantly ($p<0.05$) from 10% MOSM to 15% MOSM. Also, at week 8, birds fed 5% MOSM was similar to the control (0% MOSM) but significantly ($p<0.05$) higher than birds fed 10% MOSM and 15% MOSM (Table 3.11).

In YENLC at 4, birds fed 10% MOSM had significantly higher ($p<0.05$) body girth while the effect of MOSM at 0%, 5% and 15% were similar ($p>0.05$). At week 8, birds in the control (0% MOSM) was similar to birds fed 5% MOSM, also, birds fed 5% MOSM and 10% MOSM were also similar ($p>0.05$). Birds fed 15% MOSM had significantly ($p<0.05$) the least body girth compared to other levels of MOSM inclusion (Table 3.11).

3.9.2. Effect of Genotype on body girth. A significant difference ($P < 0.05$) was observed in the body girth throughout the experiment with the Marshall broilers having higher body girths than the local chickens throughout the experiment (Table 3.12).

*3.9.3. Effects of Diet (graded levels of MOSM) on body girth: W*hen all the birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced the body girths. At week 4, birds fed 0% MOSM and 10% MOSM were not significantly different ($p>0.05$) while birds fed 5% MOSM had significantly higher ($p<0.05$) body girths and birds fed 15% MOSM had the least body girths significantly ($p<0.05$) (Table 3.12).

At weeks 7 and 8, birds fed 5% MOSM compared well with the control as there was no significant difference ($p>0.05$) between the two but the values of body girths decreased significantly ($p<0.05$) from 10% MOSM to 15% MOSM.

3.9.4. Genotype X Diet (Graded levels of MOSM) factor interactive effect on body girth. The interaction of genotype and diet had significant effect on bodygirths. However, Marshall broilers had significantly higher ($p<0.05$) body girths than the YENLC as shown in Table 3.12.

Table 3.11. Body Girths of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Body Girth(cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Week 1	10.18 ± 0.15 (24)^{c}	9.66 ± 0.16 (24)^{b}	9.06 ± 0.18 (24)^{a}	9.35 ± 0.14 (24)^{ab}	12.98 ± 0.14 (24)^{f}	12.69 ± 0.13 (24)^{f}	12.18 ± 0.11 (24)^{e}	11.55±0.16 (24)^{d}
Week 2	11.3 ± 0.12 (22)^{b}	10.97±0.21 (15)^{ab}	10.67±0.17 (16)^{a}	10.47 ± 0.14 (16)^{a}	15.84 ± 0.25 (24)^{e}	15.52 ± 0.23 (18)^{e}	14.58 ± 0.18 (23)^{d}	13.09±0.15 (23)^{c}
Week 3	12.17 ±0.13 (22)^{b}	11.62±0.21 (15)^{ab}	11.47±0.12 (16)^{a}	11.01 ± 0.13 (16)^{a}	17.58 ± 0.37 (24)^{e}	17.61 ± 0.26 (18)^{e}	16.28 ± 0.18 (23)^{d}	14.33±0.12 (23)^{c}
Week 4	13.14 ±0.23 (22)^{a}	13.25 ± 0.27 (15)^{a}	14.5 ± 0.21 (16)^{b}	12.58 ± 0.21 (16)^{a}	19.58 ± 0.48 (24)^{e}	21.72 ± 0.77 (18)^{f}	18.4 ± 0.45 (22)^{d}	15.94±0.17 (23)^{c}
Week 5	15.07 ±0.31 (22)^{a}	15.26±0.28 (15)^{ab}	16.31 ± 0.3 (16)^{b}	14.13 ± 0.25 (16)^{a}	21.98 ±0.37 (24)^{d}	23.82 ± 0.75 (18)^{e}	20.23 ± 0.42 (22)^{c}	19.37±0.24 (23)^{c}
Week 6	17.56 ±0.26 (22)^{b}	17.46± 0.44 (15)^{b}	17.93±0.37 (16)^{b}	15.48 ± 0.38 (16)^{a}	24.55 ±0.29 (24)^{d}	25.81 ± 0.48 (18)^{e}	22.65 ± 0.33 (22)^{c}	22.26±0.46 (23)^{c}
Week 7	19.00±0.29 (22)^{ab}	18.89±0.39 (15)^{ab}	19.39±0.44 (16)^{b}	17.52 ± 0.45 (16)^{a}	30.12 ± 0.71 (24)^{e}	30.77 ± 0.81 (18)^{e}	25.86 ± 0.56 (22)^{d}	23.25±0.35 (22)^{c}
Week 8	22.01± 0.38 (22)^{c}	20.70±0.44 (15)^{bc}	20.41±0.46 (16)^{b}	18.75 ± 0.52 (16)^{a}	32.68 ± 0.53 (24)^{f}	32.96 ± 0.63 (18)^{f}	28.52 ± 0.40 (22)^{e}	25.80±0.36 (22)^{d}

a, b, c means with different superscript within genotype are significantly different
Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.12. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Body Girths of Chicks

	Genotype		Diet				
Body Girth (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**G X D**
Week 1	9.56 ± 0.09 (96)	12.35 ± 0.09 (96) *	11.58 ± 0.23 (48) c	11.18 ± 0.24 (48) b	10.62 ± 0.25 (48) a	10.45 ± 0.19 (48) a	*
Week 2	10.89 ± 0.09 (69)	14.73 ± 0.15 (88) *	13.67 ± 0.37 (46) c	13.45 ± 0.43 (33) c	12.97 ± 0.34 (39) b	12.02 ± 0.23 (39) a	*
Week 3	11.62 ± 0.09 (69)	16.4 ± 0.19 (88) *	14.99 ± 0.45 (46) c	14.89 ± 0.55 (33) c	14.31 ± 0.4 (39) b	12.97 ± 0.28 (39) a	*
Week 4	13.35 ± 0.14 (69)	18.76 ± 0.32 (87) *	16.5 ± 0.55 (46) b	17.87 ± 0.86 (33) c	16.76 ± 0.42 (38) b	14.56 ± 0.30 (39) a	*
Week 5	15.18 ± 0.17 (69)	21.23 ± 0.28 (87) *	18.67 ± 0.57 (46) b	19.93 ± 0.87 (33) c	18.58 ± 0.42 (38) b	17.22 ± 0.45 (39) a	*
Week 6	17.14 ± 0.21 (69)	23.72 ± 0.24 (87) *	21.21 ± 0.55 (46) b	22.01 ± 0.8 (33) c	20.66 ± 0.45 (38) b	19.47 ± 0.62 (39) a	*
Week 7	18.72 ± 0.21 (69)	27.41 ± 0.45 (86) *	24.8 ± 0.92 (46) c	25.37 ± 1.15 (33) c	23.14 ± 0.64 (38) b	20.84 ± 0.54 (38) a	*
Week 8	20.60 ± 0.26 (69)	29.91 ± 0.40 (86) *	27.58 ± 0.86 (46) c	27.39 ± 1.15 (33) c	25.10 ± 0.72 (38) b	22.83 ± 0.64 (38) a	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.10. Effect of MOSM and Genotype on Wing Length

3.10.1. Effect of Wing length on Graded levels of MOSM within genotype (breed). As shown in Table 3.13, a significant difference ($p < 0.05$) was observed in wing lengths throughout the experiment with the Marshall broilers having longer wings than the local chickens from week 2.

At week 4 in Marshall broilers, birds fed 5% MOSM had significantly higher ($p<0.05$) wing lengths compared to the other groups (0% MOSM, 10% MOSM and 15% MOSM) that were similar ($p>0.05$) . At weeks 7 and 8, birds fed 5% MOSM and the control (0% MOSM) were similar ($p>0.05$) but significantly different ($p<0.05$) from 10% MOSM and 15% MOSM but birds fed 10% MOSM and 15% MOSM were similar ($p>0.05$) to the control.

For the YENLC at week 2, birds fed 10% MOSM had significantly higher ($p<0.05$) wing lengths compared to the other levels of inclusion that were similar ($p>0.05$) , however, at week 8, there was no significant difference ($p>0.05$) between birds fed 10% MOSM and 15% MOSM.

3.10.2. Effect of Genotype on wing length. A significant difference ($p < 0.05$) was observed in the wing length throughout the experiment with the Marshall broilers having higher wing lengths than the local chickens throughout the experiment (Table 3.14).

*3.10.3. Effects of Diet (graded levels of MOSM) on wing lenghts: W*hen all the birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced the body girths. From week 4 to week 8, birds fed 5% MOSM had significantly ($p<0.05$) the highest wing lengths while the control (0% MOSM), 10% MOSM and 15% MOSM were similar ($p>0.05$) (Table 3.14).

3.10.4. Genotype X Diet (Graded levels of MOSM) factor interactive effect on wing length. The interaction of genotype and diet had significant effect on wing lengths. However, Marshall broilers had significantly higher ($p<0.05$) wing lengths than the YENLC as shown in Table 3.14.

Table 3.13. Wing Length of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Wing Length(cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Week 1	2.59 ± 0.08 (24)^{b}	2.52 ±0.09 (24)^{b}	2.47 ± 0.09 (24)^{b}	2.17 ± 0.06 (24)^{a}	2.98 ±0.05 (24)^{c}	2.88 ±0.08 (24)^{c}	2.24 ± 0.06 (24)^{a}	2.58 ± 0.09 (24)^{b}
Week 2	3.47 ± 0.09 (22)^{b}	3.69±0.14 (15)^{bcd}	3.51 ± 0.12 (16)^{b}	2.95 ± 0.12 (16)^{a}	4.04± 0.11 (24)^{e}	3.99±0.08 (18)^{de}	3.61 ± 0.10 (23)^{bc}	3.91±0.09 (23)^{cde}
Week 3	3.95 ± 0.06 (22)^{b}	3.96 ± 0.11 (15)^{b}	3.92 ± 0.09 (16)^{b}	3.44 ± 0.13 (16)^{a}	5.15± 0.14 (24)^{d}	5.51± 0.11 (18)^{e}	4.73 ± 0.11 (23)^{c}	4.68 ± 0.13 (23)^{c}
Week 4	4.97± 0.19 (22)^{ab}	5.06± 0.25 (15)^{ab}	5.23 ± 0.25 (16)^{c}	4.48 ± 0.24 (16)^{a}	6.62± 0.27 (24)^{c}	7.46± 0.21 (18)^{d}	6.23 ± 0.21 (22)^{c}	6.41 ± 0.14 (23)^{c}
Week 5	5.67 ± 0.16 (22)^{b}	5.71 ± 0.25 (15)^{b}	5.91 ± 0.22 (16)^{b}	4.97 ± 0.21 (16)^{a}	7.33± 0.23 (24)^{c}	8.58± 0.23 (18)^{d}	7.06 ± 0.2 (22)^{c}	7.13 ± 0.11 (23)^{c}
Week 6	6.39 ± 0.16 (22)^{b}	6.38 ± 0.24 (15)^{b}	6.56 ± 0.22 (16)^{b}	5.54 ± 0.17 (16)^{a}	8.40 ± 0.29 (24)^{c}	9.44± 0.23 (18)^{d}	7.75 ± 0.21 (22)^{c}	8.33 ± 0.22 (23)^{c}
Week 7	7.03 ±0.14 (22)^{ab}	7.77 ± 0.33 (15)^{b}	7.13 ±0.24 (16)^{ab}	6.95 ± 0.43 (16)^{a}	9.40± 0.29 (24)^{cd}	10.13±0.22 (18)^{d}	8.96 ± 0.2 (22)^{c}	8.82 ± 0.24 (22)^{c}
Week 8	8.00 ± 0.15 (22)^{b}	8.41 ± 0.31 (15)^{b}	7.62± 0.23 (16)^{ab}	7.18 ± 0.22 (16)^{a}	11.17±0.33(24)^{cd}	11.68±0.27 (18)^{d}	10.61 ±0.31 (22)^{c}	10.64 ± 0.2 (22)^{c}

a, b, c means with different superscript within genotype are significantly different
Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.14. Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Wing Lengths of Chicks

	Genotype		Diet				
Wing Length (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Week 1	2.44 ± 0.04 (96)	2.67 ± 0.05 (96) *	2.78 ± 0.06 (48) b	2.7 ± 0.07 (48) b	2.36 ± 0.05 (48) a	2.37 ± 0.06 (48) a	*
Week 2	3.4 ± 0.07 (69)	3.88 ± 0.05 (88) *	3.77 ± 0.08 (46) Bc	3.85 ± 0.08 (33) c	3.57 ± 0.08 (39) ab	3.52 ± 0.11 (39) a	*
Week 3	3.83 ± 0.05 (69)	4.99 ± 0.07 (88) *	4.58 ± 0.12 (46) bc	4.8 ± 0.16 (33) c	4.4 ± 0.1 (39) ab	4.17 ± 0.13 (39) a	*
Week 4	4.93 ± 0.12 (69)	6.64 ± 0.12 (87) *	5.83 ± 0.21 (46) a	6.37 ± 0.27 (33) b	5.81 ± 0.18 (38) a	5.62 ± 0.2 (39) a	*
Week 5	5.57 ± 0.11 (69)	7.46 ± 0.12 (87) *	6.53 ± 0.19 (46) a	7.27 ± 0.3 (33) b	6.58 ± 0.17 (38) a	6.24 ± 0.2 (39) a	*
Week 6	6.23 ± 0.11 (69)	8.43 ± 0.13 (87) *	7.44 ± 0.22 (46) a	8.05 ± 0.31 (33) b	7.25 ± 0.18 (38) a	7.19 ± 0.27 (39) a	*
Week 7	7.2 ± 0.14 (69)	9.29 ± 0.13 (86) *	8.27 ± 0.24 (46) a	9.06 ± 0.28 (33) b	8.19 ± 0.21 (38) a	8.03 ± 0.27 (38) a	*
Week 8	7.81 ± 0.12 (69)	11.00 ± 0.15 (86) *	9.65 ± 0.30 (46) a	10.19 ± 0.35 (33) b	9.35 ± 0.31 (38) a	9.18 ± 0.32 (38) a	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.11. Effect of MOSM and Genotype on Body Length

3.11.1. Effect of Body length on Graded levels of MOSM within genotype (breed). A significant difference ($p<0.05$) was observed in body lengths throughout the experiment with the Marshall broilers having longer lengths than the local chickens. From week 3 to week 8, Marshall broilers' body lengths decreased significantly ($p<0.05$) as the level of MOSM from 10% MOSM inclusion increased while there was no significant difference ($p>0.05$) between the body length of birds in the control (0% MOSM) and 5% MOSM. YENLC body lengths were statistically similar ($p>0.05$) at weeks 4, 7 and 8 (Table 3.15).

3.11.2. Effect of Genotype on body length: A significant difference ($p < 0.05$) was observed in body lengths throughout the experiment with the Marshall broilers having higher body lengths than the local chickens (Table 3.16).

*3.11.3. Effects of MOSM on body lengths: W*hen all the birds were considered irrespective of genotype, variations in the levels of MOSM offered significantly ($p<0.05$) influenced body lengths. From week 4 to week 8, body lengths of birds fed 0% MOSM and 5% MOSM were similar ($p>0.05$) and significantly higher ($p<0.05$) than the body lengths of birds fed 10% MOSM and 15% MOSM which were also similar ($p>0.05$) (Table 3.16).

3.11.4. Genotype X Diet (Graded levels of MOSM) factor interactive effect on body length. The interaction of genotype and diet had significant effect on body lengths. However, Marshall broilers had significantly higher ($p<0.05$) body lengths than the YENLC as shown in Table 3.16.

Table 3.15. Body Length of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler				
Body Length (cm)	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	
Week1	9.08 ± 0.18 (24)^{ab}	9.28 ± 0.22 (24)^{b}	9.13 ±0.16 (24)^{ab}	8.62 ± 0.22 (24)^{a}	11.24 ± 0.1 (24)^{d}	11.1 ± 0.15 (24)^{d}	11.21 ± 0.17 (24)^{d}	10.07 ± 0.20 (24)^{c}	*
Week 2	10.46 ± 0.16 (22)^{a}	10.62 ± 0.24 (15)^{a}	10.53± 0.21 (16)^{a}	10.03 ± 0.22 (16)^{a}	13.84 ± 0.17 (24)^{d}	13.33 ± 0.23 (18)^{d}	12.56 ± 0.22 (23)^{c}	11.86 ± 0.20(23)^{b}	*
Week 3	11.65± 0.18 (22)^{ab}	11.75± 0.19 (15)^{ab}	11.98± 0.27 (16)^{b}	11.18 ± 0.2 (16)^{a}	16.25 ± 0.24 (24)^{d}	15.96 ± 0.21 (18)^{d}	14.68 ± 0.13 (23)^{c}	14.10± 0.24 (23)^{c}	*
Week 4	14.51 ± 0.47 (22)^{a}	14.11 ± 0.46 (15)^{a}	14.84± 0.34 (16)^{a}	13.57 ± 0.32 (16)^{a}	21.03 ± 0.50 (24)^{c}	20.73 ± 0.40 (18)^{c}	17.81± 0.47 (22)b	17.51 ± 0.30 (23)^{b}	*
Week 5	16.92 ±0.49 (22)^{ab}	16.17± 0.43 (15)^{ab}	17.41± 0.41 (16)^{b}	15.38 ± 0.31 (16)^{a}	24.05 ± 0.39 (24)^{d}	23.47 ± 0.28 (18)^{d}	19.60 ± 0.55 (22)^{c}	20.44 ±0.34 (23)^{c}	*
Week 6	18.80± 0.45 (22)^{ab}	18.15 ± 0.4 (15)^{a}	20.29± 0.67 (16)^{b}	17.31 ± 0.57 (16)^{a}	27.48 ± 0.45 (24)^{d}	26.63 ± 0.42 (18)^{d}	22.19 ± 0.56 (22)^{c}	23.67± 0.62 (23)^{c}	*
Week 7	20.61 ± 0.55 (22)^{a}	20.80 ± 0.64 (15)^{a}	21.59± 0.44 (16)^{a}	20.41 ± 0.72 (16)^{a}	31.62 ± 0.65 (24)^{c}	30.53 ± 0.60 (18)^{c}	25.62 ± 0.72 (22)^{b}	24.64±0.42 (22)^{b}	*
Week 8	23.42 ± 0.60 (22)^{a}	23.57 ± 0.65 (15)^{a}	23.66± 0.63 (16)^{a}	23.31 ± 0.64 (16)^{a}	33.91 ± 0.62 (24)^{c}	33.26 ± 0.42 (18)^{c}	28.00 ± 0.65 (22)^{b}	28.57±0.55 (22)^{b}	*

a, b, c means with different superscript are significantly different
Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.16 Effects of Genotypes, Dietary MOSM Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Wing Lengths of Chicks

	Genotype		Diet				
Body Length (cm)	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Week1	9.03 ± 0.1 (96)	10.9 ± 0.09 (96) *	10.16 ± 0.19 (48) b	10.19 ± 0.19 (48) b	10.17 ± 0.19 (48) b	9.34 ± 0.18 (48) a	*
Week 2	10.41 ± 0.1 (69)	12.88 ± 0.13 (88) *	12.22 ± 0.28 (46) c	12.10 ± 0.29 (33) bc	11.73 ± 0.22 (39) b	11.11 ± 0.21 (39) a	*
Week 3	11.64 ± 0.11 (69)	15.22 ± 0.14 (88) *	14.05 ± 0.37 (46) c	14.05 ± 0.4 (33) c	13.57 ± 0.25 (39) b	12.91 ± 0.28 (39) a	*
Week 4	14.28 ± 0.21 (69)	19.22 ± 0.27 (87) *	17.91 ± 0.59 (46) b	17.72 ± 0.65 (33) b	16.56 ± 0.39 (38) a	15.89 ± 0.38 (39) a	*
Week 5	16.51 ± 0.23 (69)	21.85 ± 0.29 (87) *	20.64 ± 0.61 (46) b	20.15 ± 0.69 (33) b	18.67 ± 0.4 (38) a	18.36 ± 0.47 (39) a	*
Week 6	18.66 ± 0.29 (69)	24.96 ± 0.35 (87) *	23.32 ± 0.72 (46) b	22.78 ± 0.8 (33) b	21.39 ± 0.45 (38) a	21.06 ± 0.67 (39) a	*
Week 7	20.83 ± 0.3 (69)	28.07 ± 0.45 (86) *	26.35 ± 0.92 (46) b	26.11 ± 0.96 (33) b	23.92 ± 0.56 (38) a	22.86 ± 0.51 (38) a	*
Week 8	23.48 ± 0.31 (69)	30.9 ± 0.41 (86) *	28.89 ± 0.89 (46) b	28.86 ± 0.93 (33) b	26.17 ± 0.58 (38) a	26.36 ± 0.59 (38) a	*

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.*12.* Effect of Graded Levels of MOSM on Weight Gain and Feed Conversion Ratio

3.12.1. Effect of Genotype on Weight Gain and Feed Conversion Ratio. For the 8 weeks feeding trial, there was significant difference ($p<0.05$) between the effect of genotype. Marshall broilers gained ($p<0.05$) significantly more weight than the Yoruba Ecotype Nigerian Local Chickens. Also, Marshall broilers had significantly ($p<0.05$) better feed conversion ratio compared to the YENLC but there was no significant difference at weeks 3 and 5 (Table 3.15).

3.12.2. Interaction between Genotype and Diet: There was no significant interaction ($p>0.05$) in weight gain and FCR at week 1 but from week 2 to week 8, there was significant interaction ($p<0.05$) between the genotype and MOSM inclusion (Table 3.15).

3.12.3. Effect of Graded Levels of MOSM on Weight Gain and Feed Conversion Ratio irrespective of Genotype: At week 4, there was no significant difference in the weight gain of birds fed 0% MOSM and 5% MOSM however the value decreased significantly ($p<0.05$) from 10% MOSM to 15% MOSM. At week 8, there was no significant difference ($p>0.05$) between birds in the control (0% MOSM) and birds fed 5% MOSM and 10% MOSM. Also, there was no significant difference ($p>0.05$) among birds fed various levels of inclusion of MOSM but 15%inclusion of MOSM was significantly different ($p<0.05$) from the control (0% MOSM) (Table 3.15).

For FCR at week 4, there was no significant difference among the birds fed graded levels of MOSM but the FCR of birds fed graded levels of MOSM was significantly better ($p<0.05$) than the control (0% MOSM). At week 8, birds fed 0% MOSM, 5% MOSM and 10% MOSM were not significantly different ($p>0.05$). However, there was no significant difference between the control (0% MOSM) and 15% MOSM. However feeding lower levels of MOSM (5% and 10%) had the best feed conversion ratio when compared with 15% MOSM.

3.12.4. Effects of Graded Levels of MOSM on Weight Gain and Feed Conversion Ratio of Yoruba Nigeria Local Chickens and Marshall Broilers: From Table 3.14, for weight gains in YENLC, there was no significant difference in weight gain while birds fed 10% MOSM had significantly ($p<0.05$) best FCR when compared to the control (0% MOSM) and other levels of MOSM inclusion. At week 8, there was no significant difference ($p>0.05$) for weight gains while for FCR there was no significant difference between the control (0% MOSM and 5% MOSM and 10% MOSM), thus, birds fed 15% had the worst FCR ($p>0.05$)

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In Marshall broilers at week 4, there was no significant difference ($p>0.05$) between the control and all other levels of MOSM inclusion for weight gain however, birds fed 5% MOSM was significantly different ($p<0.05$) from birds fed 10% and 15% MOSM.

For FCR in Marshall broilers, there was no significant difference ($p>0.05$) between the control and all other levels of MOSM inclusion for FCR, however, birds fed 5% MOSM was significantly different ($p<0.05$) from birds fed 10% and 15% MOSM. At week 8, there was no significant difference ($p>0.05$) in FCR.

Table 3.17. Weekly Weight Gains and FCR of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Trait	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Weight Gain 1	7.21 ± 0.59^{d}	6.71 ± 0.46^{c}	7.08 ± 0.36^{b}	5.42 ± 0.47^{bc}	29.33 ± 1.14^{a}	31.13 ± 0.59^{a}	28.88 ± 0.54^{a}	26.79 ± 0.66^{a}
FCR 1	13.12 ± 1.57	10.15 ± 0.76	7.71 ± 0.45	9.64 ± 0.88	3.91 ± 0.13	3.15 ± 0.06	3.1 ± 0.08	2.82 ± 0.07
Weight Gain 2	17.25 ± 2.99^{bc}	2.79 ± 4.99^{ab}	3.67 ± 4.80^{ab}	-2.33 ± 3.84^{a}	60.75 ± 3.04^{d}	19.75 ± 10.34^{c}	27.75 ± 4.06^{c}	12.42 ± 3.46^{abc}
FCR 2	5.25 ± 0.42^{a}	3.26 ± 0.57^{a}	4.13 ± 0.65^{a}	9.47 ± 1.87^{b}	3.05 ± 0.09^{a}	3.31 ± 0.42^{a}	5.06 ± 0.26^{a}	10.65 ± 1.04^{b}
Weight Gain 3	26.42 ± 2.22^{bc}	17.29 ± 2.82^{ab}	15.21 ± 2.31^{ab}	14.33 ± 2.17^{a}	65.42 ± 1.96^{e}	60.96 ± 9.41^{e}	44.13 ± 2.36^{d}	31.42 ± 1.88^{c}
FCR 3	7.56 ± 0.59^{d}	4.66 ± 0.20^{b}	3.16 ± 0.13^{a}	4.27 ± 0.21^{b}	4.19 ± 0.13^{b}	3.24 ± 0.16^{a}	4.94 ± 0.18^{b}	6.55 ± 0.34^{c}
Weight Gain 4	29.67 ± 2.49^{a}	18.08 ± 3.01^{a}	19.88 ± 3.00^{a}	15.92 ± 2.52^{a}	110.50 ± 4.22^{a}	74.92 ± 9.94^{c}	55.33 ± 9.89^{b}	48.58 ± 3.02^{b}
FCR 4	6.78 ± 0.52^{e}	5.14 ± 0.29^{d}	3.11 ± 0.15^{ab}	4.39 ± 0.34^{cd}	2.92 ± 0.07^{ab}	2.52 ± 0.12^{a}	3.76 ± 0.24^{bc}	3.75 ± 0.15^{bc}
Weight Gain 5	38.42 ± 2.73^{ab}	27.08 ± 4.40^{ab}	31.63 ± 4.70^{ab}	23.54 ± 3.58^{a}	132.21 ± 9.44^{e}	107.83 ± 13.68^{d}	80.46 ± 6.56^{c}	46.5 ± 6.01^{b}
FCR 5	6.02 ± 0.20^{a}	3.59 ± 0.06^{a}	3.09 ± 0.06^{a}	4.13 ± 0.13^{a}	2.77 ± 0.11^{a}	1.94 ± 0.07^{a}	2.95 ± 0.11^{a}	13.37 ± 4.21^{b}
Weight Gain 6	53.75 ± 3.57^{a}	49.83 ± 8.09^{a}	50.33 ± 7.47^{d}	44.08 ± 6.65^{a}	130.42 ± 12.87^{c}	101.04 ± 14.84^{b}	156.75 ± 10.63^{d}	98.08 ± 5.67^{b}
FCR 6	5.06 ± 0.12^{e}	2.27 ± 0.04^{b}	2.26 ± 0.04^{b}	2.69 ± 0.10^{c}	3.09 ± 0.17^{d}	2.17 ± 0.15^{ab}	1.66 ± 0.04^{a}	2.17 ± 0.08^{b}
Weight Gain 7	15.79 ± 1.84^{a}	23.38 ± 3.84^{a}	7.63 ± 1.45^{a}	24.33 ± 5.21^{a}	230.63 ± 21.38^{d}	148.54 ± 23.19^{c}	121.38 ± 15.11^{c}	70.83 ± 19.85^{b}
FCR 7	11.63 ± 7.61^{a}	6.76 ± 0.24^{a}	27.03 ± 6.13^{b}	10.10 ± 1.90^{a}	2.69 ± 0.28^{a}	2.04 ± 0.27^{a}	2.98 ± 0.36^{a}	3.11 ± 0.32^{a}
Weight Gain 8	52.33 ± 6.63^{ab}	37.38 ± 7.51^{a}	57.67 ± 12.44^{ab}	17.33 ± 4.02^{a}	169 ± 21.93^{d}	105.63 ± 17.08^{c}	94.29 ± 19.21^{bc}	106.96 ± 15.67^{c}
FCR 8	5.60 ± 0.84^{a}	2.73 ± 1.18^{a}	3.51 ± 0.95^{a}	11.22 ± 2.22^{b}	4.18 ± 0.66^{a}	3.67 ± 0.60^{a}	4.13 ± 1.13^{a}	3.28 ± 0.61^{a}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.18. Effects of Genotypes, Dietary *Moringa oleifera* Seed Meal (MOSM) Level and their Interaction, On Weekly Weight Gains and FCR

	Genotype		Diet				
Trait	**YENLC ALL**	**Marshall ALL**	**0% MOSM-ALL**	**5% MOSM-ALL**	**10% MOSM-ALL**	**15% MOSM-ALL**	**GXD**
Weight Gain 1(g)	6.60 ± 0.25	29.03 ± 0.41 *	18.27 ± 1.73^{ab}	18.92 ± 1.82 ^{b}	17.98 ± 1.62^{b}	16.10 ± 1.61^{a}	NS
FCR 1	10.15 ± 0.53	3.24 ± 0.06 *	8.51 ± 1.03 ^{b}	6.65 ± 0.64^{ab}	5.40 ± 0.40 ^{a}	6.23 ± 0.66^{a}	*
Weight Gain 2(g)	5.34 ± 2.21	30.17 ± 3.51 *	39.00 ± 3.81^{d}	11.27 ± 5.81 ^{c}	15.71 ± 3.57^{b}	5.04 ± 2.77^{a}	*
FCR 2	5.53 ± 0.57	5.52 ± 0.42 *	4.15 ± 0.26 ^{a}	3.29 ± 0.35 ^{a}	4.60 ± 0.35 ^{a}	10.06 ± 1.06 ^{b}	*
Weight Gain 3(g)	18.31 ± 1.28	50.48 ± 2.84 *	45.92 ± 3.20^{c}	39.13 ± 5.81 ^{d}	29.67 ± 2.67^{b}	22.88 ± 1.89 ^{a}	*
FCR 3	5.15 ± 0.29	4.81 ± 0.17 *	5.80 ± 0.38 ^{b}	3.88 ± 0.18 ^{a}	4.21 ± 0.18 ^{a}	5.62 ± 0.28^{b}	*
Weight Gain 4(g)	20.89 ± 1.46	72.33 ± 4.43 *	70.08 ± 6.37^{c}	46.50 ± 6.60 ^{c}	37.60 ± 5.73^{b}	32.25 ± 3.08 ^{a}	*
FCR 4	5.02 ± 0.26	3.28 ± 0.10 *	4.77 ± 0.38 ^{b}	3.71 ± 0.27 ^{a}	3.49 ± 0.16 ^{a}	4.02 ± 0.17^{a}	*
Weight Gain 5(g)	30.17 ± 2.01	91.75 ± 5.68 *	85.31 ± 8.39^{c}	67.46 ± 9.23 ^{c}	56.04 ± 5.35^{b}	35.02 ± 3.84 ^{a}	*
FCR 5	4.38 ± 0.16	5.44 ± 1.21 *	4.32 ± 0.27 ^{a}	2.69 ± 0.15 ^{a}	3.01 ± 0.07 ^{a}	9.58 ± 2.57^{b}	*
Weight Gain 6(g)	49.50 ± 3.30	121.57 ± 6.18 *	92.08 ± 8.66^{ab}	75.44 ± 9.16 ^{b}	103.54 ± 10.08 ^{c}	71.08 ± 5.85^{a}	*
FCR 6	3.26 ± 0.16	2.29 ± 0.08 *	4.03 ± 0.18 ^{c}	2.22 ± 0.09^{b}	1.91 ± 0.06 ^{a}	2.39 ± 0.07^{b}	*
Weight Gain 7(g)	17.78 ± 1.83	142.84 ± 11.54 *	123.21 ± 18.93 ^{b}	85.96 ± 14.78^{b}	64.50 ± 11.19^{a}	47.58 ± 10.70^{a}	*
FCR 7	13.79 ± 2.94	2.74 ± 0.16 *	6.97 ± 3.66^{ab}	4.18 ± 0.45^{a}	13.11 ± 3.20^{b}	5.98 ± 0.96^{ab}	*
Weight Gain 8(g)	41.18 ± 4.36	118.97 ± 9.64 *	110.67 ± 14.17 ^{b}	71.50 ± 10.49 ^{ab}	75.98 ± 11.63 ^{ab}	62.15 ± 10.33^{a}	*
FCR 8	5.79 ± 0.76	3.83 ± 0.39 *	4.86 ± 0.53^{ab}	3.24 ± 0.62^{a}	3.87 ± 0.76 ^{a}	6.62 ± 1.17^{b}	*

a, b, c means with different superscript are significantly different
Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*
GXD- Interaction between genotype and diet
FCR – Feed Conversion Ratio

3.13 Effect of Graded Levels of MOSM on Body Mass Index

3.13.1. Genotype factor effect on Body Mass Index: The broiler had significantly higher body mass index than the YENLC throughout the experiment (Table 3.19).

3.13.2. Diet (graded levels of MOSM) factor effect on BMI: At weeks, 7 and 8, there was no significant difference ($p>0.05$) in the BMI of birds in the control (0% MOSM), 5% MOSM and 10% MOSM but significantly different ($p<0.05$) from the BMI of birds fed 15% MOSM.

3.13.3. Genotype x Diet (graded levels of MOSM) factor interaction effect on BMI: Genotype significantly interacted with MOSM inclusion in chickens diets at week 5 to week 7.

3.13.4. BMI effect of Graded levels of MOSM within genotype (breed). In the YENLC at week 4, there was no significant difference ($p>0.05$) between the control and 5% MOSM but significantly different ($p<0.05$) from the BMI of birds fed 10% and 15% MOSM which were also similar ($p>0.05$). However, at week 8, the control was similar ($p>0.05$) to all the levels of MOSM inclusion but birds fed 5% MOSM and 10% MOSM were significantly different ($p<0.05$) different from the BMI of birds fed 15% MOSM.

For broilers at weeks 4 and 8, there was no significant difference ($p>0.05$) between the control (0% MOSM) and 5% MOSM and 10% MOSM however, birds fed 15% had significantly lowere ($p<0.05$) BMI when compared to the inclusion of MOSM from 0% to 10%.

Table 3.19: Effects of Genotype (Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers), Dietary *Moringa oleifera* Seed Meal (MOSM) Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction, On BMI.

	Genotype		Diet				Breed × Diet
BMI ($g/cm^{2)}$	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	
WK1	0.38 ± 0.01 (96)	0.54 ± 0.01 (96) *	0.45 ± 0.01 (48) ^{a}	0.45 ± 0.02 (48) ^{a}	0.43 ± 0.02 (48) ^{a}	0.51 ± 0.02 (48) ^{b}	NS
WK2	0.46 ± 0.01 (69)	0.62 ± 0.01 (88) *	0.58 ± 0.02 (46) ^{b}	0.56 ± 0.02 (33) ^{b}	0.55 ± 0.02 (39) ^{b}	0.49 ± 0.02 (39) ^{a}	NS
WK3	0.55 ± 0.01 (69)	0.67 ± 0.01 (88) *	0.67 ± 0.02 (46) ^{c}	0.68 ± 0.03 (33) ^{c}	0.6 ± 0.02 (39) ^{b}	0.53 ± 0.02 (39) ^{a}	NS
WK4	0.52 ± 0.02 (69)	0.65 ± 0.02 (87) *	0.64 ± 0.02 (46) ^{b}	0.63 ± 0.03 (33) ^{b}	0.59 ± 0.03 (38) ^{b}	0.50 ± 0.02 (39) ^{a}	NS
WK5	0.55 ± 0.01 (69)	0.71 ± 0.02 (87) *	0.67 ± 0.03 (46) ^{b}	0.71 ± 0.03 (33) ^{b}	0.67 ± 0.03 (38) ^{b}	0.51 ± 0.02 (39) ^{a}	*
WK6	0.64 ± 0.02 (69)	0.78 ± 0.03 (87) *	0.69 ± 0.02 (46)b	0.77 ± 0.03 (33) ^{bc}	0.81 ± 0.04 (38) ^{c}	0.61 ± 0.03 (39) ^{a}	*
WK7	0.57 ± 0.02 (69)	0.81 ± 0.02 (86) *	0.69 ± 0.03 (46) ^{ab}	0.74 ± 0.03 (33) ^{b}	0.76 ± 0.04 (38) ^{b}	0.63 ± 0.03 (38) ^{a}	*
WK8	0.55 ± 0.02 (69)	0.81 ± 0.02 (86) *	0.70 ± 0.03 (46) ^{b}	0.73 ± 0.04 (33) ^{b}	0.78 ± 0.04 (38) ^{b}	0.58 ± 0.03 (38) ^{a}	NS

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.20. BMI of Yoruba Ecotype Nigerian Local Chickens and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM) From Hatch to 8 Weeks Age.

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
BMI ($g/cm^{2)}$	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
WK1	0.40 ± 0.02 (24) ^{a}	0.36 ± 0.03 (24) ^{a}	0.36 ± 0.02 (24) ^{a}	0.39 ± 0.02 (24) ^{a}	0.50 ± 0.01 (24) ^{b}	0.53 ± 0.01 (24) ^{b}	0.51 ± 0.02 (24) ^{b}	0.62 ± 0.03 (24) ^{c}
WK2	0.50 ± 0.02 (22) ^{bc}	0.47 ± 0.02 (15) ^{b}	0.46 ± 0.02 (16) ^{b}	0.39 ± 0.02 (16) ^{a}	0.66 ± 0.03 (24) ^{e}	0.64 ± 0.02 (18) ^{e}	0.61 ±0.02 (23) ^{de}	0.56± 0.03 (23) ^{cd}
WK3	0.62± 0.02 (22) ^{cd}	0.58 ± 0.02(15) ^{bc}	0.52 ±0.03 (16) ^{ab}	0.48 ± 0.02 (16) ^{a}	0.73 ± 0.03 (24) ^{e}	0.77 ± 0.04 (18) ^{e}	0.65 ± 0.01 (23) ^{d}	0.56± 0.02 (23) ^{bc}
WK4	0.58 ± 0.03 (22) ^{b}	0.57 ± 0.03 (15) ^{b}	0.48 ± 0.02 (16) ^{a}	0.46 ± 0.02 (16) ^{a}	0.7 ± 0.03 (24) ^{c}	0.69 ± 0.03 (18) ^{c}	0.68 ± 0.03 (22) ^{c}	0.53± 0.02 (23) ^{ab}
WK5	0.57 ± 0.03 (22) ^{a}	0.60 ± 0.03 (15) ^{a}	0.51 ± 0.03 (16) ^{a}	0.51 ± 0.02 (16) ^{a}	0.76 ± 0.03 (24) ^{b}	0.80 ± 0.04 (18) ^{b}	0.80 ± 0.04 (22) ^{b}	0.51 ± 0.02 (23) ^{a}
WK6	0.63± 0.03 (22) ^{ab}	0.72 ±0.03(15) ^{bcd}	0.58 ± 0.04 (16) ^{a}	0.65 ± 0.05(16) ^{abc}	0.75 ±.0.30(24) ^{cd}	0.82 ± 0.05 (18) ^{d}	0.98 ± 0.05 (22) ^{e}	0.58 ± 0.04 (23) ^{a}
WK7	0.57± 0.03 (22) ^{ab}	0.64 ±0.04 (15) ^{bc}	0.52 ± 0.03 (16) ^{a}	0.55 ± 0.03 (16) ^{ab}	0.80 ± 0.03 (24) ^{d}	0.83 ± 0.03 (18) ^{d}	0.94 ± 0.04 (22) ^{e}	0.68 ± 0.05 (22) ^{c}
WK8	0.55± 0.03 (22) ^{ab}	0.61 ± 0.03 (15) ^{b}	0.59 ± 0.04 (16) ^{b}	0.47 ± 0.03 (16) ^{a}	0.84 ± 0.04 (24) ^{c}	0.83 ± 0.05 (18) ^{c}	0.92 ± 0.05 (22) ^{c}	0.66 ± 0.05 (22) ^{b}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

3.14. Effect of Graded Levels of MOSM on Relative Organ Weights of YENLC and Marshall Broilers

3.14.1. Genotype factor effect on Relative Organ Weights: The Marshall broilers have significant higher ($p<0.05$) values for wings, drumstick, chest, thigh and back as shown in Table 3.22.

3.14.2. Diet (graded levels of MOSM) factor effect on Relative Organ Weights: When the birds were considered irrespective of the genotype, there was no significant difference ($p>0.05$) for drumstick and chest while the inclusion of MOSM significantly influenced ($p<0.05$) relative wing, thigh and back weights. Birds in the control and 15% MOSM had significantly ($p<0.05$) highest weight for wings but while birds fed 0% MOSM and 5% MOSM had the highest weight for thigh and back.

3.14.3. Genotypes X Diet (graded levels of MOSM) factor interaction effect on Relative Organ Weights – Genotype significantly interacted ($p<0.05$) with MOSM to determine the relative organ weights as shown in Table 3.22.

3.14.4. Relative Organ Weights of birds fed Graded level of MOSM within genotype (breed): Relative weights of wings, drumstick, chest, thigh and back were significantly ($p<0.05$) influenced by the inclusion of varying levels of MOSM for both genotypes. When considered separately, in YENLC, relative weights of wings, drumstick and chest were similar ($p>0.05$) while drumstick and wing were similar ($p>0.05$) for the Marshall broilers (Table 3.21).

Table 3.21. Carcass Evaluation of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Relative Weight	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Wings (%)	0.10 ± 0.01 (6) [a]	0.05 ± 0.00 (6) [a]	0.09 ± 0.01 (6) [a]	0.10 ± 0.00 (6) [a]	0.13 ± 0.01 (6) [b]	0.07 ± 0.01 (6) [b]	0.12 ± 0.01 (6) [b]	0.12 ± 0.01 (6) [b]
Drumstick(%)	0.08 ± 0.01 (6) [a]	0.06 ± 0.00 (6) [a]	0.07 ± 0.01 (6) [a]	0.00 ± 0.05 (6) [a]	0.12 ± 0.01 (6) [b]	0.10 ± 0.01 (6) [b]	0.11± 0.01 (6) [b]	0.12 ± 0.01 (6) [b]
Chest (%)	0.10 ± 0.01 (6) [a]	0.06 ± 0.00 (6) [a]	0.08 ± 0.01 (6) [a]	0.11 ± 0.01 (6) [a]	0.14 ± 0.01 (6) [c]	0.11 ± 0.02 (6) [b]	0.12 ±0.02 (6) [bc]	0.12 ±0.01 (6) [bc]
Thigh (%)	0.09 ± 0.01 (6) [a]	0.09 ±0.01 (6) [ab]	0.08 ± 0.01 (6) [a]	0.08 ± 0.01 (6) [a]	0.13 ± 0.02 (6) [d]	0.13 ± 0.01 (6) [d]	0.10 ± 0.01 (6)[bc]	0.10 ±0.01 (6) [bc]
Back (%)	0.14 ± 0.01 (6) [a]	0.20± 0.02 (6) [bc]	0.13 ± 0.01 (6) [a]	0.13 ± 0.01 (6) [a]	0.25 ± 0.02 (6) [d]	0.27 ± 0.04 (6)[d]	0.17 ± 0.02 (6) [c]	0.15 ±0.01 (6) [bc]

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.22: Effects of Genotype (Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers), Dietary *Moringa oleifera* Seed Meal (MOSM) Level (0, 5, 10 and 15 %) and their Interaction, On Carcass Evaluation.

	Genotype		Diet				
Relative Weights	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Wings (%)	0.09 ± 0.00 (24)	0.11 ± 0.01 (24)	0.12 ± 0.01 (12) ^{c}	0.06 ± 0.01 (12) ^{a}	0.10 ± 0.01 (12)^{ab}	0.11 ± 0.01(12)^{bc}	*
Drumstick (%)	0.07 ± 0.00 (24)	0.11 ± 0.01 (24)	0.10 ± 0.01 (12) ^{a}	0.08 ± 0.01 (12) ^{a}	0.09 ± 0.01 (12) ^{a}	0.10 ± 0.01(12) ^{a}	*
Breast (%)	0.09 ± 0.01 (24)	0.12 ± 0.01(24)	0.12 ± 0.01 (12) ^{a}	0.09 ± 0.01 (12) ^{a}	0.10± 0.01 (12) ^{a}	0.11 ± 0.01 (12) ^{a}	*
Thigh (%)	0.09 ± 0.00 (24)	0.12 ± 0.01 (24)	0.11 ± 0.01 (12) ^{bc}	0.11 ± 0.01 (12) ^{c}	0.09 ± 0.01 (12) ^{ab}	0.09 ± 0.01 (12) ^{a}	*
Back (%)	0.15 ± 0.01 (24)	0.21 ± 0.02 (24)	0.19 ± 0.02 (12) ^{b}	0.24 ± 0.02 (12) ^{c}	0.15 ± 0.01 (12) ^{a}	0.14 ± 0.01(12) ^{a}	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.15. Effect of Moringa Seed Meal on Nutrients' Digestibility and Efficiency of Utilization by Two Genotypes of Chickens

3.15.1. Effect of Genotype on Digestibility Coefficients: There was no significant difference ($p>0.05$) between the digestibility coefficients of both genotypes as shown in Table 3.23.

3.15.2. Effect of Graded Levels of MOSM on Digestibility Coefficients irrespective of Genotype: From Table 3.23, it was observed that diet significantly influenced ($p<0.05$) all the digestibility coefficient parameters. There was no significant difference ($p>0.05$) among birds fed MOSM but significantly different ($p<0.05$) from the control (0% MOSM) for digestible crude fat and total digestible nutrients. For digestible crude protein, there was no significant difference ($p>0.05$) between 10% MOSM and 15% MOSM but the control (0% MOSM) had the significantly highest ($p<0.05$) value while birds fed 5% MOSM had the least value for digestible crude protein. Digestible crude fibre increased significantly ($p<0.05$) from 0% to 15% MOSM inclusion levels while digestible crude fat decreased significantly ($p<0.05$) across the group. Digestible crude fibre and total digestible nutrient increased significantly ($p<0.05$) as the level of MOSM increased. Nitrogen free extracts increased significantly from 0% to 5% MOSM inclusion levels. Digestible total ash increased significantly from 0% to 5% MOSM inclusion levels but 0% MOSM was similar ($p>0.05$) to 10% MOSM while 5% MOSM was also similar ($p>0.05$) to 15% MOSM.

3.15.3. Interaction between genotype and diet: There was significant interactions ($p<0.05$) in all the digestibility coefficient parameters between the genotype and MOSM inclusion as shown in Table 3.23.

3.15.4. Effect of Graded Levels of MOSM on Digestibility Coefficients of Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers: From Table 3.24 for both genotypes considered, the control (0% MOSM) had significantly ($p<0.05$) higher digestible crude protein than birds fed graded levels of MOSM. This implied that birds fed graded levels of MOSM retained more crude protein than the control group but birds fed 5% MOSM retained crude protein most for both genotypes.

For YENLC, the control (0% MOSM) had significantly higher ($p<0.05$) digestible crude fat than those fed on MOSM. However, birds fed 15% MOSM retained crude fat most. Also, for the Marshall broilers, the values for the digestibility coefficients of crude fat decreased significantly ($p<0.05$) as the level of MOSM increased.

For digestible crude fibre for both genotypes, birds fed the control diet (0% MOSM) had significantly lower ($p<0.05$) values than birds fed MOSM. This implied that the birds in the control diet retained crude fibre most.

For both genotypes, the control had better retention of NFE while birds fed 5% MOSM lost NFE the most. However, for TDN, among the YENLC, there was no significant difference ($p>0.05$) while among the Marshall broilers, birds fed graded levels of MOSM had significantly better ($p<0.05$) TDN retention than the control (0% MOSM).

Table 3.23. Effects of Genotypes, Dietary *Moringa oleifera* Seed Meal (MOSM) Level, and their Interaction, On Weekly Digestibility Coefficients

	Genotype		Diet				
	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GxD**
CP (%)	0.35 ± 0.01	0.35 ± 0.00	0.38 ± 0.10^{c}	0.32 ± 0.00^{a}	0.36 ± 0.00^{b}	0.35 ± 0.00^{b}	*
CFat (%)	0.48 ± 0.00	0.51 ± 0.02	0.58 ± 0.02^{b}	0.48 ± 0.01^{a}	0.48 ± 0.01^{a}	0.45 ± 0.01^{a}	*
CF (%)	0.70 ± 0.00	0.70 ± 0.00	0.69 ± 0.00^{a}	0.70 ± 0.00^{b}	0.71 ± 0.00^{c}	0.71 ± 0.00^{d}	*
T.Ash (%)	0.58 ± 0.00	0.57 ± 0.00	0.57 ± 0.00^{a}	0.58 ± 0.00^{b}	0.57 ± 0.00^{a}	0.58 ± 0.00^{b}	*
NFE (%)	0.12 ± 0.00	0.12 ± 0.00	0.11 ± 0.00^{a}	0.14 ± 0.00^{d}	0.12 ± 0.00^{b}	0.12 ± 0.00^{c}	*
TDN (%)	22.43 ± 0.04	22.45 ± 0.10	22.76± 0.17^{b}	22.29± 0.08^{a}	22.31± 0.06^{a}	22.40± 0.04^{a}	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

CP-Crude Protein, CFat – Crude Fat, CF- Crude Fibre, T,Ash –Total Ash, NFE –Nitrogen Free Extract, TDN – Total Digestible Nutrient

Table 3.24. Digestibility Coefficients of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
	0% MOSM	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
CP	0.39 ± 0.00^{e}	0.31 ± 0.00^{a}	0.35 ± 0.00^{c}	0.35 ± 0.00^{c}	0.40 ± 0.06^{d}	0.32 ± 0.01^{b}	0.36 ± 0.00^{cd}	0.35 ± 0.00^{c}
CFat	0.51 ± 0.01^{b}	0.46 ± 0.01^{ab}	0.49 ± 0.00^{ab}	0.45 ± 0.00^{c}	0.64 ± 0.04^{c}	0.49 ± 0.01^{ab}	0.47 ± 0.01^{ab}	0.45 ± 0.01^{a}
CF	0.69 ± 0.00^{a}	0.70 ± 0.00^{b}	0.71 ± 0.00^{cd}	0.71 ± 0.00^{d}	0.69 ± 0.00^{a}	0.71 ± 0.00^{c}	0.71 ± 0.00^{cd}	0.71 ± 0.00^{e}
T.Ash	0.58 ± 0.00^{bc}	0.59 ± 0.00^{e}	0.57 ± 0.00^{a}	0.58 ± 0.00^{c}	0.57 ± 0.00^{a}	0.58 ± 0.00^{bc}	0.57 ± 0.00^{ab}	0.58 ± 0.00^{bc}
NFE	0.11 ± 0.00^{ab}	0.14 ± 0.00^{e}	0.12 ± 0.00^{bc}	0.12 ± 0.00^{c}	0.11 ± 0.00^{a}	0.13 ± 0.00^{d}	0.12 ± 0.00^{bc}	0.12 ± 0.00^{c}
TDN	22.64 ± 0.11^{ab}	22.30 ± 0.03^{a}	22.39 ± 0.04^{a}	22.39 ± 0.04^{a}	22.89 ± 0.33^{b}	22.28 ± 0.16^{a}	22.22 ± 0.12^{a}	22.42 ± 0.07^{a}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

CP – Crude Protein, CFat-Crude Fat, CF-Crude Fibre, T.Ash- Total Ash, NFE-Nitrogen Free Extracts, TDN-Total Digestible Nutrient

3.16. EFFECT OF MOSM ON HAEMATOLOGICAL AND CLINICAL CHEMISTRY ON TWO GENOTYPES OF CHICKENS

3.16.1. Effect of Genotype on Haematological Parameters. As shown in Table 3.26, genotype did not significantly affect ($p>0.05$) the haematological parameters measured.

Interaction between Genotype and Diet: As shown in Table 3.26, there was no significant interaction ($p>0.05$) in haematological parameters.

3.16.2. Effect of Graded Levels of MOSM on Haematological Parameters irrespective of Genotype: As shown in Table 4.51, PCV, RBC, WBC, Hb, MCV, MCH, MCHC, Monocytes, Lymphocytes, Basophils, Eosinophils, Heterophils, were significantly ($p<0.05$) influenced by dietary inclusion of MOSM as shown in Table 3.26.

PCV, RBC, WBC and Hb increased significantly ($p<0.05$) as the level of MOSM increased in the diet.

However MCV decreased significantly ($p<0.05$) from 5% to 15% inclusion of MOSM. MCH decreased significantly ($p<0.05$) as the level of MOSM increased. The differential counts (monocytes, lymphocytes, basophils, eosinophils, heterophils) increased significantly ($p<0.05$) from 0% to 15% 0f MOSM as presented in Table 3.26.

3.16.3. Effects of Graded Levels of MOSM on Haematological Parameters of Yoruba Nigeria Local Chickens and Marshall Broilers. From Table 3.25., PCV, RBC, WBC, Hb, MCV, MCH, MCHC, Monocytes, Lymphocytes, Basophils, Eosinophils, Heterophils, were significantly ($p<0.05$) influenced by dietary inclusion of MOSM as shown in Table 3.25.

PCV, RBC, WBC and Hb increased significantly ($p<0.05$) as the level of MOSM increased in the diet.

However MCV decreased significantly ($p<0.05$) from 5% to 15% inclusion of MOSM while MCHC values increased significantly ($p<0.05$) from 5% to 15% levels of MOSM for Marshall broilers. MCH decreased significantly ($p<0.05$) as the level of MOSM increased. The differential counts (monocytes, lymphocytes,

basophils, eosinophils, heterophils) increased significantly ($p<0.05$) from 0% to 15% 0f MOSM as presented in Table 3.25. except basophils whose values increased from 5% to 15% for YENLC.

Table 3.25. Haematological Parameters of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
	0% MOSM	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
PCV (%)	32.72 ± 0.56 (6) ^{a}	36.98 ±0.55 (6) ^{b}	38.67 ± 0.3 (6) ^{c}	41.43 ± 0.25 (6) ^{d}	32.27 ± 0.36 (6) ^{a}	37.12 ± 0.41 (6) ^{b}	38.65 ± 0.26 (6) ^{c}	40.75 ± 0.3 (6) ^{d}
RBC ($X10^6/mm^3$)	1.92 ± 0.04 (6) ^{a}	2.15 ± 0.03 (6) ^{b}	2.47 ± 0.03 (6) ^{c}	2.69 ± 0.02 (6) ^{d}	1.90 ± 0.03 (6) ^{a}	2.09 ± 0.04 (6) ^{b}	2.44 ± 0.02 (6) ^{c}	2.66 ± 0.05 (6) ^{d}
WBC $X10^6/mm^3$	18.55 ± 0.28 (6) ^{a}	20.98 ±0.48 (6) ^{b}	24.28 ± 0.43 (6) ^{c}	28.77 ± 0.3 (6) ^{d}	17.88 ± 0.24 (6) ^{a}	20.68 ± 0.43 (6) ^{b}	23.70 ± 0.43 (6) ^{c}	28.52 ±0.39 (6) ^{d}
Hb (gm%)	11.14±0.29 (6) ^{ab}	11.97 ±0.41(6) ^{bc}	12.73 ± 0.18 (6) ^{cd}	13.28 ± 0.05 (6) ^{d}	10.85 ± 0.33 (6) ^{a}	11.50 0.49 (6) ^{ab}	12.62±0.34 (6) ^{cd}	13.37 ±0.14 (6) ^{d}
MCV (fl)	17.09± 0.22 (6) ^{b}	17.22 ± 0.4 (6) ^{b}	15.64 ± 0.19 (6) ^{a}	15.40 ± 0.12 (6) ^{a}	17.01 ± 0.14 (6) ^{b}	17.81 ± 0.42 (6) ^{b}	15.85 ± 0.16 (6) ^{a}	15.34 ± 0.26 (6) ^{a}
MCH (µµ/g)	5.81 ± 0.07 (6) ^{b}	5.57 ± 0.17 (6) ^{b}	5.15 ± 0.05 (6) ^{a}	4.94 ± 0.05 (6) ^{a}	5.71 ± 0.09 (6) ^{b}	5.50 ± 0.18 (6) ^{b}	5.17 ± 0.11 (6) ^{a}	5.03 ± 0.07 (6) ^{a}
MCHC (%)	34.05± 0.57 (6) ^{b}	32.33 ±0.80(6) ^{ab}	32.93 ± 0.46 (6) ^{ab}	32.06 ± 0.21 (6) ^{ab}	33.60 ± 0.77 (6) ^{b}	30.97 ± 1.21 (6) ^{a}	32.63±0.74 (6) ^{ab}	32.81±0.37 (6) ^{ab}
Monocytes (%)	1.14 ± 0.02 (6) ^{a}	1.30 ± 0.03 (6) ^{b}	1.42 ± 0.01 (6) ^{c}	1.50 ± 0.02 (6) ^{d}	1.08 ± 0.03 (6) ^{a}	1.29 ± 0.03 (6) ^{b}	1.45 ± 0.01 (6) ^{cd}	1.51 ± 0.01 (6) ^{d}
Lymphocytes (%)	78.74 ± 0.31 (6) ^{a}	80.77± 0.72 (6) ^{b}	83.96 ± 0.1 (6) ^{c}	84.66 ± 0.15 (6) ^{c}	78.62 ± 0.24 (6) ^{a}	80.34 ± 0.3 (6) ^{b}	83.87 ± 0.11 (6) ^{c}	84.59 ± 0.17 (6) ^{c}
Basophils (%)	0.20 ± 0.15 (6) ^{ab}	0.17 ± 0.03 (6) ^{ab}	0.33 ± 0.02 (6) ^{bc}	0.48 ± 0.01 (6) ^{c}	0.06 ± 0.01 (6) ^{a}	0.14 ± 0.02 (6) ^{a}	0.32 ± 0.03 (6) ^{bc}	0.49 ± 0.01 (6) ^{c}
Eosinophils (%)	0.38 ± 0.03 (6) ^{a}	0.53 ± 0.03 (6) ^{b}	0.67 ± 0.03 (6) ^{c}	0.78 ± 0.01 (6) ^{d}	0.37 ± 0.03 (6) ^{a}	0.52 ± 0.01 (6) ^{b}	0.65 ± 0.02 (6) ^{c}	0.77 ± 0.03 (6) ^{d}
Heterophils (%)	3.14 ± 0.17 (6) ^{a}	3.99 ± 0.12 (6) ^{b}	5.02 ± 0.10 (6) ^{c}	5.55 ± 0.09 (6) ^{d}	3.01 ± 0.06 (6) ^{a}	3.90 ± 0.11 (6) ^{b}	4.87 ± 0.12 (6) ^{c}	5.38 ± 0.12 (6) ^{d}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.26. Effects of Genotypes, Dietary *Moringa oleifera* Seed Meal (MOSM) Level, and their Interaction, On Haematological Parameters

	Genotype		Diet				
	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
PCV (%)	37.45 ± 0.69 (24)	37.2 ± 0.67 (24)	32.5 ± 0.32 (12) [a]	37.05 ± 0.33 (12) [b]	38.66 ± 0.19 (12) [c]	41.09 ± 0.21 (12) [d]	NS
RBC ($X10^6/mm^3$)	2.31 ± 0.06 (24)	2.27 ± 0.06 (24)	1.91 ± 0.03 (12) [a]	2.12 ± 0.03 (12) [b]	2.46 ± 0.02 (12) [c]	2.68 ± 0.03 (12) [d]	NS
WBC $X10^6/mm^3$)	23.15 ± 0.82 (24)	22.7 ± 0.84 (24)	18.22 ± 0.2 (12) [a]	20.83 ± 0.31 (12) [b]	23.99 ± 0.3 (12) [c]	28.64 ± 0.24 (12) [d]	NS
Hb (gm%)	12.28 ± 0.21 (24)	12.08 ± 0.26 (24)	11 ± 0.21 (12) [a]	11.73 ± 0.31 (12) [b]	12.68 ± 0.18 (12) [c]	13.33 ± 0.07 (12) [d]	NS
MCV (fl)	16.34 ± 0.21 (24)	16.5 ± 0.24 (24)	17.05 ± 0.13 (12) [b]	17.52 ± 0.29 (12) [b]	15.74 ± 0.12 (12) [a]	15.37 ± 0.14 (12) [a]	NS
MCH (µµ/g)	5.37 ± 0.08 (24)	5.35 ± 0.08 (24)	5.76 ± 0.06 (12) [c]	5.53 ± 0.12 (12) [b]	5.16 ± 0.06 (12) [a]	4.98 ± 0.04 (12) [a]	NS
MCHC (%)	32.84 ± 0.30 (24)	32.5 ± 0.43 (24)	33.82 ± 0.46 (12) [b]	31.65 ± 0.72 (12) [a]	32.78 ±0.42 (12) [ab]	32.44 ±0.23 (12) [ab]	NS
Monocytes (%)	1.34 ± 0.03 (24)	1.33 ± 0.04 (24)	1.11 ± 0.02 (12) [a]	1.30 ± 0.02 (12) [b]	1.43 ± 0.01 (12) [c]	1.50 ± 0.01 (12) [d]	NS
Lymphocytes (%)	82.03 ± 0.53 (24)	81.86 ± 0.52 (24)	78.68 ± 0.19 (12) [a]	80.56 ± 0.38 (12) [b]	83.92 ± 0.07 (12) [c]	84.63 ± 0.11 (12) [d]	NS
Basophils (%)	0.30 ± 0.04 (24)	0.25 ± 0.04 (24)	0.13 ± 0.08 (12) [a]	0.15 ± 0.02 (12) [a]	0.32 ± 0.02 (12) [b]	0.49 ± 0.01 (12) [c]	NS
Eosinophils (%)	0.59 ± 0.03 (24)	0.58 ± 0.03 (24)	0.37 ± 0.02 (12) [a]	0.52 ± 0.01 (12) [b]	0.66 ± 0.02 (12) [c]	0.78 ± 0.01 (12) [d]	NS
Heterophils (%)	4.42 ± 0.2 (24)	4.29 ± 0.20 (24)	3.08 ± 0.09 (12) [a]	3.94 ± 0.08 (12) [b]	4.94 ± 0.08 (12) [c]	5.46 ± 0.07 (12) [d]	NS

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal, GXD- Interaction between genotype and diet*

3.17. Influence of *Moringa oleifera* seed meal on serum biochemical components and selected organs of two types of chickens

3.17.1. Genotype factor effect on Serum Electrolytes: Genotype did not significantly affect ($p>0.05$) sodium, sodium/potassium, calcium, bicarbonate and chloride ions while potassium and phosphate ions were significantly ($p<0.05$) by genotype.

3.17.2. **Diet (graded levels of MOSM) factor effect on Serum Electrolytes**: When the birds were considered irrespective of the genotype, sodium, potassium, sodium/potassium, calcium, bicarbonate, phosphate and chloride ions were significantly different ($p<0.05$) . The values for sodium, potassium, calcium, bicarbonate, phosphate and chloride ions increased significantly ($p<0.05$) as the level of MOSM increased while sodium-potassium ratio decreased significantly ($p<0.05$) as the level of MOSM increased.

3.17.3. **Genotypes X Diet (graded levels of MOSM) factor interaction effect on Biochemical Parameters** – Genotype did not significantly interact with MOSM to determine serum electrolytes except for potassium and phosphate ions.

3.17.4. **Serum Electrolytes effects of Graded level of MOSM within genotype (breed)**: For both genotypes, sodium, potassium, sodium/potassium, calcium, bicarbonate, phosphate and chloride ions were significantly different ($p<0.05$) . The values for sodium, potassium, calcium, bicarbonate, phosphate and chloride ions increased significantly ($p<0.05$) as the level of MOSM increased while sodium-potassium ratio decreased significantly ($p<0.05$) as the level of MOSM increased.

Table 3.27. Serum Electrolytes of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Trait	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Na+ (mg/100ml)	134.35±0.71 (6) [a]	150.9± 2.28 (6) [b]	165.65 ±1.45 (6) [c]	172.63 ± 0.89 (6) [d]	133.73±0.76 (6) [a]	150.6 ±2.33 (6) [b]	164.67±1.14 (6) [c]	171.68 ±0.86 (6) [d]
K^+ (mg/100ml)	74.07 ± 2.82 (6) [a]	85.03± 1.68 (6) [b]	100.52 ±1.98 (6) [c]	115.82 ± 2.08 (6) [d]	73.8 ± 2.73 (6) [a]	83.78 ±1.98 (6) [b]	99.65 ± 1.98 (6) [c]	113.52 ± 2.5 (6) [d]
Sodium/Potassium	1.83 ± 0.06 (6) [c]	1.78 ± 0.02 (6) [c]	1.65 ± 0.04 (6) [b]	1.49 ± 0.02 (6) [a]	1.82 ± 0.06 (6) [c]	1.8 ± 0.02 (6) [c]	1.66 ± 0.04 (6) [b]	1.52 ± 0.03 (6) [a]
Ca^{2+}(mg/100ml)	3.83 ± 0.49 (6) [a]	8.12 ± 0.32 (6) [b]	11.67 ± 0.56 (6) [c]	15.23 ± 0.31 (6) [d]	3.67 ± 0.41 (6) [a]	7.93 ± 0.49 (6) [b]	11.28 ± 0.46 (6) [c]	14.67 ± 0.37 (6) [d]
$HCO3^{2-}$(mg/100ml)	71.22 ± 0.94 (6) [a]	76.48± 0.72 (6) [b]	80.48 ± 0.85 (6) [c]	83.17 ± 0.5 (6) [d]	70.62 ± 0.41 (6) [a]	75.83 ±0.68 (6) [b]	79.9 ± 0.72 (6) [c]	83.13 ± 0.43 (6) [d]
$PO4^{2-}$(mg/100ml)	6.08 ± 0.24 (6) [a]	9.55 ± 0.47 (6) [b]	9.87 ± 0.4 (6) [cd]	10.92 ± 0.27 (6) [d]	5.73 ± 0.27 (6) [a]	9.37 ± 0.39 (6) [b]	10.02±0.38 (6) [cd]	10.3 ± 0.36 (6) [cd]
Cl^-(mg/100ml)	60 ± 0.64 (6) [a]	63.33± 0.42 (6) [b]	67.58 ± 0.77 (6) [c]	71.1 ± 0.69 (6) [d]	58.87 ± 0.48 (6) [a]	62.73 ± 0.5 (6) [b]	67.5 ± 0.6 (6) [c]	71.05 ± 0.4 (6) [d]

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.28. Effects of Genotype (Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers), Dietary *Moringa oleifera* Seed Meal (MOSM) Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Serum Electrolytes

	Genotype		Diet				
	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Na+ (mg/100ml)	155.88 ± 3.14 (24)	155.17 ± 3.1 (24)	134.04 ± 0.5 (12) ^{a}	150.75 ± 1.55 (12) ^{b}	165.16 ± 0.89 (12) ^{c}	172.16 ± 0.61 (12) ^{d}	NS
K^{+} (mg/100ml)	93.86 ± 3.44 (24)	92.69 ± 3.34 (24)	73.93 ± 1.87 (12) ^{a}	84.41 ± 1.25 (12) ^{b}	100.08 ± 1.34 (12) ^{c}	114.67 ± 1.59 (12) ^{d}	*
Sodium/Potassium	1.69 ± 0.03 (24)	1.7 ± 0.03 (24)	1.82 ± 0.04 (12) ^{c}	1.79 ± 0.01 (12) ^{c}	1.65 ± 0.02 (12) ^{b}	1.50 ± 0.02 (12) ^{a}	NS
Ca^{2+}(mg/100ml)	9.71 ± 0.90 (24)	9.39 ± 0.87 (24)	3.75 ± 0.31 (12) ^{a}	8.03 ± 0.28 (12) ^{b}	11.48 ± 0.35 (12) ^{c}	14.95 ± 0.25 (12) ^{d}	NS
$HCO3^{2-}$(mg/100ml)	77.84 ± 1.01 (24)	77.37 ± 1.01 (24)	70.92 ± 0.5 (12) ^{a}	76.16 ± 0.48 (12) ^{b}	80.19 ± 0.54 (12) ^{c}	83.15 ± 0.32 (12) ^{d}	NS
$PO42^{-}$(mg/100ml)	9.10 ± 0.41 (24)	8.85 ± 0.42 (24)	5.91 ± 0.18 (12) ^{a}	9.46 ± 0.29 (12) ^{b}	9.94 ± 0.26 (12) ^{bc}	10.61 ± 0.23 (12) ^{c}	*
Cl^{-}(mg/100ml)	65.5 ± 0.93 (24)	65.04 ± 0.99 (24)	59.43 ± 0.42 (12) ^{a}	63.03 ± 0.32 (12) ^{b}	67.54 ± 0.46 (12) ^{c}	71.08 ± 0.38 (12) ^{d}	NS

a, b, c, d means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.18. Effect of MOSM on Serum Biochemical Parameters of YENLC and Marshall Broilers

3.18.1. **Genotype factor effect on Biochemical Parameters**: The Marshall broilers have higher values of albumin, albumin-globulin ratio and cholesterol. However, the values are relatively the same.

3.18.2. **Diet (graded levels of MOSM) factor effect on Biochemical Parameters**: When the birds were considered irrespective of the genotype, total protein, albumin, urea, total cholesterol, creatinine, ALT, AST, ALP and ALT-AST ratio were significantly different ($p<0.05$) while there was no significant difference ($p>0.05$) for globulin and albumin-globulin ratio. The values for total protein, urea, creatinine, ALT, ALP and ALT-AST ratio increased as the level of MOSM increased. Birds fed MOSM had significantly higher values ($p<0.05$) than birds on the control diet while birds fed MOSM had significantly lower values ($p<0.05$) for serum total cholesterol while AST increased significantly from 5% to 15% level of inclusion of MOSM.

3.18.3. **Genotypes X Diet (graded levels of MOSM) factor interaction effect on Biochemical Parameters** – Genotype did not significantly interact with MOSM to determine total cholesterol and other biochemical parameters.

3.18.4. **Biochemical Parameters effects of Graded level of MOSM within genotype (breed)**: All serum biochemical parameters measured (Total protein, Albumin, Urea, Cholesterol, Creatinine, ALT, AST and ALP) were significantly influenced ($p<0.05$) except globulin and albumin-globulin ratio that were not significantly ($p>0.05$) influenced by varying levels of MOSM as shown in Table 3.29.

From Table 4.19, total protein increased significantly ($p<0.05$) from the control to 15% inclusion of MOSM for the Marshall broilers while it increased from 5% to 15% for YENLC. The values obtained for albumin was significantly higher ($p<0.05$) for birds fed MOSM when compared with the control. The values for urea increased significantly ($p<0.05$) as the level of MOSM increased. The values for decreased significantly ($p<0.05$) from the control to 10% inclusion, however the value for cholesterol was higher in the control than for birds fed MOSM. The values of creatinine were significantly higher ($p<0.05$) for birds fed MOSM than the control (0% MOSM). ALT and ALP increased significantly ($p<0.05$) as the level of MOSM increased

for YENLC while the values increased significantly from birds fed 5% MOSM to those fed 15% MOSM for Marshall broilers. The value of AST increased significantly from 5% to 15% for YENLC while it increased from the control to 15% for the Marshall broilers.

Table 3.29. Serum Biochemical Parameters of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
Trait	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Total Protein								
(mg/100ml}	6.88±0.09 (6) ^{abc}	6.81 ±0.06 (6) ^{ab}	6.88 ± 0.14 (6) ^{abc}	7.15 ± 0.02 (6) ^{c}	6.59 ± 0.1 (6) ^{a}	6.82 ± 0.09 (6) ^{ab}	6.98 ± 0.13 (6) ^{bc}	7.14 ± 0.04 (6) ^{c}
Albumin (mg/dl)	3.45 ± 0.05 (6) ^{a}	3.6 ± 0.06 (6) ^{ab}	3.53 ± 0.05 (6) ^{ab}	3.61 ± 0.19 (6) ^{ab}	3.39 ± 0.04 (6) ^{a}	3.65 ± 0.06 (6) ^{ab}	3.58 ± 0.08 (6) ^{ab}	3.75 ± 0.05 (6) ^{b}
Globulin	3.43 ± 0.11 (6) ^{a}	3.21 ± 0.09 (6) ^{a}	3.35 ± 0.14 (6) ^{a}	3.55 ± 0.2 (6) ^{a}	3.21 ± 0.13 (6) ^{a}	3.17 ± 0.1 (6) ^{a}	3.4 ± 0.19 (6) ^{a}	3.39 ± 0.07 (6) ^{a}
Albumin-Globulin								
Ratio	1.01 ± 0.05 (6) ^{a}	1.13 ± 0.05 (6) ^{a}	1.06 ± 0.05 (6) ^{a}	1.04 ± 0.09 (6) ^{a}	1.07 ± 0.05 (6) ^{a}	1.16 ± 0.05 (6) ^{a}	1.07 ± 0.09 (6) ^{a}	1.11 ± 0.04 (6) ^{a}
Urea (mg/100ml)	0.75 ± 0.03 (6) ^{a}	0.76 ± 0.03 (6) ^{a}	1.08 ± 0.04 (6) ^{c}	1.28 ± 0.02 (6) ^{d}	0.69 ± 0.03 (6) ^{a}	0.69 ± 0.04 (6) ^{a}	0.99 ± 0.04 (6) ^{b}	1.23 ± 0.02 (6) ^{d}
Cholesterol (mg/dl)	76.19± 0.06 (6) ^{c}	58.24 ±0.22 (6) ^{a}	58.43 ± 0.46 (6) ^{a}	60.23 ± 0.3 (6) ^{b}	76.2 ± 0.07 (6) ^{c}	58.46 ± 0.27 (6) ^{a}	58.39 ±0.37 (6) ^{a}	60.24± 0.09 (6) ^{b}
Creatinine (mg/dl)	2.5 ± 0.07 (6) ^{a}	2.75 ± 0.05 (6) ^{b}	2.85 ± 0.05 (6) ^{b}	2.8 ± 0.03 (6) ^{b}	2.39 ± 0.07 (6) ^{a}	2.72 ± 0.08 (6) ^{b}	2.79 ± 0.04 (6) ^{b}	2.86 ± 0.02 (6) ^{b}
ALT (U/L)	16.18± 0.37 (6) ^{a}	17 ± 0.27 (6) ^{abc}	17.35 ±0.29 (6) ^{bcd}	17.98 ± 0.2 (6) ^{d}	16.37 ±0.27 (6) ^{a}	16.29 ± 0.21 (6) ^{a}	16.81±0.39 (6) ^{ab}	17.73±0.21 (6) ^{cd}
AST (U/L)	22.9 ± 0.3 (6) ^{b}	22.12± 0.26 (6) ^{a}	22.67 ± 0.17 (6) ^{ab}	22.9 ± 0.12 (6) ^{b}	22.08 ± 0.2 (6) ^{a}	22.21±0.27 (6) ^{ab}	22.43±0.27 (6) ^{ab}	22.72 ± 0.2 (6) ^{ab}
ALP	23.32± 0.22 (6) ^{a}	23.63±0.34(6) ^{ab}	23.9 ± 0.15 (6) ^{ab}	24.17 ± 0.21 (6) ^{b}	23.6 ±0.29 (6) ^{ab}	23.37 ± 0.27 (6) ^{a}	23.48±0.22 (6) ^{ab}	24 ± 0.19 (6) ^{ab}
ALT_AST	0.71 ± 0.02 (6) ^{a}	0.77±0.01 (6) ^{bcd}	0.77 ± 0.01 (6) ^{bcd}	0.79 ± 0.01 (6) ^{d}	0.74 ±0.01 (6) ^{abc}	0.73 ± 0.01 (6) ^{ab}	0.75 ±0.01 (6) ^{bcd}	0.78 ± 0.01 (6) ^{cd}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.30. Effects of Genotype (Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers), Dietary *Moringa oleifera* Seed Meal (MOSM) Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Serum Biochemical Parameters

	Genotype		Diet				
Trait	**YENLC**	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Total Protein (mg/100ml}	6.93 ± 0.05 (24)	6.88 ± 0.06 (24)	6.73 ± 0.08 (12) [a]	6.81 ± 0.05 (12) [a]	6.93 ± 0.09 (12) [a]	7.15 ± 0.02 (12) [b]	NS
Albumin (mg/dl)	3.55 ± 0.05 (24)	3.59 ± 0.04 (24)	3.42 ± 0.03 (12) [a]	3.63 ± 0.04 (12) [b]	3.55 ± 0.04 (12) [ab]	3.68 ± 0.10 (12) [b]	NS
Globulin	3.38 ± 0.07 (24)	3.29 ± 0.06 (24)	3.32 ± 0.09 (12) [a]	3.19 ± 0.07 (12) [a]	3.38 ± 0.11 (12) [a]	3.47 ± 0.10 (12) [a]	NS
Albumin-Globulin Ratio	1.06 ± 0.03 (24)	1.10 ± 0.03 (24)	1.04 ± 0.03 (12) [a]	1.15 ± 0.03 (12) [a]	1.07 ± 0.05 (12) [a]	1.08 ± 0.05 (12) [a]	NS
Urea (mg/100ml)	0.97 ± 0.05 (24)	0.90 ± 0.05 (24)	0.72 ± 0.02 (12) [a]	0.72 ± 0.03 (12) [a]	1.03 ± 0.03 (12) [b]	1.26 ± 0.02 (12) [c]	NS
Cholesterol (mg/dl)	63.27 ± 1.57 (24)	63.32 ± 1.56 (24)	76.2 ± 0.05 (12) [c]	58.35 ± 0.17 (12) [a]	58.41 ± 0.28 (12) [a]	60.23 ± 0.15 (12) [b]	NS
Creatinine (mg/dl)	2.72 ± 0.04 (24)	2.69 ± 0.05 (24)	2.44 ± 0.05 (12) [a]	2.73 ± 0.05 (12) [b]	2.82 ± 0.03 (12) [b]	2.83 ± 0.02 (12) [b]	NS
ALT (U/L)	17.13 ± 0.19 (24)	16.8 ± 0.18 (24)	16.28 ± 0.22 (12) [a]	16.64 ± 0.19 (12)[ab]	17.08 ± 0.25 (12) [b]	17.86 ± 0.14 (12) [c]	NS
AST (U/L)	22.65 ± 0.12 (24)	22.36 ± 0.12 (24)	22.49 ± 0.21 (12) [ab]	22.17 ± 0.18 (12) [a]	22.55 ± 0.15 (12)[ab]	22.81 ± 0.12 (12) [b]	NS
ALP	23.76 ± 0.13 (24)	23.61 ± 0.12 (24)	23.46 ± 0.18 (12) [a]	23.5 ± 0.21 (12) [a]	23.69 ± 0.14 (12)[ab]	24.08 ± 0.14 (12) [b]	NS
ALT_AST	0.76 ± 0.01 (24)	0.75 ± 0.01 (24)	0.72 ± 0.01 (12) [a]	0.75 ± 0.01 (12) [b]	0.76 ± 0.01 (12) [b]	0.78 ± 0.01 (12) [c]	NS

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.19. Effect of MOSM to Relative Organs Weight of YENLC and Marshall

3.19.1 **Genotype factor effect on Relative Organ Weights**: The Marshall broilers have significant higher ($p<0.05$) values for liver, heart, spleen, lung, small intestine and long intestine.

3.19.2. **Diet (graded levels of MOSM) factor effect on Relative Organ Weights**: When the birds were considered irrespective of the genotype, relative liver, heart, spleen, lung, small intestine and long intestine weights were significantly influenced ($p<0.05$) by the inclusion of MOSM.

3.19.3. **Genotypes X Diet (graded levels of MOSM) factor interaction effect on Relative Organ Weights** – Genotype significantly interacted ($p<0.05$) with MOSM to determine the relative organ weights.

3.19.4. **Relative Organ Weights of birds fed Graded level of MOSM within genotype (breed)**: Relative weights of liver, heart, lung, small intestine and long intestine were significantly ($p<0.05$) influenced by the inclusion of varying levels of MOSM for both genotypes.

Table 3.31. Relative Organ Weights of Yoruba Ecotype Nigerian Local Chicken and Marshall Broiler Chickens Fed Graded Levels of *Moringa oleifera* Seed Meal (MOSM)

	Yoruba Ecotype Nigerian local chicken				Marshall Broiler			
	0% MOSM	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Kidney(%)					0.07 ± 0.01 (6)	0.08 ± 0.03 (5)	0.08 ± 0.01 (3)	0.06 ± 0.02 (3)
Liver(%)	0.03 ± 0.00 (6) [a]	0.02 ± 0.00 (6) [a]	0.02 ± 0.00 (6) [a]	0.03 ± 0.00 (6) [a]	0.03 ± 0.00 (6) [a]	0.03 ±0.00 (6) [a]	0.03 ±0.00 (6) [a]	0.03 ±0.00 (6) [a]
Heart(%)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.02 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)
Gizzard (%)	0.05 ± 0.00 (6)	0.06 ± 0.00 (6)	0.06 ± 0.00 (6)	0.06 ± 0.00 (6)	0.05 ± 0.00 (6)[e]	0.05± 0.00 (6)[e]	0.05 ± 0.00 (6)[e]	0.05 ± 0.00 (6)[e]
Spleen(%)		0.07 ± 0.01 (6)			0.05 ± 0.01 (5)	0.01 ± 0.00 (6)	0.06 ± 0.01 (4)	0.04 ± 0.00 (2)
Lung(%)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)	0.01 ± 0.00 (6)
Small Intestine (%)	0.17 ± 0.02 (6) [b]	0.18 ± 0.03 (6)[bc]	0.17 ± 0.03 (6)[bc]	0.23 ± 0.01 (6)[d]	0.11 ± 0.02 (6) [a]	0.11± 0.01 (6) [a]	0.15 ±0.01 (6) [b]	0.20 ±0.01 (6) [d]
Large Intestine (%)	0.11 ± 0.02 (6)[b]	0.10 ± 0.01 (6)[b]	0.11 ± 0.02 (6) [b]	0.14 ± 0.02 (6)[c]	0.07 ± 0.00 (6) [a]	0.08± 0.01 (6)[a]	0.11 ±0.01 (6) [b]	0.11± 0.01 (6)[b]

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 3.32. Effects of Genotype (Yoruba Ecotype Nigerian Local Chickens and Marshall Broilers), Dietary *Moringa oleifera* Seed Meal (MOSM) Level (0, 5, 10 and 15 %) From 0-8 Weeks Age, and their Interaction on Relative Organ Weights

	Genotype		**Diet**			
	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Kidney(%)		0.07 ± 0.01 (17)	0.07 ± 0.01 (6) [a]	0.08 ± 0.03 (5) [a]	0.08 ± 0.01 (3) [a]	0.05 ± 0.01 (4) [a]
Liver(%)	0.03±0.00(24)	0.03±0.00(24)	0.03 ± 0.00 (12) [a]	0.03 ± 0.00 (12) [a]	0.03 ± 0.00 (12) [a]	0.03 ± 0.00 (12) [a]
Heart(%)	0.01 ± 0.00 (24)	0.01 ± 0.00 (24)	0.01 ± 0.00 (12)	0.01 ± 0.00 (12)	0.01 ± 0.00 (12)	0.01 ± 0.00 (12)
Gizzard (%)	0.07 ± 0.01 (5)	0.07 ± 0.01 (17)	0.05 ± 0.01 (5) [ab]	0.09 ± 0.01 (11) [b]	0.06 ± 0.01 (4) [ab]	0.04 ± 0.00 (2) [a]
Spleen(%)	0.01 ± 0.00 (22)	0.01 ± 0.00 (24)	0.01 ± 0.00 (12) [ab]	0.01 ± 0.00 (12) [ab]	0.01 ± 0.00 (12) [ab]	0.01 ± 0.00 (12) [ab]
Lung(%)	0.19 ± 0.01 (24)	0.14 ± 0.01 (24)	0.14 ± 0.02 (12) [a]	0.14 ± 0.02 (12) [ab]	0.16 ± 0.02 (12) [b]	0.22 ± 0.01 (12) [b]
Small Intestine (%)	0.12 ± 0.01 (24)	0.09 ± 0.01 (24)	0.09 ± 0.01 (12) [a]	0.09 ± 0.01 (12) [a]	0.11 ± 0.01 (12) [a]	0.13 ± 0.01 (12) [a]

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

GXD- Interaction between genotype and diet

3.20. Discussion

The dry matter (DM) value obtained in this study was in agreement with the report of Mutayoba *et al.* (2011) who reported DM of 87.20%. The energy value was in agreement with the report of Foidl *et al.* (2001) who reported 17.7MJ/Kg and 18.7MJ/Kg for the extracted and unextracted leaves of Moringa.

The values of CP in this study was higher than the value reported by kawo *et al.* (2009), who reported a CP value of 18.63% but lower than 32.19% CP reported by Melo *et al.* (2013) and 30.29% reported for *Moringa oleifera* leaves by Moyo *et al.* (2011). The variations might be due to different geographical locations from where the samples were collected.

The values for crude fat and crude fibre in this study were close to the values reported by Melo *et al.* (2013), they reported 32.40% for fat and 15.87% for crude fibres for *Moringa oleifer*a seeds. Also, Aja *et al.* (2013) reported fat and oil of 40.00% but higher values of 20.00% and 5.00% for crude fibre and ash respectively. Bichi (2013) also reported 34.6% for lipids of *Moringa oleifera* seeds.

This study is also in agreement with the report of Kumar (2017) that *Moringa oleifera* contain alkaloids, flavonoids, anthocyanins, proanthocyanidins and cinnamates. This was in agreement with the report of Foidl *et al.* (2001) who reported the range of 0.00 to 1.40% for tannins and 0.20 to 5.00% for saponins and 5.20 to 31.20Mg HCN equivalent/Kg. However, the cyanogen levels in a complete feed should not exceed 50Mg HCN equivalent/Kg except for chickens whose safe level is fixed at 10Mg HCN equivalent/Kg (FAO/WHO, 1991). Also, the values for glucosinolate was in variance with the report of Foidl *et al.* (2001) who did not detect values for extracted meal of Moringa but reported 4.40µmol/g for extracted kernel of Moringa.

This variation in values may be as a result of difference in climatic condition, time of the year and different soil types from which the samples were collected.

Effect of genotype on body weight irrespective of dietary MOSM level. Results of the experiment showed that the body weight of both genotypes of chicken were significantly different irrespective of age and dietary inclusion of MOSM though they were raised under identical conditions. Marshall broiler chickens were

generally heavier and bigger than the YENLC. This is in agreement with the report of Mmereole and Udeh (2009) who studied effect on genotype by diet interaction on body weight of the local chicken and its crosses with barred Plymouth Rock and observed that the effect of genotype body weight was significant throughout the 12 week period and significant in weight gain at the period of 0 – 4 weeks and 4-8 weeks of age only.

Effect of dietary MOSM level on bodyweight irrespective of genotype. MOSM inclusion had significant effect on bodyweight of the birds. However, from week 5 to week 8, birds fed 5% MOSM had the highest body weight.

This is in agreement with the report of Gadzirayi *et al*. (2012), who observed that final weight and weight gained declined as MOLM level increased, however, they offered 0%, 25%, 50%, 75% and 100% levels of MOLM to Chickens.

Effect of dietary MOSM on bodyweight within genotype (breeds). Dietary MOSM inclusion had significant effect on both genotypes. In Marshall broilers, it was observed that the inclusion of MOSM depreciated growth. Also, in YENLC, highest levels of MOSM (10% and 15%) was found to depress body weight but birds fed 5% MOSM had the highest body weight from week 6 to week 8.

Selle *et al*. (2010) reported that inconsistencies, and even sub-optimal growth performance in broiler chickens are often encountered with feedstuffs that contain kafirin, phytate and condensed tannin, however, *Moringa oleifera* contained both phytate and tannins, which have the capacity to bind proteins in the gut and depress protein digestibility, as well as intestinal uptakes of dietary and endogenous nutrients (Selle *et al*., 2010; Moyo *et al*., 2011). This may account for lowered rate of growth at 10% and 15% inclusion levels for the Marshall broilers and 15% inclusion levels for the YENLC.

There was a decline in FCR from the control to birds fed 10% MOSM which implied that feeding chickens of both genotypes diets up to 10% MOSM enhanced better utilization of diet and this was in agreement with the report of Ogbe and Affiku (2012) who reported a slight decline in FI from 7 to 8 weeks of age in broilers that were fed diets with a higher concentration of poly-herbal extract (20%w/v) made up of Moringa oleifera

leaves, Gum Arabic and wild Ganoderma lucidum. This may also be due to the presence of anti nutritional factors in MOSM. Dietary tannins are said to reduce feed efficiency and weight gain in chicks (Armstrong *et al*., 1974; Dei *et al*., 2007). Saponins are glycosides, which include steroid saponins and triterpenoid saponins (Dei *et al*., 2007). High levels of saponins in feed affect feed intake and growth rate in poultry (Sim *et al*., 1984; Dei *et al*., 2007). Reduction in feed intake has been ascribed to the bitter taste of saponins (Cheeke, 1976) and due to the irritating taste (Oleszek *et al*., 1994). Oxalate binds with calcium to form calcium-oxalate crystals which are deposited as urinary calcium (stones) that are associated with blockage of renal tubules (Blood and Radostit, 1989). Hydrogen cyanide is toxic when ingested by monogastric animals in large quantity. The levels of these anti-nutrients and cyanide detected in the Moringa seeds were low. The result was also in line with the report of Olawumi *et al.* (2012) that Marshall broilers are poor converters of feed to flesh, and at maturity will not generate good returns or dividends.

It also agreed with the report of Olawumi *et al.* (2012) that genotype of birds had significant ($p<0.01$) effect on all the performance traits.

The carcass evaluation was in agreement with the report of Ayssiwede *et al.* (2011) who reported that the *Moringa* leaves meal inclusion in the diets globally had no adverse effect on dressing carcass. Dressing percentage obtained in this study was similar to 54-68.5% reported by Adebanjo and Oluyemi (1981) and Joseph *et al.* (1992).

Inconsistencies, and even sub-optimal growth performance in broiler chickens are often encountered with feedstuffs that contain kafirin, phytate and condensed tannin (Selle *et al*., 2010). *Moringa oleifera* contain both phytate and tannins, which have the capacity to bind proteins in the gut and depress protein digestibility, as well as intestinal uptakes of dietary and endogenous nutrients (Selle *et al*., 2010; Moyo *et al*., 2011).

There was a decline in FCR from the control to birds fed 10% MOSM which implied that feeding chickens of both genotypes diets up to 10% MOSM enhanced better utilization of diet and this was in agreement with the report of Ogbe and Affiku (2012) who reported a slight decline in FI from 7 to 8 weeks of age in broilers that were fed diets with a higher concentration of poly-herbal extract (20%w/v) made up of Moringa oleifera

leaves, Gum Arabic and wild Ganoderma lucidum. This may also be due to the presence of anti nutritional factors in MOSM. Dietary tannins are said to reduce feed efficiency and weight gain in chicks (Armstrong *et al*., 1974; Dei *et al*., 2007). Saponins are glycosides, which include steroid saponins and triterpenoid saponins (Dei *et al*., 2007). High levels of saponins in feed affect feed intake and growth rate in poultry (Sim *et al*., 1984; Dei *et al*., 2007). Reduction in feed intake has been ascribed to the bitter taste of saponins (Cheeke, 1971) and due to the irritating taste (Oleszek *et al*., 1994). Oxalate binds with calcium to form calcium-oxalate crystals which are deposited as urinary calcium (stones) that are associated with blockage of renal tubules (Blood and Radostit, 1989). Hydrogen cyanide is toxic when ingested by monogastric animals in large quantity. The levels of these anti-nutrients and cyanide detected in the Moringa leaves were low. Soaking of plant materials or boiling in water is said to reduce toxic effects and improves utilization in terms of feed intake and protein digestibility (Okai *et al*., 1995; Dei *et al*., 2007).

All the haematological parameters measured were within the normal physiological ranges reported for poultry. Madubuike and Ekenyem (2006) reported that haematological characteristics of livestock suggested their physiological disposition to the plane of nutrition.

The results on haematological and serum biochemical profiles were in contrast with the report of Odetola *et al* (2012) who studied the utilization of Moringa leaves meal as a replacement for soyabean meal in rabbits' diets and the report of Ewuola *et al* (2012)

They observed that feeding rabbits to 15% MOLM showed no significant effect ($p>0.05$) on serum biochemical parameters and haematological parameters except WBC.

The results on WBC contradicted with the report of Odetola *et al.* (2012), which stated that WBC decreased as the level of MOLM increased in rabbit but the opposite was observed in broiler chickens fed varying levels of MOSM.

Reports by Aletor and Egberongbe (1992) and Aletor (1989) indicated that the blood variables most consistently affected by dietary influence include: RBC, PCV and Plasma protein. The higher values of

WBC observed in broiler chickens fed MOSM diet compared with the control is an indication that the immunity levels of the birds were challenged.

There was significant difference ($p<0.05$) for all the serum biochemical parameters observed. Isaac *et al.* (2013) stated that haematological components, which consists of red blood cells, white blood cells or leucocytes, Mean Corpuscular Haemoglobin and Mean Corpuscular Haemoglobin Concentration are valuable in monitoring feed toxicity, especially, with feed constituents that affect the blood as well as the health status of farm animals. Aro and Akinmoegun (2012) and Aro *et al.* (2013) reported that haematological parameters like haematocrit value, haemoglobin concentration, white blood cell count, red blood cell count among others are used in routine screening for the health and physiological status of livestock and even humans.

Etim *et al.* (2014) reported that haematological traits especially Packed Cell Volume (PCV) and Haemoglobin (Hb) were correlated with the nutritional status of the animal. Isaac *et al.* (2013) stated that PCV is involved in transport of oxygen and absorbed nutrient. Other blood parameters like blood viscosity are often neglected in routine clinical and physiological investigations. Blood viscosities are however, also affected by nutrition, especially, when processed agro-industrial wastes are taken into consideration. Livestock blood, for instance, may be subjected to hyperviscosity syndrome consequent on the feed they consume which may ultimately affect other blood values like haematocrit and erythrocyte sedimentation rate (Rosencranz and Bogen, 2006; Aro *et al.,* 2013). Blood viscosity can also help to unravel clinical case of blood abnormalities like polycythemia and reduced plasma volume (Jain, 1993; Aro and Akinmoegun, 2012).

Haematological constituents reflect the physiological responsiveness of the animal to its internal and external environments which include feed and feeding (Esonu *et al.,* 2001).

As reported by Etim *et al.* (2014), haematological traits, especially, PCV and Hb were correlated with the nutritional status of the animal. Adamu *et al.* (2006) observed that nutrition had significant effect on

haematological values like PCV, Hb and RBC. Togun *et al.* (2007) reported that increase in PCV coupled with the marginal increase in RBC is indicative of more efficient erythropoiesis in experimental rabbits.

Eheba *et al.* (2008) noted that a decrease in WBC count, however, reflected a fall in the production of defensive mechanism to combat infection. Togun *et al.* (2007) reported that a significantly lower lymphocyte count was an indication of a reduction in the ability of the experimental rabbits to produce and release antibiotics when infections occur (Campbell and Lasley, 1975). White Blood Cells Count (WBC) of 5 – 13 (x109/l) is considered to be within normal range according to Burke (1994).

Reilly (1993) opined that normal range of values for WBC indicated that the animals were healthy because decrease in number of WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism.

Schalm *et al.* (1975) reported a normal PCV range of 31 – 50%. Harkness and Wagner (1989) reported a RBC range of 4.8 – 6.3 ($x10^6/mm^3$). Etim *et al.* (2014) opined that increased RBC values are associated with high quality dietary protein and with disease free animals. PGCVS (1990) reported a normal range of values for Hb of 8 – 17g/dl. Normal range of values for Hb indicated that the vital physiological relationship of haemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal (Njidda *et al.*, 2006). According to Isaac *et al.* (2013) Packed Cell Volume is involved in the transport of oxygen and absorbed nutrients. Njidda *et al.* (2006) posited that MCV, MCH and MCHC are used in diagnosing anaemic conditions. Ahmed *et al.* (1994) observed that MCHC values decrease with increase in the level of protein.

The results obtained for serum biochemical parameters was in contrast with the report of Ewuola *et al.* (2012) who observed no significant difference in total protein, albumin, globulin, AST, ALT, ALP, urea, creatinine, cholesterol and glucose in rabbits fed graded levels of *Moringa oleifera* leaf meal but the results agree with the reports of Ewuola *et al.* (2012) who observed that ALT, AST and ALP of rabbits fed moringa diets were within the normal range.

The results also shows that MOSM is a hypocholesterolemic, this agrees with the results of Ghasi *et al.* (1999) and Ewuola *et al.* (2011) that crude extract from moringa leaves was a potent hypercholesterlemic agent.

Effect of Genotype (irrespective of diet) on blood cholesterol. The parameter was considerably higher in broilers than in the local chickens. This higher cholesterol is indicative of, and associated with, the tendency for broilers to accumulate more body fat than the YENLC. Broilers have been genetically modified for fat growth and this has increased their tendency for increased fat deposition which is substantially related to increased blood cholesterol.

Effect of diet (irrespective of genotype) on blood cholesterol – Dietary MOSM significantly reduced the total cholesterol. MOSM appears to act principally through a lowering of total cholesterol.

Serum Cholesterol effects of graded levels of MOSM within genotype (breed); within both genotypes results of the present study showed that cholesterol declined in response to dietary MOSM.

The results in this study agreed with the report of Yang *et al* (2006) that Moringa leaf meal inclusion in the diet reduced blood triglycerides and enhanced immune response due to increased peripheral and splenocyte T – cell proliferations in rats.

Genotype factor effect on creatinine, ALT, AST and ALP: YENLC have higher values of creatinine, ALT, AST and ALP than the Marshall broilers.

Diet (graded levels of MOSM) factor effect on creatinine, ALT, AST and ALP: there were significant differences for all the parameters. The values of creatinie, ALT, and ALP increased as the levels of MOSM was increasing, however, there was no significant difference among 5%, 10% and 15% treatment groups.

For AST, the values of birds fed 10% and 15% MOSM were higher than the control (0% MOSM) while birds fed 5% MOSM had the least value of AST.

Genotypes X Diet (graded levels of MOSM) factor interaction effect on creatinine, ALT, AST and ALP – Genotype did not significantly interact with MOSM to determine creatinine, ALT, AST and ALP.

Creatinine, ALT, AST and ALP effect s of Graded level of MOSM within genotype (breed): There were significant differences for all the parameters. In YENLC, creatinine, ALT and ALP increased as the levels of MOSM increased while the values of AST increased from 5% MOSM level to 15% MOSM level but the value obtained for 15% was the same with that of the control.

In Marshall broilers, the values for creatinine and AST increased as the levels of MOSM increased while for ALT, the values increased from 5% MOSM treatment group to 15% MOSM treatment group however, the values obtained for 10% and 15% were higher than that of the control. The values obtained for ALP were significantly not different but birds fed 10% MOSM had the highest values (5%<0%<15%<10%).

The result was in agreement with the report of Jimoh *et al., (*2012) who observed a linear decrease in the serum level of total cholesterol, low-density lipoprotein (HDL) and triacylglycerol but progressive increase in high-density lipoprotein (HDL) was obtained from the birds fed with garlic-supplemented diets when their sera were analyzed. This indicated that the MOSM has modulatory effect on cholesterol and lipid metabolism and can elicit hypocholesterolemic effects. The levels of cholesterol in sera of the birds in all the treatments were lower than the level considered risky to human health. According to Helen (1989), hypercholesterolaemia (>240mg/dl) is considered a risk factor in coronary heart disease especially when LDL cholesterol in serum is relatively higher compared to HDL cholesterol. In this case, the chance of heart disease is greater. Liver accounts for approximately 50% of total cholesterol synthesis (Murray *et al.*, 1988). The hypocholesterolemic effects of *Moringa oleifera* and of its various extracts on chickens have been reported to occur, mainly through the inhibition of the key liver enzymes involved in cholesterol and lipid synthesis.

The results agreed with the report of Kasolo *et al.* (2012) who studied on sub-acute toxicity evaluation of *Moringa oleifera* leaves aqueous and ethanol extracts in Swiss Albino rats. They also observed a statistically significant increase in the mean concentration of chloride, potassium and calcium ions (Cl^-, K^+ and Ca^{2+}). The increased chloride ion concentration attracts hydrogen ions into plasma making the blood acidic. The lower pH does not favour majority of metabolic processes that take place in the body and therefore

contributes to the toxicity profile. Metabolic acidosi is associated with increased morbidity and mortality because of its depressive effects on cardiovascular function, facilitation of cardiac arrhythmias, stimulation of inflammation, and suppression of the immune response. (Kraut, 2012). Metabolic acidosis reduces calcium excretion and may have contributed to serum Ca^{2+} rise (Testerman *et al.,* 1995).

Maintenance of K^+ balance depends primarily on excretion by the kidneys. Increase in serum K^+ in the intervention groups may be caused by reduced renal tubule function (Kasolo *et al.,* 2012)

Effect of Genotype (irrespective of diet) on relative organ weight. The parameters were considerably higher in broilers than in local chickens and this may be due to the higher sizes of the broilers than the local chickens.

Effect of diet (irrespective of genotype) on relative organ weights. MOSM inclusion did not significantly influence the relative weight of the kidney and this is an indication that the feed was not toxic and the relative heart weights of birds fed MOSM at 5% and 10% levels were similar to the control whereas the relative weight at 15% was significantly lower than the control and this implied that the inclusion of MOSM up to 15% was safe. The relative weights of liver at 10% and 15% levels of MOSM were similar to the control which implied that the feed was not toxic even at 15%.

Relative organ weights effects of graded levels of MOSM within genotype (breed); all the parameters were similar in YENLC for the graded levels of MOSM. In broilers, birds fed 10% and 15% MOSM had significantly similar relative liver weight when compared to the control and the relative heart weight of birds fed 10% MOSM was similar to the control however the graded level of MOSM did not significantly influence the relative kidney weights.

The numerical difference in relative organ weights of kidney, liver and heart of broilers and those fed MOSM may probably be due to the their differences in live weight, since the surface area and the live weight determine the amount of feathers and visceral organs required. (Broadbent *et al.*, 1981). Esonu *et al.* (2008) reported that organ weights are an index of nutrients retained by the birds. According to Butcher *et*

al. (1983), external and internal offal percentages tend to increase as slaughter weight of the animal increase. The non significant influence of MOSM among treatments on the kidney and the similarities of birds fed MOSM up to 10% level of broilers when compared with the control and 15% level for YENLC when compared with the control on the liver and heart is an indication of absence of toxin up to that levels of MOSM since hypertrophy or hypotrophy of these organs has been associated with the presence of toxins. (Voss *et al.,* 1990; Ewuola *et al.,* 2003).

CHAPTER 4

4.0. COMPARATIVE RESPONSE OF YENLC AND ISA BROWN CHICKENS ON REPRODUCTIVE PARAMETERS OF CHICKENS FED MOSM

4.1. Introduction

Feed has been implicated by some researchers (Hocking and Bernard, 1997; Omeje and Ude, 1998) as one of the factors known to affect semen production and quality in the male bird. Studies by Boone and Hughes (1969) showed that starvation of cocks for six days led to a marked reduction in semen production, but the condition was reversed after 14 days of resumption of normal feeding. With intensive production and improved feeding, Nwosu (1979) reported a remarkable improvement in the reproductive traits of local chickens. This therefore shows that adequate nutritional environment is essential to maintain the breeding flock in good reproductive condition. Pana *et al.* (2000) reported that Cornish broiler cocks whose daily feed consumption was limited to 130g produced ejaculates whose concentration did not differ significantly from their full-fed counterparts. According to Ezekwe *et al.* (2003) the effects of underfeeding on semen quality traits appeared to be more severe on the physical rather than biochemical characteristics, which implies that the spermatogenic functions of the testes are more responsive to underfeeding than the secretory activities of the reproductive tract. Dietary crude protein and food intake were reported to affect semen production of broiler breeder males (Hocking and Bernard, 1997). Moderate underfeeding was reported to affect semen production and semen quality attributes of local cocks whereas volume, motility and concentration were significantly depressed by severe underfeeding (Ezekwe *et al.* 2003).

Poultry egg is one of the cheapest, most affordable and acceptable animal products. Egg possesses two characteristics that make them valuable as foodstuffs, namely, they are highly nutritious and serve important role in many food products because of their functional properties (Scott and Silversides, 2000). Thus, they are excellent means through which the animal protein of the populance can be met (Oleforu-Okoleh *et al.*, 2016).The Nigerian local chicken has been reported to be small in size and grows slowly but possesses good potential for egg and meat production (Omeje and Nwosu 1983). However, besides genetics make-ups, growth response generally in domesticated animals to a large extent is absolutely determined by its environment (Gunn *et al.,* 2016). Oluyemi and Robert (1979) reported that egg production i.e. fertility and hatchability of eggs are both functions of breed and environment. Peters *et al*., (2005) reported that strain had prominent effect on fertility and hatchability of eggs.

Many researchers have reported the anti-fertility properties of non-conventional feedstuff. However, it has been shown that diets with phytochemicals may retard spermatogenesis and egg production in animal breeding.

Also, it is establisghed that the reproductive potentials (that is sperm production and egg production) differ per different breeds and plane of nutrition.

The objectives of the experiments carried out are to determine whether the inclusion of MOSM in two genotypes of chickens' diets has a deterrent action on the sperm production and egg production.

This study also examined that the effect of MOSM on sperm characteristics and egg production was not universal across the genotypes of chickens but exhibited a genotype effect on the chicken.

The study also aimed to explore the level at which MOSM can be used for different genotypes of chickens.

EXPERIMENT I

4.2. SPERMIOGRAMIC PARAMETERS OF CHICKENS FED MORINGA SEED MEAL

The objectives of this experiment are to determine whether the inclusion of MOSM in chickens' diets have a deterrent action on the reproductive capability and efficiency of two genotypes of chickens and also the possibility of enhancement of reproductive performance.

The specific objectives are:

- To determine the sperm characteristics and egg characteristics of different genotypes of chickens to the varying levels of MOSM inclusion.
- To determine the genotype effect, interaction and diet effect (MOSM) on the sperm and egg parameters of local and exotic chickens.

***Justification*:** There are many factors that affect the reproductive efficiency of chickens. These factors are breed, age, season, bio-climatic changes, hormone balance, drugs and nutrition. In this section, the possible effects of the inclusion of MOSM in local and broiler chickens' diets on the reproductive potential of will be looked into. Reproductive efficiency can be reduced because of improper nutrition. It was suggested by Etches *et al.* (1979) that production of defective spermatozoa and their failure to ascend the oviduct properly is due possibly to defective nutrient metabolism. The differences in genetic make-up coupled with the bird's inherent abilities to adjust and adapt to fluntuating weather conditions are the major factors determining the reproductive performance of any breed of chickens reared in any production environment.

4.3. Materials and Methods

4.3.1. Animals, experimental design and management

One hundred and ninety two chickens (ninety six broiler chicks and ninety six local chickens) were allotted to four treatment groups as previously described in earlier studies. The chickens were weighed at weekly intervals till they were sexually matured. The spermiogramic characteristics of the cocks were determined after weekly semen collection for a period of four weeks.

MOSM were fed to the chickens from day 1 to week 8 after which the reproductive parameters were examined. This is to examine the effects of early feeding of MOSM on the reproductive performance of chickens.

4.3.2. Experimental Birds

The YENLC were sourced from the Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta. The Isa Brown cockerels were also sourced from Obasanjo Farm, Ibadan, Oyo State.

4.3.3. Semen Collection and Evaluation

The semen were collected and the semen thus collected were analysed for semen volume, semen colour, semen pH, mass activity, mass motility, sperm concentration and hen bred/ejaculate were estimated using the appropriate formula.

Semen was obtained once every week for eight consecutive weeks. The volume of the semen collected was read directly from graduated collection tube. Mass activity was determined within one minute of collection in a drop of concentrated semen without coverslip under low magnification (X4). The microscopic wave pattern was observed, ranging from slow to very rapid motion depending on the quality of the semen. The activities were graded as: 0= no mass activity; += slow wave motion; ++= rapid wave motion; +++= very-wave motion. Progressive sperm motility was determined with a drop of semen in a drop of Sodium citrate under coverslip at a magnification of X10 as the percentage of sperm moving straight forward over the microscopic field. The concentration was determined by the use of an improved Neubauer haemocytometer (Bearden and Fuquay, 1997). Semen was pipetted to the 0.5 mark on the pipette (using the red blood cell pipette) and this was made up to 1.01 marks on the pipette with normal saline. Normal saline serves both to dilute the semen and fix the spermatozoa present. The pipette was then introduced into pipette shaker and allowed to mix. About 2 to 3 drops of the diluents were discarded from the pipette before it was introduced into the counting chamber of the haemocytometer chamber for counting. The five squares that formed the diagonal segment of the square were counted. Semen colour was determined by visual assessment.

Testes were collected after slaughtering , weighed and processed for testicular sperm reserves and daily sperm production (Ewuola and Egbunike, 2009) and (Amann,1970) respectively

Testicular and epididymal sperm reserve: This is the total number of spermatozoa and late spermatids counted in testicular/epididymal aqueous suspension. The process involves the homogenisation of known

weight of testes and epididymides in ice-cold physiological saline for two minutes, and counting sperm cells with the Neubuar haemocytometer (Egbunike *et al*., 1975).

Daily sperm production (DSP): Daily sperm production was calculated from gonadal sperm reserve using a formula proposed by Amann (1970):

$$DSP = \frac{\text{Spermatozoa count}}{\text{Time divisor}}$$

Also, hens bred per ejaculate was estimated using number of motile sperms per the average number of sperm cells required to fertilize the eggs of hens.

4.4. Statistical Analysis

Least squares means and standard error values for each treatment group were determined by the use of Microsoft Office Excel 2007 (Microsoft Corp.) and all data from this study were further subjected to a two-way analysis of variance for the effect of breed and treatment and their interactions. Means were separated by the use of Duncan New Multiple Range Test at 95% confidence interval.

Data were analyzed using the General Linear Model procedure of the SPSS Version 22 (IBM, SPSS). The appropriate statistical model used was:

$Yijk = \mu + Gi + Mj + (GM)ijk + \varepsilon ijk$

Yijk = observation on kth population, of ith genotype and jth MOSM inclusion

μ = common mean

Gi = fixed effect of genotype (i=2)

Mj =fixed effect of MOSM inclusion (j=4)

(GM)ijk = interaction effect of genotype and MOSM

εijk = error term associated with each record (normally, independently and identically distributed with zero mean and constant variance)

4.5. Results

From the Table below, it was observed that the birds in the control groups for both genotypes had the highest weights for left testes, right testes and both testes. Also, diets did not significantly influence the weight of the left epididymis for the exotic chickens however, the weights decreased across group for the YENLC. Also, the weights of right epididymis decreased across group for YENLC up till the birds in the 10% MOSM group. However, the right epididymal weights for the birds fed MOSM were uniform but significantly lower than that of the control. The paired epididymal weights increased significantly across the group for YENLC while it decreased significantly across group for the ISA Brown Cockerels.

It is noteworthy to state that as the levels of MOSM was increasing, the body weight was significantly reducing for both genotypes. This implies that the higher the level of the test ingredients the lower their growth rates. When the weight of the testis was .compared with the body weights of the birds, it was observed that the relative testis weights decreased significantly across the group for both groups. There was no significant difference on the relative epididymis weight for birds fed the graded levels of MOSM. Daily sperm production in the testis was relative the same for all the birds in all the group.

Considering the genotype effects of the birds, it was observed that the ISA Brown cockerels had significantly higher values for all the parameters when compared with the YENLC.

Also, from the table it was observed that the left testis weight, right testis weight, paired testis weight, left epididymis weight, right epididymis weight, paired epididymis weight, left testes volume, right testes volume paired testes volume decreased significantly ($p<0.05$) from the control (0% MOSM) to 10% MOSM treatments. However, the body weights of the birds decreased significantly ($p<0.05$) across the group.

It was also observed that the spermatozoa reserves decreased significantly ($p<0.05$) across the group while birds fed 15% MOSM had the highest values for epididymal sperm reserves.

Table 4.1. Semen Characteristics of YENLC and Isa Brown Cocks fed graded levels of MOSM

	YENLC				ISA BROWN COCK			
	0% MOSM	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Semen Vol (ml)	0.22 ± 0.01 (8)^{c}	0.18 ± 0.01 (7)^{b}	0.17 ± 0.01 (7)^{b}	0.24 ± 0.09 (5)^{d}	0.09 ± 0.01 (12)^{ab}	0.21 ± 0.07 (12)^{c}	0.06 ± 0.01 (12)a	0.16 ± 0.06 (11)^{ab}
Semen Colour	Milky	Milky	Milky	Milky	Milky	Milky	Milky	Milky
Mass Activity	1.63 ± 0.26 (8)^{d}	2.57 ± 0.20 (7)^{f}	2.14 ± 0.40 (7)^{e}	1.60 ± 0.24 (5)^{c}	0.92 ± 0.19 (12)^{a}	0.92 ± 0.19 (12)^{a}	1.00 ± 0.17 (12)^{b}	0.92 ± 0.16 (11)^{a}
Sperm Motility(%)	61.56± 0.75 (8)^{c}	64.57± 1.74 (7)^{d}	65.00 ±3.09 (7)^{d}	58.00 ± 1.22 (5)^{ab}	58.75 ± 0.90 (12)^{b}	63.92 ± 1.42 (12)^{cd}	57.50 ± 1.79 (12)^{a}	59.17± 1.57 (11)^{b}
Sperm Conc.(x10^{9}/ml)	5.38 ± 0.21 (8)^{c}	4.69 ± 0.24 (7)^{ab}	5.87 ± 0.40 (7)^{cd}	6.48 ± 0.37 (5)^{d}	4.36 ± 0.06 (12)^{a}	4.62 ± 0.16 (12)^{ab}	6.06 ± 0.09 (12)^{d}	4.67 ± 0.13 (11)^{ab}
No of Motile Sperms	3.32 ± 0.15 (8)^{c}	3.03 ± 0.18 (7)^{b}	3.81 ± 0.32 (7)^{d}	3.75 ± 0.20 (5)^{d}	2.56 ± 0.06 (12)^{a}	2.93 ± 0.07 (12)^{ab}	3.49 ± 0.14 (12)^{cd}	2.75 ± 0.07 (11)^{a}
Estimated Hen Bred/Ejaculate	66.31± 3.09 (8)^{c}	60.56± 3.64 (7)^{b}	76.13 ±6.38 (7)^{d}	75.02 ± 4.06 (5)^{d}	51.26 ± 1.22 (12)^{a}	58.66 ±1.42 (12)^{ab}	69.84 ± 2.80 (12)^{c}	54.99± 1.46 (11)^{a}

Table 4.2 Semen Characteristics of Chickens fed graded levels of MOSM and Genotype effects

	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Semen Vol(ml)	0.20 ± 0.02 (27) *	0.13 ± 0.02 (48)	0.14 ± 0.02 (20)^{a}	0.20 ± 0.05 (19)^{b}	0.10 ± 0.01 (19)^{a}	0.18 ± 0.05(17)^{b}	*
Semen Colour	Milky	Milky	Milky	Milky	Milky	Milky	*
Mass Activity	2.00 ± 0.16 (27) *	0.94 ± 0.09 (48)	1.20 ± 0.17 (20)^{ab}	1.53 ± 0.23 (19)^{c}	1.42 ± 0.22 (19)^{c}	1.12± 0.15 (17)^{a}	*
Sperm Motility(%)	62.57 ± 1.05 (27)*	59.83 ± 0.78 (48)	59.88 ± 0.68 (20)^{a}	64.16 ± 1.07 (19)^{b}	60.26 ± 1.77 (19)^{b}	58.82±1.10(17)^{a}	*
Sperm Conc.(X10^{9}/ml)	5.53 ± 0.19 (27) *	4.93 ± 0.11 (48)	4.77 ± 0.14 (20)^{a}	4.64 ± 0.13 (19)^{a}	5.99 ± 0.15 (19)^{c}	5.20±0.25(17)^{abc}	*
No of Motile Sperms	3.45 ± 0.12 (27) *	2.93 ± 0.07 (48)	2.86 ± 0.11 (20)^{a}	2.97 ± 0.08 (19)^{a}	3.61 ± 0.15 (19)^{c}	3.04±0.13 (17)^{ab}	*
Estimated Hen Bred/Ejaculate	68.98 ± 2.45 (27)*	58.69 ± 1.34 (48)	57.28 ± 2.19 (20)^{a}	59.36 ± 1.57 (19)^{a}	72.16 ± 2.92 (19)^{c}	60.88± 2.7 (17)^{b}	

Table 4.3: Spermiogramic parameters of YENLC and Isa Brown Cocks fed graded levels of MOSM

	YENLC				ISA BROWN COCKEREL			
	(0% MOSM)	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**	**(0% MOSM)**	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**
Left Testis Weight(g)	3.88 ± 0.23 (8)^{b}	3.14 ± 0.26 (7)^{a}	3.14 ± 0.14 (7)^{a}	3.40± 0.24 (5)^{b}	6.63 ± 0.81 (12)^{de}	5.58 ± 0.83 (12)^{d}	5.38 ± 0.63 (12)^{cd}	4.63 ± 1.12 (11)^{c}
Right Testis Weight(g)	2.00 ± 0.19 (8)^{ab}	2.14 ± 0.14 (7)^{b}	1.86 ± 0.26 (7)^{a}	1.80 ± 0.2 (5)^{a}	5.25 ± 0.35 (12)^{d}	4.50 ± 0.41 (12)^{c}	4.63 ± 0.5 (12)^{c}	6.25 ± 0.5 (11)^{e}
Paired Testis Weight(g)	5.88 ± 0.3 (8)^{b}	5.29 ± 0.29 (7)^{a}	5.00 ± 0.31 (7)^{a}	5.20 ± 0.37 (5)^{a}	11.88 ± 0.88 (12)^{e}	10.08 ± 1.11 (12)^{c}	10.00 ± 1.05 (12)^{c}	10.88 ± 1.35 (11)^{d}
Left Epididymis(g)	0.58 ± 0.05 (8)^{b}	0.30 ± 0.04 (7)^{a}	0.18 ± 0.03 (7)^{a}	0.17 ± 0.05 (5)^{a}	0.48 ± 0.04 (12)^{b}	0.44 ± 0.04 (12)^{b}	0.47 ± 0.01 (12)^{b}	0.49 ± 0.02 (11)^{b}
Right Epididymis(g)	0.39 ± 0.06 (8)^{b}	0.18 ± 0.04 (7)^{a}	0.14 ± 0.02 (7)^{a}	0.15 ± 0.04 (5)^{a}	0.40 ± 0.03 (12)^{b}	0.45 ± 0.03 (12)^{c}	0.45 ± 0.01 (12)^{c}	0.45 ± 0.01 (11)^{c}
paired epididymis (g)	0.97 ± 0.07 (8)^{b}	0.49 ± 0.05 (7)^{a}	0.32 ± 0.04 (7)^{a}	0.32 ± 0.07 (5)^{a}	0.88 ± 0.05 (12)^{b}	0.89 ± 0.07 (12)^{b}	0.92 ± 0.01 (12)^{b}	0.93 ± 0.03 (11)^{b}
left testis vol(ml)	4.04 ± 0.19 (8)^{a}	3.41 ± 0.3 (7)^{a}	3.57 ± 0.18 (7)^{a}	3.72 ± 0.19 (5)^{a}	7.16 ± 0.57 (12)^{b}	6.60 ± 0.68 (12)^{b}	6.19 ± 0.51 (12)^{b}	6.48 ± 0.62 (11)^{b}
right testis vol(ml)	2.85 ± 0.2 (8)^{ab}	3.17 ± 0.35 (7)^{b}	2.37 ± 0.22 (7)^{a}	2.50 ± 0.23 (5)^{a}	6.93 ± 0.58 (12)^{d}	5.15 ± 0.58 (12)^{c}	5.45 ± 0.47 (12)^{c}	6.31 ± 0.44 (11)^{d}
paired vol(ml)	6.89 ± 0.29 (8)^{b}	6.58 ± 0.52 (7)^{ab}	5.94 ± 0.29 (7)^{a}	6.22 ± 0.32 (5)^{a}	14.09 ± 0.99 (12)^{d}	11.75 ± 1.1 (12)^{c}	11.64 ± 0.84 (12)^{c}	12.78 ± 0.97 (11)^{c}
Body Weight(g)	1447.88 ±36.41 (8)^{c}	1462.29±15.39 (7)^{b}	1167.14 ±27.55(7)^{b}	833.2 ± 82.06 (5)^{a}	2204.5 ± 37.14 (12)^{e}	2095.75±24.66 (12)^{de}	1962.17±23.89(12)^{d}	1862.5±39.01 (11)^{d}
Relative Testis Weight (%)	0.41 ± 0.02 (8)^{a}	0.36 ± 0.02 (7)^{a}	0.43 ± 0.03 (7)^{a}	0.65 ± 0.09 (5)^{c}	0.54 ± 0.04 (12)^{b}	0.48 ± 0.05 (12)^{b}	0.51 ± 0.05 (12)^{b}	0.59 ± 0.07 (11)^{b}
rel. epididymis weight (%)	0.07 ± 0.01 (8)	0.03 ± 0 (7)	0.03 ± 0 (7)	0.04 ± 0.01 (5)	0.04 ± 0 (12)	0.04 ± 0 (12)	0.05 ± 0 (12)	0.05 ± 0 (11)
testis density(g/ml)	0.86 ± 0.05 (8)	0.82 ± 0.05 (7)	0.84 ± 0.04 (7)	0.84 ± 0.08 (5)	0.90 ± 0.1 (12)	0.87 ± 0.06 (12)	0.84 ± 0.04 (12)	0.86 ± 0.09 (11)
spermatozoa reserves (X109}	2.01 ± 0.08 (8)	1.87 ± 0.03 (7)	1.64 ± 0.05 (7)	1.46 ± 0.1 (5)	3.36 ± 0.06 (12)	2.89 ± 0.05 (12)	2.77 ± 0.08 (12)	2.64 ± 0.08 (11)
DSP (TESTIS)	0.46 ± 0.02 (8)^{a}	0.43 ± 0.01 (7)^{a}	0.38 ± 0.01 (7)^{a}	0.33 ± 0.02 (5)^{a}	0.77 ± 0.01 (12)^{c}	0.66 ± 0.01 (12)^{b}	0.63 ± 0.02 (12)^{b}	0.60 ± 0.02 (11)^{b}
spermatozoa reserves (X109}	0.21 ± 0.03 (8)^{ab}	0.18 ± 0.00 (7)^{a}	0.16 ± 0.01 (7)^{a}	0.12 ± 0.01 (5)^{a}	0.29 ± 0.01 (12)^{b}	0.25 ± 0.01 (12)^{b}	0.25 ± 0.01 (12)^{b}	0.39 ± 0.10 (11)^{c}
DSP(EPIDIDYMIS)	0.05 ± 0.01 (8)	0.04 ± 0 (7)	0.04 ± 0 (7)	0.03 ± 0 (5)	0.07 ± 0 (12)	0.06 ± 0 (12)	0.06 ± 0 (12)	0.09 ± 0.02 (11)

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

SXD- Interaction between genotype and diet

Table 4.4: Spermiogramic parameters of Chickens fed graded levels of MOSM and Genotype effects

	YENLC	ISA BROWN COCKEREL	0%MSOM	5% MOSM	10% MOSM	15% MOSM	GXD
Left Testis Weight(g)	3.41 ± 0.12 (27)	5.55 ± 0.42 (48)*	5.53 ± 0.58 (20)^{b}	4.68 ± 0.59 (19)a	4.55 ± 0.47 (19)^{a}	4.26 ± 0.75 (17)^{a}	*
Right Testis Weight(g)	1.96 ± 0.1 (27)	5.16 ± 0.24 (48) *	3.95 ± 0.42 (20)	3.63 ± 0.37 (19)	3.61 ± 0.45 (19)	4.94 ± 0.62 (17)	*
Paired Testis Weight(g)	5.37 ± 0.16 (27)	10.71 ± 0.55 (48) *	9.48 ± 0.86 (20)^{b}	8.32 ± 0.88 (19)^{a}	8.16 ± 0.87 (19)^{a}	9.21 ± 1.14 (17)^{ab}	*
Left Epididymis(g)	0.33 ± 0.04 (27)	0.47 ± 0.01 (48) *	0.52 ± 0.03 (20)^{b}	0.39 ± 0.03 (19)^{a}	0.36 ± 0.04 (19)^{a}	0.39 ± 0.04 (17)^{a}	*
Right Epididymis(g)	0.23 ± 0.03 (27)	0.44 ± 0.01 (48) *	0.40 ± 0.03 (20)	0.35 ± 0.04 (19)	0.33 ± 0.04 (19)	0.36 ± 0.04 (17)	*
paired epididymis (g)	0.55 ± 0.06 (27)	0.90 ± 0.02 (48) *	0.92 ± 0.04 (20)^{b}	0.74 ± 0.06 (19)^{a}	0.70 ± 0.07 (19)^{a}	0.75 ± 0.08 (17)^{a}	*
left testis vol(ml)	3.69 ± 0.12 (27)	6.61 ± 0.29 (48) *	5.91 ± 0.49 (20)	5.42 ± 0.57 (19)	5.23 ± 0.44 (19)	5.67 ± 0.52 (17)	*
right testis vol(ml)	2.74 ± 0.14 (27)	5.96 ± 0.27 (48) *	5.30 ± 0.58 (20)^{b}	4.42 ± 0.44 (19)^{a}	4.31 ± 0.46 (19)^{a}	5.19 ± 0.52 (17)^{b}	*
paired vol(ml)	6.44 ± 0.19 (27)	12.57 ± 0.49 (48) *	11.21 ± 1.00 (20)^{b}	9.85 ± 0.92 (19)^{a}	9.54 ± 0.84 (19)^{a}	10.85 ± 0.99 (17)^{b}	*
Body Weight(g)	1265 ±50.5 (27)	2031.23 ±24.33 (48)*	1901.85±88.91 (20)^{d}	1862.37±73.83 (19)c	1669.26±92.11 (19)b	1559.76±122.22 (17)^{a}	*
Relative Testis Weight (%)	0.45 ± 0.03 (27)	0.53 ± 0.03 (48) *	0.49 ± 0.03 (20)^{a}	0.44 ± 0.04 (19)^{a}	0.48 ± 0.04 (19)a	0.61 ± 0.06 (17)^{b}	*
rel. epididymis weight (%)	0.04 ± 0 (27)	0.05 ± 0.00 (48) *	0.05 ± 0.00 (20)	0.04 ± 0.00 (19)	0.04 ± 0.00 (19)	0.05 ± 0 .00(17)	*
testis density(g/ml)	0.84 ± 0.02 (27)	0.87 ± 0.04 (48) *	0.88 ± 0.06 (20)	0.85 ± 0.04 (19)	0.84 ± 0.03 (19)	0.86 ± 0.06 (17)	*
spermatozoa reserves (X109}	1.78 ± 0.05 (27)	2.91 ± 0.05 (48) *	2.82 ± 0.16 (20)^{b}	2.51 ± 0.12 (19)^{b}	2.35 ± 0.14 (19)^{a}	2.29 ± 0.15 (17)^{a}	*
DSP (TESTIS)	0.41 ± 0.01 (27)	0.67 ± 0.01 (48) *	0.64 ± 0.04 (20)^{b}	0.58 ± 0.03 (19)^{ab}	0.54 ± 0.03 (19)^{a}	0.52 ± 0.03 (17)^{a}	*
spermatozoa reserves (X109}	0.17 ± 0.01 (27)	0.3 ± 0.02 (48) *	0.26 ± 0.02 (20)	0.22 ± 0.01 (19)	0.22 ± 0.01 (19)	0.31 ± 0.07 (17)	*
DSP(EPIDIDYMIS)	0.04 ± 0 (27)	0.07 ± 0.01 (48) *	0.06 ± 0 (20)	0.05 ± 0 (19)	0.05 ± 0 (19)	0.07 ± 0.02 (17)	*

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal, GXD- Interaction between genotype and diet*

4.6. Discussion

The information relating to morphometric parameters of the reproductive tract have been observed to give an invaluable information on adjudging the breeding and fertililizing ability of animals (Ogbuewu *et al*., 2009). According to Gage and Freckleton (2003), the testes size, length and width of mammals are described as favourable pointer to the present and future spermatozoa production. Knowledge of the important morphometric qualities of the reproductive organ is important to enhance the opinion and forecast not only of sperm production ability, but likewise the storage potential and fertilizing capability of the breeder male. Moreira *et al.* (2001) verified in a study of Santa Ines sheep, that changes in testicular length and scrotal circumference is considered viable indicators of the effect of thermal stress on gonads. In accordance with Ezekwe (1998) and Perry and Petterson (2001), testes size, length and width are high quality indicators of present and future sperm production. This enhances increased fertilizing potential in poultry.

This study agreed with the findings of Priyadarshani and Varma (2014) who studied the effect of *Moringa oleifera* leaf powder on sperm counts, histology of testis and epididymis hyperglycaemic mice Mus musculus, they reported that the administration of *Moringa oleifera* leaf powder to hyperglycaemic mice increased the sperm counts. Also, the administration of *Moringa oleifera* leaf powder accounted for the increase in the testes weight and epididymis weight.

This result also agreed with the findings of Ojo and Abdurahman (2017) who studied the effect of *Moringa oleifera* leaf extract (MOLE) on some reproductive parameters of rabbits reared in a semi-humid environment. It was observed that MOLE did not significantly ($p>0.05$) influence the weight of the pair of testes. Also, MOLE did not significantly influence the testis length and testis volume.

The result also agreed with the report of Ekeocha (2002) that within species, sperm production is a function of testicular size.

Also in the report of Ojo and Abdurahman (2017), it was reported that sperm concentration of rabbit bucks given MOLE is significantly ($P< 0.05$) influenced by the experimental diet. Oyeyemi and Okediran (2007)

reported that an increased concentration of spermatozoa is a signal to a possible high fertility rate by the reason of the number of spermatozoa available during service or insemination.

Ajayi *et al*. (2009) established the influence of quality feeding on sperm characteristics of rabbits. Oyeyemi *et al*. (1998) declared that quality nutrition with high percentage of protein will improve motility and concentration of spermatozoa and Moringa seed is known to have high crude protein content, thus this accounts for the good quality of sperm characteristics in the study.

In a study on biometry of male genitalia and internal organ characteristics of indigenous genotypes of domestic fowl in the Southern Guinea Savanna Region of Nigeria by Ahemen *et al.* (2016), The volume of the left testis of 5.00±2.08ml, 5.33±2.33ml, and 6.33±2.67ml for normal feather bird, naked neck and frizzle feather respectively were not significantly ($p>0.05$) different. These values were similar to the values obtained for YENLC in this present study. According to Ezekwe (1998) and Perry and Petterson (2001), testes size, length and width are good indicators of present and future sperm production. The testis volume recorded in this study for YENLC was however lower than the value of 11.74±4.53ml reported by Bath and Chaudhari (2002) in local cock in the Sahel region of Nigeria. These differences may be due to the influence of the environment on the reproductive parameters of indigenous chickens.

Also, in the study conducted by Ahemen *et al.* (2016), positive significant relationship were observed between live weight and testes weight ($r=0.65$; $p<0.05$) as well as epididymal weight ($r=0.85$; $p<0.05$). The good and positive correlations between live weight and testes weight indicate the possibility of predicting testes weight from live weight Since testes weight is known to be very highly correlated with sperm production and testicular sperm reserves (Ahemen *et al*. 2013). Togun et al. (2006) also reported live weight to be significantly correlated with testes weight. Togun *et al.* (2006) however opined that males with larger testes will tend to produce more sperm.

Ahemen *et al.* (2016) also observed that the average mean left, right and paired epididymis weights were 0.15±0.06, 0.16±0.05 and 0.32±0.10g respectively. The comparison of the biometric values of the epididymis in the different genotypes showed non-significant differences ($p<0.05$) in left and paired

epididymis weights. But significant differences ($p<0.05$) were observed in the right epididymis weights. The mean weight values of the right epididymis of a normal feather birds (0.14±0.03) was significantly ($p<0.05$) lower than the naked neck value (0.17±0.60g) and frizzle feather value (0.17±0.05g). This difference suggests genetic influence on the right epididymis of the fowl genotypes. This report was contradictory to this study as all the sperm parameters were significantly different ($p<0.0\%$) when the genotype effect was considered. The results also contrasted the findings of Oke and Ihemeson (2010) who observed no significant ($p>0.05$) variation in the weights of the right epididymis of the three genotypes (Frizzled feather, Naked head and Normal feathered local chickens).

Aviagen (2004) found that at low testis weight (<11g), a high proportion of males were infertile. However, it was reported that there was a general improvement in fertility with an increase in testis weight. Aviagen (2004) however concluded that testis weight less than 5g would be small and non-functional, testis weight of between 6g and 10g would be borderine while testis weight greater than 10g would be functional. This however implied that the testis of the YENLC in this study would be borderine while that of the Isa Brown Cocks were functional. This could account for the high spermatozoa reserves reported in the study. Aviagen (2004) also reported a positive relationship between body weight and testis weight. This accounted for the high principal components for body weights and testis weights.

Low bodyweights or a loss of body condition/weight is associated with low testis weight. This may have a negative impact on fertility as smaller testis is associated with poorer fertility. The data from the study of Aviagen (2004) emphasized the need to maintain male bodyweight and condition, the avoidance of weight loss in older males will help to maintain testis weight and hence fertility, later on in production. The data did not show a requirement to grow males heavier - heavy males show reduced fertility due to ineffective mating but highlighted that maintaining male bodyweight and condition throughout lay is important if late fertility is to be improved/maintained.

The mean for semen volume obtained in this study was found to be contrary to the range of 0.34 -0.59 ml reported by Bilcik *et al.* (2005) on broiler cocks and 0.40-0.73 ml obtained by Peters et al. (2008) on seven

different indigenous chickens. This may be due to the fact that the genotypes of the birds used for this study was different from the broiler breeder cocks and the indigenous cocks used by the authors. This further substantiated that genotypes affect semen characteristics in cocks. The values for motility was also in variance with the range obtained by Peters *et al.* (2008), who reported a range of 70% to 87.35% as well as within the range of 74.5-85.67 reported by Tabatabaei *et al.* (2010) on Iranian broiler breeder chickens and the 73.9% reported by Bah *et al*. (2001). This could be as a result of differences in the genotypes of the birds used for this study. However, sperm concentration was within the range of 3.40-9.70 billion/cc reported by Bilcik *et al.* (2005) and the 4.3 billion sperm/ml obtained by Moya *et al*. (1996) in broiler cocks and 6.6 billion sperm/ml reported by Tabartabaei *et al*. (2009) on Ross broiler breeder. It was however higher than values of 2.17-3.14 x109 reported by Tabartabaei *et al*. (2010) and the 2.26 x 109 reported by Bah *et al.* (2001) on Nigerian local breeder cocks.

Differences in values of semen quality characteristics of the YENLC and Isa Brown cocks used in this study and some of those reported in literatures can been attributed to effects of genotypes, body weight, age and season. Strain differences in volume, concentration and motility had been reported by Abd El Ghany *et al.* (2011) while Udeh *et al.* (2011) reported significant difference in volume but not in concentration and motility due to strain effect. Makhafola *et al.* (2012) reported strain differences in ejaculate volume, semen pH, sperm concentration and total motility while Tabartabaei *et al*. (2009) reported significantly higher motility in indigenous roosters than from the Ross breed of male. Body weight was reported by Gebriel *et al.* (2009) to have significant effect on concentation and motility but not on semen volume and pH in Norfa chickens while Abd El Ghany *et al.* (2011) reported body weight influence on volume, concentration and motility in two local strains of chickens. These authors reported that the heavy weight had the advantage of high concentration but motility was to the advantage of the light weight group.

4.7. EXPERIMENT II

4.7.1 EGG CHARACTERISTICS OF CHICKENS FED MORINGA SEED MEAL

Objective: To determine the effect of feeding MOSM to chickens on egg parameters.

***Justification*:** Egg production is one of the reasons for raising chickens hence the need to evaluate the comparative response of YENLC and Isa Brown layers to varying levels of MOSM

4.7.2. Materials and Methods

Animals, experimental design and management

Ninety six Isa Brown pullets and ninety six local chickens were allotted to the four experimental diets for the feeding trials. The experimental design and management practice were as earlier described in study 1. YENLC were sourced from the Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta while the Isa Brown pullets were sourced from Obasanjo Farm, Oluyole, Ibadan.

4.7.3. Determination of Egg Characteristics Parameters

Egg weight was individually determined to 0.01g accuracy using a digital weighing scale. Egg length (along the longitudinal axis) and egg width (along the equatorial axis) were measured with a Vernier Calliper. Egg shape index was calculated as the ratio of egg width to length (%) by the method of Anderson *et al.* (2004). After the eggs were broken, egg shells were washed with water and dried in order to clean the remaining albumen. Following this procedure, shell weight (with membrane) was measured using a sensitive weighing scale and the percentage proportion of the shell in the egg was determined. The albumen weight was calculated from the difference between the egg weight, and the yolk and shell weight and the percentage proportion of the albumen in the egg was determined. Albumen index (%) was determined by the method of Alkan *et al*. (2010) on the basis of the ratio of the thick albumen height (mm) measurement taken with a micrometer to the average of width (mm) and length (mm) of this albumen with 0.01mm accuracy. Haugh unit was calculated according to the procedure of Haugh (1937). Yolk weight with 0.01 g accuracy was determined using a sensitive weighing scale and its percentage proportion was calculated. Yolk index (%)

was measured on the basis of the ratio of the yolk height (mm) to the yolk width (mm) by the method of Funk (1948) using micrometer with 0.01mm accuracy

4.7.4. Statistical Analysis

Least squares means and standard error values for each treatment group were determined by the use of Microsoft Office Excel 2007 and all data from this study were further subjected to a two-way analysis of variance for the effect of breed and treatment and their interactions. Means were separated by the use of Duncan New Multiple Range Test at 95% confidence interval.

Data were analyzed using the General Linear Model procedure of the SPSS Version 22 (IBM, SPSS). The appropriate statistical model used was:

$Yijk = \mu + Gi + Mj + (GM)ijk + \varepsilon ijk$

Yijk = observation on kth population, of ith genotype and jth MOSM inclusion

μ = common mean

Gi = fixed effect of genotype (i=2)

Mj =fixed effect of MOSM inclusion (j=4)

(GM)ijk = interaction effect of genotype and MOSM

εijk = error term associated with each record (normally, independently and identically distributed with zero mean and constant variance)

4.7.5. Results

For the body weights of hens, it was observed that in the YENLC at week 8, the weights increased significantly ($p<0.05$) across the group while for ISA Brown pullets, the weights increased significantly ($p<0.05$) from 0% to 10% while birds fed 15% MOSM recorded the least body weight.

However, at week 20, for the YENLC, the weights increased significantly ($p<0.05$) across the group while for for the ISA Brown chickens, the weights increased significantly ($p<0.05$) till 10% and then reduced significantly ($p<0.05$) at 10%.

Table 4.5: Body Weights of YENLC and Isa Brown Pullets fed graded levels of MOSM

	YENLC				ISA BROWN			
	(0% MOSM)	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**	**(0% MOSM)**	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**
INITIAL	23.25 ± 0.59 (12)	23.08 ± 0.36 (12)	23.33 ± 0.5 (12)	22.75 ± 0.33 (12)	25.42 ± 0.53 (12)	31.17 ± 1.45 (12)	32 ± 1.23 (12)	25.83 ± 0.32 (12)
WK4	90.75 ± 1.12 (12)^{a}	95.17 ± 0.89 (12)^{a}	99.33 ± 2.61 (12)^{a}	108.17 ± 2.62 (12)^{b}	338.08 ± 13.23 (12)^{d}	321.58 ± 14.67 (12)^{d}	353.58 ± 25.04 (12)^{d}	227.50 ± 12.9 (12)^{c}
WK8	322.58 ± 5.88 (12)^{a}	337.17 ± 1.06 (12)^{a}	363 ± 12.36 (12)^{a}	437.33 ± 8.05 (12)^{b}	641.92 ± 19.85 (12)^{c}	731.17 ± 39.25 (12)^{cd}	809.17 ± 52.38 (12)^{d}	531.00 ± 19.25 (12)^{b}
WK12	548.08 ± 1.12 (12)^{a}	552 ± 1.56 (12)^{a}	580.00 ± 17.19 (12)^{a}	714.33 ± 7.52 (12)^{b}	911.08 ± 21.8 (12)^{c}	1225.83 ± 71.74 (12)^{d}	1322.58 ± 90.72 (12)^{d}	845.25 ± 19.92 (12)^{b}
WK16	786.50 ± 3.53 (12)^{a}	795.17 ± 1.81 (12)^{a}	843.83 ± 22.2 (12)^{a}	1027.08 ± 18.49 (12)^{b}	1375.42 ±15.31 (12)^{bc}	1487 ± 38.91 (12)^{c}	1498.08 ± 37.11 (12)^{c}	1185 ± 34.44 (12)^{b}
WK20	918.67 ± 4.00 (12)^{a}	953.08 ± 7.04 (12)a	1086 ± 57.35 (12)^{b}	1576.67 ± 23.43 (12)^{c}	1588.17 ±15.67 (12)^{cd}	1599.67 ± 20.31 (12)^{cd}	1610.17 ± 21.92 (12)^{d}	1536.33 ±17.43 (12)^{c}

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

When the genotypes were considered irrespective of diets, the weights of the ISA Brown pullets were significantly higher ($p<0.05$) than that of the YENLC for all the weeks.

When the birds were considered irrespective of the genotypes, at week 8, the weights increased till 10% group and then reduced again at 15%. However, at week 20, the weights increased significantly ($p<0.05$) across the group.

For the ISA Brown pullets, egg weight, egg length, egg width, albumen weight, yolk length and yolk height reduced significantly across the group while for the YENLC, egg weight, egg length, egg width, albumen weight, yolk length, yolk height, shell weight, albumen height and yolk height decreased significantly ($p<0.05$) across the group.

From Table 4.10, it was observed that all the egg parameters of ISA Brown pullets were significantly higher than that of YENLC.

For all the egg parameters, the values decreased significantly ($p<0.05$) across the group.

Table 4.6. Body Weights of chickens fed graded levels of MOSM and effects on genotypes

	YENLC	ISA BROWN	0% MOSM	5% MOSM	10% MOSM	15% MOSM	GXD
INITIAL	23.1 ± 0.22 (48)	28.60 ± 0.65 (48)	24.33 ± 0.45 (24)	27.13 ± 1.12 (24)	27.67 ± 1.11 (24)	24.29 ± 0.39 (24)	
WK4	98.35 ± 1.34 (48)	310.19 ± 10.98 (48) *	214.42 ± 26.59 (24)^{b}	208.38 ± 24.68 (24)^{b}	226.46 ± 29.23 (24)^{b}	167.83 ± 14.01 (24)^{a}	*
WK8	365.02 ± 7.51 (48)	678.31 ± 22.89 (48) *	482.25 ± 34.80 (24)^{a}	534.17 ± 45.34 (24)^{ab}	586.08 ± 53.45 (24)^{b}	484.17 ± 14.12 (24)^{a}	*
WK12	598.6 ± 10.91 (48)	1076.19 ± 41.29 (48) *	729.58 ± 39.32 (24)^{a}	888.92 ± 78.53 (24)^{ab}	951.29 ± 89.63 (24)^{b}	779.79 ± 17.17 (24)^{a}	*
WK16	863.15 ± 15.83 (48)	1386.38 ± 24.27 (48) *	1080.96 ± 61.88 (24)	1141.08 ± 74.6 (24)	1170.96 ± 71.41 (24)	1106.04 ± 25.23 (24)	*
WK20	1133.6 ± 41.28 (48)	1583.58 ± 10.08 (48) *	1253.42 ± 70.25 (24)^{a}	1276.38 ± 68.23 (24)^{a}	1348.08 ± 62.35 (24)^{a}	1556.5 ± 14.89 (24)^{b}	*

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera seed meal*

4.8. Effect of YENLC and Isa Brown Hens on Body Weights, Feed Conversion Ratio and Hen Day Production

The body weights of Isa Brown pullets at weeks 8 and 24 was significantly ($p<0.05$) higher than that of YENLC but YENLC consumed more feeds than the Isa Brown pullets. The egg number, FCR and HDP of Isa Brown was significantly higher than that of YENLC.

At week 8, birds fed 5% and 10% MOSM had significantly ($p<0.05$) higher body weight when compared with the control (0% MOSM) aand 15% MOSM whose body weights were similar but at week 24, birds fed 5% and 15% MOSM had significantly ($p<0.05$) higher body weights when compared with the control 0% MOSM) and 10% MOSM. Egg number and hen day production decreased significantly ($p<0.05$) with increasing levels of MOSM. Feed intake up to 10% MOSM was significantly ($p<0.05$) than 15% MOSM. FCR of birds in the control (0% MOSM) and 5% MOSM were significantly ($p<0.05$) better than 10% and 15% MOSM.

In YENLC, at week 8, body weight increased significantly ($p<0.05$) with increasing levels of MOSM while body weight increased significantly ($p<0.05$) till 10% MOSM and then a significantly ($p<0.05$) high decrease at 15% for Isa Brown pullets.

At week 24, body weights of YENLC also increased significantly with increasing levels of MOSM while in Isa Brown hens, birds fed 5% MOSM had significantly higher ($p<0.05$) body weights compared to the control (0% MOSM) and 10% MOSM that were similar but feeding MOSM at 15% inclusion significantly ($p<0.05$) depressed the growth.

However, for both genotypes, egg number and hen day production significantly ($p<0.05$) decreased with increasing levels of MOSM.

Feed intake also decreased significantly ($p<0.05$) with increasing levels of MOSM for YENLC while in Isa Brown, birds fed 10% MOSM had significantly higher ($p<0.05$) feed intake compared to 0% MOSM, 5% MOSM and 15% MOSM that were similar.

In YENLC, birds fed 5% MOSM and 10% MOSM had significantly better ($p<0.05$) compared to the control (0% MOSM) and 15% MOSM while for the Isa Brown hens, FCR was significantly better ($p<0.05$) at 0% MOSM and 5% MOSM.

Table. 4.7. Effect of Genotype and MOSM on Body Weight, Feed Intake and Egg Production

	YENLC ALL	Isa Brown-ALL	0% MOSM	5% MOSM	10% MOSM	15% MOSM	GXD
INITIAL	23.10 ± 0.22 (48)	28.60 ± 0.65 (48)*	24.33 ± 0.45 (24)	27.13 ± 1.12 (24)	27.67 ± 1.11 (24)	24.29 ± 0.39 (24)	*
WK8	365.02 ± 7.51 (48)	678.31 ± 22.89 (48) *	482.25 ± 34.80 (24)^{b}	534.17 ± 45.34 (24)b	586.08 ± 53.45 (24)^{b}	484.17 ± 14.12 (24)^{a}	*
WK 24	1124.12±33.65 (48)	1783.26 ± 29.03 (47) *	1347.38±79.49 (24)^{a}	1504.61 ± 107.63 (24)^{b}	1387.21 ± 83.18 (24)^{a}	1566.52 ± 22.77 (23)^{b}	*
EGG							*
NUMBER	4.75 ± 0.29 (48)	60.21 ± 1.56 (48) *	37.83 ± 6.61 (24)^{b}	34.50 ± 6.22 (24)^{b}	28.58 ± 5.35 (24)^{a}	29.00 ± 5.53 (24)^{a}	
FEED							*
INTAKE	114.25 ± 3.07 (48)	113.54 ± 2.55 (48) *	119.71 ± 5.79 (24)^{b}	111.42 ± 1.99 (24)^{b}	119.63 ± 4.01 (24)^{b}	104.83 ± 2.20 (24)^{a}	
FCR	3.79 ± 0.10 (47)	2.49 ± 0.07 (48) *	3.07 ± 0.25 (24)^{b}	2.85 ± 0.15 (23)^{a}	3.34 ± 0.10 (24)^{b}	3.25 ± 0.18 (24)^{b}	*
HDP	5.95	71.43	45.24	41.67	34.52	34.52	

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera seed meal*

Table 4.8. Effect of MOSM on Body Weight, Feed Intake and Egg Production of YENLC and Isa Brown Hens

	YENLC(0% MOSM)	YENLC(5% MOSM)	YENLC (10% MOSM)	YENLC (15% MOSM)	Isa Brown(0% MOSM)	Isa Brown (5% MOSM)	Isa Brown (10% MOSM)	Isa Brown (15% MOSM)
INITIAL	23.25 ± 0.59 (12)	23.08 ± 0.36 (12)	23.33 ± 0.50 (12)	22.75 ± 0.33 (12)	25.42 ± 0.53 (12)	31.17 ± 1.45 (12)	32.00 ± 1.23 (12)	25.83 ± 0.32 (12)
WK8	322.58 ± 5.88 (12)^{a}	337.17 ± 1.06 (12)^{a}	363.00 ± 12.36 (12)^{a}	437.33 ± 8.05 (12)	641.92 ± 19.85 (12)	731.17 ± 39.25 (12)	809.17 ± 52.38 (12)	531.00 ± 19.25 (12)
WK 24	968.5 ± 4.5 (12)^{a}	1002.97 ± 16.28 (12)^{a}	1045.83 ± 56.71 (12)^{a}	1479.17 ± 17.39 (12)^{b}	1726.25 ± 17.37 (12)^{d}	2006.25 ± 49.24 (12)^{e}	1728.58 ± 67.29 (12)^{d}	1661.82 ± 16.78 (11)^{c}
EGG NUMBER	6.58 ± 0.48 (12)^{b}	5.00 ± 0.63 (12)^{b}	3.92 ± 0.43 (12)^{a}	3.50 ± 0.38 (12)^{a}	69.08 ± 2.17 (12)^{d}	64.00 ± 1.77 (12)^{d}	53.25 ± 2.95 (12)^{c}	54.50 ± 3.05 (12)^{c}
FEED INTAKE	129.67 ± 10.47 (12)^{c}	113.42 ± 1.94 (12)^{b}	110.17 ± 2.25 (12)^{b}	103.75 ± 3.09 (12)^{a}	109.75 ± 3.55 (12)^{ab}	109.42 ± 3.48 (12)^{ab}	129.08 ± 6.77 (12)^{c}	105.92 ± 3.23 (12)^{a}
FCR	3.96 ± 0.33 (12)^{bc}	3.55 ± 0.08 (11)^{b}	3.60 ± 0.07 (12)b	4.04 ± 0.12 (12)^{c}	2.18 ± 0.07 (12)^{a}	2.22 ± 0.09 (12)^{a}	3.08 ± 0.17 (12)^{b}	2.47 ± 0.07 (12)^{a}
HDP	8.33	5.32	4.76	4.76	82.14	76.19	63.10	65.48

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera seed meal*

Table 4.9: Egg characteristics of YENLC and Isa Brown Pullets fed graded levels of MOSM

	YENLC				ISA BROWN			
	(0% MOSM)	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**	**(0% MOSM)**	**(5% MOSM)**	**(10% MOSM)**	**(15% MOSM)**
EGG WEIGHT(g)	32.85 ± 0.42 (12)^{b}	29.35 ± 2.69 (12)a	30.61 ± 0.49 (12)^{ab}	25.73 ± 0.3 (12)^{a}	50.39 ± 0.29 (12)^{d}	49.65 ± 0.9 (12)^{cd}	42.02 ± 0.44 (12)^{c}	42.84 ± 0.23 (12)^{c}
EGG LENGTH(cm)	2.74 ± 0.02 (12)^{b}	2.55 ± 0.24 (12)^{b}	2.33 ± 0.04 (12)^{b}	1.87 ± 0.08 (12)^{a}	4.15 ± 0.02 (12)^{d}	3.96 ± 0.06 (12)^{d}	3.32 ± 0.05 (12)^{c}	2.92 ± 0.05 (12)^{b}
EGWDT(mm)	1.95 ± 0.01 (12)^{b}	1.76 ± 0.16 (12)^{ab}	1.61 ± 0.02 (12)^{ab}	1.46 ± 0.03 (12)^{a}	3.24 ± 0.02 (12)^{d}	3.05 ± 0.03 (12)^{d}	2.74 ± 0.03 (12)^{cd}	2.47 ± 0.03 (12)^{c}
ALBWT(cm)	19.82 ± 0.2 (12)^{bc}	17.4 ± 1.6 (12)^{b}	17.23 ± 0.2 (12)^{b}	14.88 ± 0.22 (12)^{a}	26.62 ± 0.25 (12)^{d}	23.49 ± 0.34 (12)^{c}	21.83 ± 0.27 (12)^{c}	17.38 ± 0.36 (12)^{b}
YOLKWT(g)	9.84 ± 0.17 (12)^{b}	8.89 ± 0.83 (12)^{b}	8.32 ± 0.26 (12)^{b}	6.84 ± 0.12 (12)^{a}	12.47 ± 0.22 (12)^{d}	10.98 ± 0.19 (12)^{c}	10.04 ± 0.3 (12)^{b}	9.09 ± 0.09 (12)^{b}
SHLWT(g)	2.55 ± 0.02 (12)^{b}	2.12 ± 0.2 (12)^{b}	1.85 ± 0.04 (12)^{a}	1.61 ± 0.03 (12)^{a}	5.89 ± 0.17 (12)^{cd}	6.12 ± 0.24 (12)^{de}	6.3 ± 0.18 (12)^{e}	5.77 ± 0.14 (12)^{c}
ALBHEIGHT(cm)	2.86 ± 0.01 (12)^{b}	2.56 ± 0.23 (12)^{a}	2.42 ± 0.02 (12)^{a}	2.3 ± 0.03 (12)^{a}	5.66 ± 0.12 (12)^{de}	5.72 ± 0.08 (12)^{e}	5.29 ± 0.17 (12)^{cd}	4.92 ± 0.2 (12)^{c}
YOLKHEIGHT(cm)	14.87 ± 0.09 (12)^{c}	13.07 ± 1.2 (12)^{b}	13.87 ± 0.19 (12)^{bc}	12.87 ± 0.23 (12)^{b}	13.22 ± 0.31 (12)^{b}	9.73 ± 0.35 (12)^{a}	9.25 ± 0.38 (12)^{a}	9.02 ± 0.28 (12)^{a}
HAUGH UNIT	62.71 ± 0.33 (12)^{a}	64.79 ± 2.11 (12)^{a}	59.8 ± 0.36 (12)^{a}	62.47 ± 0.5 (12)^{a}	77.57 ± 0.92 (12)^{b}	78.39 ± 0.54 (12)^{b}	78.22 ± 1.26 (12)^{b}	74.96 ± 1.61 (12)^{b}
EGG INDEX	71.11 ± 0.53 (12)^{a}	63.53 ± 5.84 (12)^{a}	69.36 ± 0.92 (12)^{a}	80.58 ± 4.88 (12)^{a}	78.13 ± 0.47 (12)^{ab}	77.21 ± 1.19 (12)^{a}	82.56 ± 1.07 (12)^{b}	84.98 ± 2.01 (12)^{b}
ALB. INDEX	14.42 ± 0.15 (12)^{b}	13.51 ± 1.24 (12)^{a}	14.08 ± 0.25 (12)^{b}	15.48 ± 0.24 (12)^{a}	21.27 ± 0.46 (12)^{d}	24.42 ± 0.53 (12)^{e}	24.28 ± 0.84 (12)^{e}	28.66 ± 1.68 (12)^{e}
YOLK INDEX	66.23 ± 1.2 (12)^{b}	62.38 ± 5.83 (12)^{b}	60.06 ± 1.96 (12)^{b}	53.27 ± 1.15 (12)^{a}	94.72 ± 2.11 (12)^{c}	114.01 ± 3.53 (12)^{e}	110.86 ± 6.47 (12)^{de}	101.76 ± 3.3 (12)^{d}

a, b, c means with different superscript are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

SXD- Interaction between genotype and diet

Table 4.10: Egg characteristics of chickens fed graded levels of MOSM and effects of genotypes

	YENLC	ISA BROWN	0% MOSM	5% MOSM	10% MOSM	15% MOSM	GXD
EGG WEIGHT	29.63 ± 0.77 (48)	46.23 ± 0.61 (48) *	41.62 ± 1.85 (24)^{b}	39.5 ± 2.53 (24)^{ab}	36.31 ± 1.23 (24)^{a}	34.29 ± 1.79 (24)^{a}	*
EGG LENGTH	2.37 ± 0.08 (48)	3.59 ± 0.08 (48) *	3.44 ± 0.15 (24)^{b}	3.26 ± 0.19 (24)^{b}	2.82 ± 0.11 (24)^{ab}	2.39 ± 0.12 (24)^{a}	*
EGWDT	1.7 ± 0.05 (48)	2.88 ± 0.05 (48) *	2.59 ± 0.14 (24)^{c}	2.41 ± 0.16 (24)^{bc}	2.18 ± 0.12 (24)^{ab}	1.97 ± 0.11 (24)^{a}	*
ALBWT	17.33 ± 0.47 (48)	22.33 ± 0.51 (48) *	23.22 ± 0.73 (24)^{b}	20.45 ± 1.02 (24)^{a}	19.53 ± 0.51 (24)^{a}	16.13 ± 0.33 (24)^{a}	*
YOLKWT	8.47 ± 0.27 (48)	10.64 ± 0.21 (48) *	11.16 ± 0.31 (24)^{c}	9.93 ± 0.47 (24)^{b}	9.18 ± 0.26 (24)^{b}	7.96 ± 0.25 (24)^{a}	*
SHLWT	2.03 ± 0.07 (48)	6.02 ± 0.09 (48) *	4.22 ± 0.36 (24)^{c}	4.12 ± 0.44 (24)^{bc}	4.07 ± 0.47 (24)^{ab}	3.69 ± 0.44 (24)^{a}	*
ALBHEIGHT	2.53 ± 0.06 (48)	5.40 ± 0.09 (48) *	4.26 ± 0.3 (24)^{b}	4.14 ± 0.35 (24)^{b}	3.86 ± 0.31 (24)^{a}	3.61 ± 0.29 (24)^{a}	*
YOLKHEIGHT	13.67 ± 0.32 (48)	10.31 ± 0.3 (48) *	14.04 ± 0.23 (24)^{b}	11.4 ± 0.7 (24)^{a}	11.56 ± 0.52 (24)^{a}	10.94 ± 0.44 (24)^{a}	*
HAUGH UNIT	62.44 ± 0.6 (48)	77.28 ± 0.59 (48) *	70.14 ± 1.62 (24)^{b}	71.59 ± 1.77 (24)^{bc}	69.01 ± 2.03 (24)^{ab}	68.72 ± 1.54 (24)^{a}	*
EGG INDEX	71.14 ± 2.06 (48)	80.72 ± 0.78 (48) *	74.62 ± 0.81 (24)^{b}	70.37 ± 3.25 (24)a	75.96 ± 1.54 (24)^{b}	82.78 ± 2.62 (24)^{c}	*
ALB. INDEX	14.38 ± 0.33 (48)	24.66 ± 0.62 (48) *	17.85 ± 0.75 (24)^{a}	18.97 ± 1.31 (24)^{b}	19.18 ± 1.15 (24)^{b}	22.07 ± 1.6 (24)^{c}	*
YOLK INDEX	60.48 ± 1.69 (48)	105.34 ± 2.3 (48) *	80.48 ± 3.2 (24)^{b}	88.2 ± 6.33 (24)^{c}	85.46 ± 6.24 (24)^{c}	77.52 ± 5.34 (24)^{a}	

a, b, c means with different superscript within genotype are significantly different

Group mean, standard error and number count of samples (x±sem(n)) shown

**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

SXD- Interaction between genotype and diet

4.9. DISCUSSION

The report agreed with the findings of Hrncar *et al. (*2014), who studied the effect of genotype on egg quality characteristics of Japanese quails (*Coturnix japonica),* they observed that egg weight was significantly ($p < 0.05$) affected by the quail type. Also, the egg shape index was significantly ($p < 0.05$) influenced by genotypes.

Also, in the study of Adeosun (2004) on the effects of genotype of dam on egg quality characteristics of chickens, the results showed that egg weight, length and width were highly significantly ($P<0.01$) by the genotypes of the chickens but on the contrary, the internal egg parameters indicated that albumen height, albumen pH, yolk weight, egg shell, thickness and yolk colour were not significantly ($p > 0.05$) affected by genotype.

In a related study, Olugbemi *et al.* (2010) found that *Moringa oleifera* leaf (MOL) can be safely included in layer diets up to 10% without negatively affecting productivity. Ebenebe *et al*. (2013) concluded from their study on the effect of various levels of MOL in the diet that inclusion of MOL at lower levels improved egg production and egg quality but higher levels of inclusion resulted in lower productivity and poorer egg quality indices of Isa Brown Breed of layers.

This finding is in agreement with the findings of Bhatnagar *et al.* (1996) who reported that eggs characteristics of commercial layer ISA Brown were not significantly affected by the incorporation of *Leuceana leucocephala* leaf in the diet. The present result is also in close agreement with the finding of Kakengi *et al.* (2007) who recorded heavier egg with 5% of MOL in the diet as compared to 10% inclusion. Generally, many authors (Olugbemi *et al.,* 2010, Abou-Elezz *et al.,*2011 and Kakengi *et al.,* 2007) agreed that use of MOL up to 10% had no negative effect on the productive performance of laying hens, but levels above that (>10%) are expected to produce adverse effects.

The study was also in agreement with the report of Raphael *et al.*(2015) who studied the effects of substituting soybean with *Moringa oleifera* meal in diets on laying and eggs quality characteristics of KABIR chickens, they reported that egg weight, egg width, yolk weight and yolk diameter significantly

($p<0.05$) decreased with increasing levels of MOL in the diets while egg length, yolk length, yolk index and shell weight and thickness were not significantly ($p>0.05$) affected by MOL in the rations.

The result of this study contradicted with the report of Key *et al.* (2016) who stated reported higher albumen heights in laying hens fed 10% *Moringa oleifera* leaf.

Egg weight is among the most important parameters not only for consumers but for egg producers (Gencher, 2012). The result was in agreement with the report of Hrncar *et al.*(2014) who studied the effect of genotype on egg quality characteristics of Japanese quail (*Cortunix japonica),* it was reported that average egg weight was significantly ($p<0.05$) affected by the quail genotype. Also, they found out that the egg shape index was significantly ($p<0.05$) influenced by the genotype. Higher egg weight in the meat type of Japanese quail caused statistically ($p<0.05$) higher egg weight. For yolk characteristics of eggs, the genotype significantly ($p<0.05$) affected yolk weight and yolk index for quail. However, genotype did not significantly ($p>0.05$) affect Haugh unit. The higher the Haugh unit and yolk index, the more desirable is the interior quality of egg (Adeogun and Amole, 2004)

Chapter 5

GENOTYPE-DIET EFFECT ON BODY PARAMATERS AND HEALTH STATUS OF CHICKENS

5.1. INTRODUCTION

The effect of MOSM on body parameters was necessary as it is established that diets influenced the phenotypic expressions of different genotypes of chickens. However, body weight of chicken is a phenotypic expression of their genetic make- up under prevailing environmental condition and feeding regime. It is established that body weight play a pivotal role in the marketability of chickens. Variations in the body weight within a flock can be ascribed to variation in the genetic make-up and environmental condition (diet composition/quality inclusive) (Fayeye and Owoeye, 2016).

For effective livestock characterization as it relates to different genotypes, the evaluation of body size and conformation are highly important as reported by Ibe (1989). Morphometric or qualitative analyses of form, structure, shape and size of an animal were reported useful in contrasting, size and shape of animals (Ajayi *et al*., 2008). Morphometric indices would also point to the potentials of some body parts and the impact of genotype on these parameters when fed graded level of MOSM.

Morphometric traits such as shank length is a good indicator of leg development while body girth is an indicator of breast development.

Phenotypic correlation between body weight and morphometric traits of different genotypes and the impact of MOSM on these trait could help in the selection programme and also the developmental response of different genotype to the same diet under the similar environmental condition.

More importantly, the within breed pairwise correlation of trait was determined and whether the size of correlation changed with diet as well as the correlation level between each of the breed.

It is also useful to predict performance at the end of the finisher period and the end of the production cycle from measurements of body parts and lengths taken earlier in the life of birds and this study has modelled this relationship. Whether or not the source of alteration of diets in nutriceuticals may influence or distort may determine key earlier predictors.

Finally, it is useful to examine by the use of dimension reduction tools in which the growth rate appear to be in each of the traits examined is most sensitive of the breed response of MOSM and whether this is the same across breeds or different and as a test for whether the biology of response is similar.

5.2. OBJECTIVES

- To assess correlations among body weight, body parameters, haematology and serum biochemical parameters of chickens per genotype and per dietary treatment group.
- To identify the components of early body weights and other body parameters that best define body weight at later age in the two genotypes of chickens and the different dietary treatments.
- To determine similarities or differences between the two genotypic groups and the four dietary treatments in body weight, body morphometrics, haematology and serum biochemical parameters.

5.3. Location of the study

The study was carried out at the Livestock Section of the Teaching and Research Farm of the Federal College of Animal Health and Production Technology, Moore Plantation, Ibadan. The experiment lasted for eight weeks.

5.4. Data collection

Data collected from study one were used to estimate the correlation, regression and principal component analyses effect for body weight, morphometric indices, carcass evaluation, haematological and serum biochemical parameters in Yoruba Ecotype Nigeria Local Chickens and Marshall Broilers as well as the overall effect on graded levels of MOSM.

Pearson correlations between body weight and morphometric quality traits as well as the haematological and serum biochemical parameters were assessed for the two genotypes of chickens and the four graded levels of MOSM for all the chickens irrespective of the genotypes using SPSS Version 20 (2012).

Predicting late body weight from early parameters in the two genotypes of chickens and for all the chickens in the various dietary treatment.

5.5. Statistical Analysis

Pearson's coefficients of correlation were first estimated for all the traits measured in the study. This was followed by principal component (PC) analysis. Cumulative proportion of variance criterion was employed in determining the number of PCs to extract. The factor matrix was rotated using the varimax criterion for easy interpretation of the PC analysis, which reliability was tested using The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity.

Pearson correlation coefficients among the body measurements were calculated for each genotype of birds and each level of MOSM inclusion and the correlation matrix which was the primary data required for PCA generated. Bartletts test of sphericity was used to test if the correlation matrix was an identity matrix (each variable correlated with itself) or a correlation matrix full of zero. The suitability of the data set to PCA was further tested by KaiserMeyer-Olkin (KMO) measure of sampling adequacy. This tested whether the partial correlations among variables were small. A KMO measure of 0.60 and above is considered adequate (Eyduran et al., 2010). Everitt et al., (2001) defined principal component analysis as a method of transforming variables in a multivariate data set, x1, x2, ……..xp into new uncorrelated variables y1, y2,…….yp which account for decreasing proportions of the total variance in the original variables defined as:

y1=a11x1+a12x2+ ……+ a1pxp.

y2=a21x1+a22x2+……+ a2pxp.

yp=ap1x1+ap2x2+..…+ appxp.

The principal components y1, y2…….yp account for decreasing proportions of the total variance in the original variables x1, x2,……xp. Variance maximizing orthogonal rotation was used in the linear transformation of the factor pattern matrix in order to make the interpretation of the extracted principal components easier. The principal components analyses were performed using the factor program of SPSS 22 statistical package.

A forward regression procedure using a stepwise variable selection was used to obtain models of estimation from biometric measurements and from established principal components factor scores (Dahloum et al., 2016):

Y = a + b1X1 + ... + bkXk,

where Y is the dependent variable, a is the regression intercept, bi is the ith partial regression coefficients of the ith measurement or principal component, and Xi and PCi are the ith traits or principal component.

5.6. Correlation of body parts of all the experimental birds irrespective of diet and genotype

It was observed from Table 5.1 that there were high positive correlations between the body weights and all the morphometric indices measured. This implies that as one part is increasing the other parts are also increasing.

5.7. Correlation of body parts of YENLC irrespective of diet

It was observed from Table 5.1 that there were positive correlations between the body weights and all the morphometric indices measured. However, there was low and no significant ($p > 0.001$) relationship between body weight and wing length, shank length, body length, keel length and body girth for YENLC.

Table 5.1. Phenotypic Correlations between body parts and body weight of YENLC

	BW	TL	WL	SL	BL	KL	BG
BW	1						
TL	0.301*	1					
WL	0.225	0.653**	1				
SL	0.207	0.645**	0.623**	1			
BL	0.115	0.644**	0.479**	0.507**	1		
KL	0.138	0.244*	0.298*	0.350**	0.062	1	
BG	0.197	0.455**	0.306*	0.331**	0.217	0.587**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.8. Correlation of body parts of Marshall Broilers irrespective of diet

It was observed from Table 5.2 that there were positive correlations between the body weights and all the morphometric indices measured. However, there were high positive significant ($p<0.001$) relationship between body girth and body length ($r=0.757$) and thigh length and body length ($r=0.702$) for Marshall Broilers.

Table 5.2. Phenotypic Correlations between body parts and body weight of Marshall Broilers

	KL	BG	BW	TL	WL	SL	BL
KL	1						
BG	0.418**	1					
BW	0.199	0.668**	1				
TL	0.218*	0.651**	0.470**	1			
WL	0.203	0.533**	0.355**	0.608**	1		
SL	0.556**	0.678**	0.456**	0.506**	0.366**	1	
BL	0.332**	0.757**	0.573**	0.702**	0.514**	0.588**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.9. Correlation of body parts of birds fed 0% MOSM

It was observed from Table 5.3 that there were positive correlations between the body weights and all the morphometric indices measured. However, there were high positive significant ($p<0.001$) relationship between all the morphometric parameters and body weights of birds YENLC and Marshall Broilers fed then control diet (0% MOSM).

Table 5.3. Phenotypic Correlations between body parts and body weight of YENLC and Marshall Broilers fed 0% MOSM

	BW	TL	WL	SL	BL	KL	BG
BW	1						
TL	0 .816**	1					
WL	0.855**	0.874**	1				
SL	0.793**	0.857**	0.736**	1			
BL	0.879**	0.885**	0.828**	0.835**	1		
KL	0.722**	0.781**	0.665**	0.871**	0.764**	1	
BG	0.923**	0.912**	0.888**	0.869**	0.936**	0.811**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.10. Correlation of body parts of YENLC and Marshall Broilers fed 5% MOSM

It was observed from Table 5.4 that there were positive correlations between the body weights and all the morphometric indices measured. However, there were high positive significant ($p<0.001$) relationship between all the morphometric parameters and body weights of birds YENLC and Marshall Broilers fed with diets with 5% MOSM. The relationship however compared well with the control (0% MOSM).

Table 5.4. Phenotypic Correlations between body parts and body weight of YENLC and Marshall Broilers fed 5% MOSM

	BW	**TL**	**WL**	**SL**	**BL**	**KL**	**BG**
BW	1						
TL	0.720**	1					
WL	0.703**	0.850**	1				
SL	0.803**	0.868**	0.859**	1			
BL	0.811**	0.891**	0.871**	0.928**	1		
KL	0.728**	0.797**	0.841**	0.869**	0.879**	1	
BG	0.829**	0.840**	0.840**	0.933**	0.906**	0.910**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.11. Correlation of body parts of birds of YENLC and Marshall Broilers fed 10% MOSM

It was observed from Table 5.5 that there were positive correlations between the body weights and all the morphometric indices measured. However, there were high positive significant ($p<0.001$) relationship between all the morphometric parameters and body weights of birds YENLC and Marshall Broilers fed with diets with 10% MOSM except with body length and keel length with significant ($p<0.01$) low positive correlation coefficient ($r=0.482$). However, when compared with the control (0% MOSM), the association between body length and keel length and keel length and thigh length decreased from high to medium.

Table 5.5. Phenotypic Correlations between body parts and body weight of YENLC and Marshall Broilers fed 10% MOSM

	BW	TL	WL	SL	BL	KL	BG
BW	1						
TL	0.778**	1					
WL	0.707**	0.806**	1				
SL	0.753**	0.733**	0.818**	1			
BL	0.624**	0.870**	0.768**	0.706**	1		
KL	0.782**	0.566**	0.741**	0.826**	0.482**	1	
BG	0.837**	0.818**	0.807**	0.787**	0.706**	0.794**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.12. Correlation of body parts of YENLC and Marshall Broilers fed 15% MOSM

It was observed from Table 5.6 that there were positive correlations between the body weights and all the morphometric indices measured. However, there were high positive significant ($p<0.001$) relationship between all the morphometric parameters and body weights of birds YENLC and Marshall Broilers fed with diets with 10% MOSM except with body length and keel length with significant ($p<0.01$) low positive correlation coefficient ($r=0.482$). When compared with the control (0% MOSM), the association between body length and body weight and body girth and body weigth reduced from high to medium while MOSM at 15% in the diet strengthened the relationship between keel length and wing length.

Table 5.6. Phenotypic Correlations between body parts and body weight of YENLC and Marshall Broilers fed 15% MOSM

	BW	TL	WL	SL	BL	KL	BG
BW	1						
TL	0.745**	1					
WL	0.748**	0.900**	1				
SL	0.699**	0.877**	0.952**	1			
BL	0.524**	0.795**	0.762**	0.756**	1		
KL	0.662**	0.751**	0.812**	0.814**	0.712**	1	
BG	0.641**	0.813**	0.816**	0.812**	0.689**	0.876**	1

BW – Body Weight, TL- Thigh Length, WL – Wing Length, SL – Shank Length, BL – Body Length, KL – Keel Length, BG – Body Girth

5.13. Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in YENLC and Marshall Broiler Chickens from linear measurements of age 1,3, 5 and 7 weeks

Week 1: For both genotypes, adding a single trait (body girth) produced an R^2 value of 63.20% while the addition of wing length produced a 1.00% increment and an R^2 value of 64.20% (Table 5.7)

Week 3: knowing the value of body weight could be useful in predicting body weight at week 7 (R^2=89.30%). The addition of another trait body girth further increased the R^2value to 90.50% (Table 5.7).

Week 5: Body weight would be helpful in predicting body weight at week 7 (R^2=91.80%). The addition of another trait – thigh length increased the R^2 to 92.20%

Week 7: Body girth would be of utmost importance in predicting body weight at week 7 (R^2 = 80.00%) while the addition of shank length increased the accuracy of the prediction to 81.70%.

Table 5.7. Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in YENLC and Marshall Broiler Chickens from linear measurements of age 1,3, 5 and 7 weeks

Dependent Variable	Regression equation	R^2	SE
BW	-904.702 + 122.726BG_1	63.20*	0.151
BW	-1007.227 + 118.707BG_1 + 57.040WL_1	64.20*	0.150
BW	-88.767 + 4.566BW_3	0.893*	0.817
BW	-271.511 + 3.529BW_3 + 21.54BG_3	0.905*	0.773
BW	-15.302 + 01.876BW_5	0.918*	0.714
BW	-89.741 + 1.770BW_5 + 17.301TL_5	0.922*	0.698
BW	-501.601 + 40.870BG_7	0.800*	0.111
	-567.845 + 30.463BG_7 + 36.818SL_7	0.817*	0.107

Key: BG (Body Girth), BW (Body Weight), WL (Wing Length), TL (Thigh Length), SL (Shank Length), R^2 (Variance explained), SE (Associated Standard Error)

5.14. Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in Marshall Broiler Chickens from linear measurements of age 1,3, 5 and 7 weeks

Week 1: For Marshall broilers, adding a single trait (body girth) produced an R^2 value of 23.20% while the addition of body weight produced a 10.80% increment and an R^2 value of 34.00%. The addition of wing length further increased the R^2 value to 38.90% (Table 5.8).

Week 3: knowing the value of body weight could be useful in predicting body weight at week 7 (R^2=74.40%). The addition of another trait body girth did not significantly increase the R^2value. (Table 5.8).

Week 5: Body weight would be helpful in predicting body weight at week 7 (R^2=81.30%). (Table 5.8)

Week 7: Body girth would be of utmost importance in predicting body weight at week 7 (R^2 = 56.30%) while the addition of body length increased the accuracy of the prediction to 58.40%.

Table 5.8: Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in Marshall Broiler Chickens from linear measurements of age 1,3, 5 and 7 weeks

Dependent Variable (y)	Regression equation	R2	SE
BW	-724.826 + 110.447BG1	0.232*	0.176
BW	-1825.738 + 95.790BG1 + 20.445BW1	0.340*	0.165
BW	-2000.005 + 84.672BG1 + 21.055BW1 + 102.649WL1	0.389*	0.159
BW	-39.477 + 4.307BW3	0.744*	0.102
BW	-339.600 + 3.521BW3 + 250844BG3	0.744*	0.964
BW	74.394 + 1.655BW5	0.813*	0.871
BW	-343.727 + 35.836BG7	0.563*	0.133
BW	-408.694 + 24.604BG7 +13.282BL7	0.584*	0.138

Key: BG (Body Girth), BW (Body Weight), WL (Wing Length), R^2 (Variance explained), SE (Associated Standard Error)

5.15. Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in YENLC from linear measurements of age 1, 3, 5 and 7 weeks

Week 3: knowing the value of thigh length could be useful in predicting body weight at week 7 (R^2=21.60%). The addition of another trait - body weight increased the R^2value to 26.90%. (Table 5.9).

Week 5: Thigh length would be helpful in predicting body weight at week 7 (R^2=20.50%) while the addition of body weight further increased the R^2value to 27.60%. (Table 5.9)

Week 7: Thigh length would be of utmost importance in predicting body weight at week 7 (R^2 = 23.20%) while the addition of body length increased the accuracy of the prediction to 58.40%.

Table 5.9: Forward Stepwise regression analysis of the effect of length of body parts in predicting week 7 Body Weight in YENLC from linear measurements of age 1, 3, 5 and 7 weeks

Dependent	Regression equation	R^2	SE
BW	$171.810 + 21.341TL_3$	0.216*	0.187
BW	$148.287 + 16.704TL_3 + 0.514BW_3$	0.269*	0.182
BW	$180.136 + 11.985TL_5$	0.205*	0.189
BW	$141.749 + 8.062TL_5 + 0.397BW_5$	0.276*	0.181
BW	$160.263 + 12.332TL_7$	0.232*	0.185

Key: BG (Body Girth), BW (Body Weight), WL (Wing Length), TL (Thigh Length), SL (Shank Length), R^2 (Variance explained), SE (Associated Standard Error)

5.16. Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body Weight and Linear Measurements over an 8 week period in the experimental birds (irrespective of genotypes)

Principal component analysis of fifty seven original variables in 192 chickens revealed that six principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.10), collectively explaining 84.153% of the overall variation. PC1 accounted for over half (67.407%) of total variance while PC2, PC3, PC4, PC5 and PC 6 accounted for the successively lower proportions of the explained variance.

Table 5.10: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient featuresunderlying variation in Body weight and linear measurements over an 8 week period in the entire set of 192 chickens

Principal Component	Eigen Value	% of Variance	Cumulative %
1	38.421	67.406	67.406
2	3.217	5.644	73.050
3	2.402	4.214	77.264
4	1.551	2.721	79.984
5	1.328	2.330	82.314
6	1.048	1.839	84.153

5.18. Rotated Component Matrix and Communalities of the length of body parts of the Chickens irrespective of genotype and diet

As shown in Table 5.11, Communalities in the whole of the experimental birds ranged between 0.690 and 0.930. PC1 had high loadings (correlations between the components and the variables) on body weights at weeks 4, 5 and 3 while PC2 loaded heavily on wing lengths at weeks 4 and 5 while PC3 had the highest loadings on shank length and keel length at week 1.

Table 5.11: Analysis showing the Principal Components extracted and their communalities irrespective of diet, genotype when all the birds were examined

Principal Component/Trait	1	2	3	4	5	6	Communalities
BW0	.546	.371	.384	.350	-.172	.017	.736
BW1_1	.714	.498	.147	.318	-.086	.068	.893
TL_1	-.006	-.018	.094	-.052	.128	.871	.786
WL_1	.177	.153	.298	.008	.777	.080	.754
SL_1	.299	.146	.728	.014	.097	.025	.651
BL_1	.750	.132	.157	.218	.011	.283	.732
KL_1	.075	.006	.725	.107	.304	.200	.675
BG_1	.781	.359	.252	.170	-.057	.112	.847
BW2	.854	.371	.133	.141	.112	.031	.917
TL_2	.101	.285	.106	.249	.016	.827	.849
WL_2	.196	.417	.152	.171	.702	.121	.772
SL_2	.335	.528	.457	.308	.094	.059	.706
BL_2	.817	.114	.200	.206	.119	.220	.826
KL_2	.055	.479	.396	.443	.311	.171	.711
BG_2	.818	.391	.175	.160	.023	.060	.883
BW3	.876	.357	.100	.066	.147	-.018	.931
TL_3	.270	.795	-.018	.170	.030	.316	.836
WL_3	.524	.602	-.041	.234	.389	.066	.850
SL_3	.471	.658	.317	.276	.009	.020	.833
BL_3	.752	.463	.167	.120	.108	.130	.851
KL_3	.481	.351	.147	.595	.214	.156	.801
BG_3	.807	.446	.097	.187	.053	.037	.898
BW4	.887	.346	.109	.052	.157	-.035	.946
TL_4	.293	.842	.052	-.001	.072	.191	.839
WL_4	.309	.840	.029	.099	.248	-.011	.874
SL_4	.388	.778	.256	.217	.065	-.029	.874
BL_4	.640	.619	.199	-.070	.129	.079	.860
KL_4	.592	.456	.070	.445	.188	.113	.809
BG_4	.698	.565	.025	.062	.054	-.032	.815
BW5	.886	.340	.051	.022	.198	-.040	.943
TL_5	.376	.809	.121	.099	.080	.164	.854
WL_5	.377	.820	.039	.158	.188	.010	.877

Table 5.11: Analysis showing the Principal Components extracted and their communalities irrespective of diet, genotype when all the birds were examined (contd)

Principal Component	1	2	3	4	5	6	Communalities
SL_5	.477	.736	.273	.175	.040	-.051	.879
BL_5	.640	.601	.300	-.056	.105	.047	.878
KL_5	.640	.378	.086	.501	.113	.145	.845
BG_5	.683	.581	.095	.123	.048	-.026	.832
BW6	.866	.376	.008	.050	.143	-.029	.915
TL_6	.467	.776	.152	.078	.070	.112	.867
WL_6	.432	.760	.048	.218	.117	.042	.830
SL_6	.595	.632	.318	.182	.015	-.068	.892
BL_6	.611	.597	.261	.005	.110	.000	.810
KL_6	.722	.303	.174	.488	.011	.114	.895
TL_8	.594	.655	.151	.111	.135	.126	.852
WL_8	.535	.669	.045	.316	.111	.013	.847
SL_8	.735	.468	.260	.177	.064	-.009	.863
BL_8	.666	.556	.181	.027	.186	-.013	.821
KL_8	.755	.259	.196	.410	.012	.131	.861
BG_8	.827	.421	.100	.161	.084	.039	.906

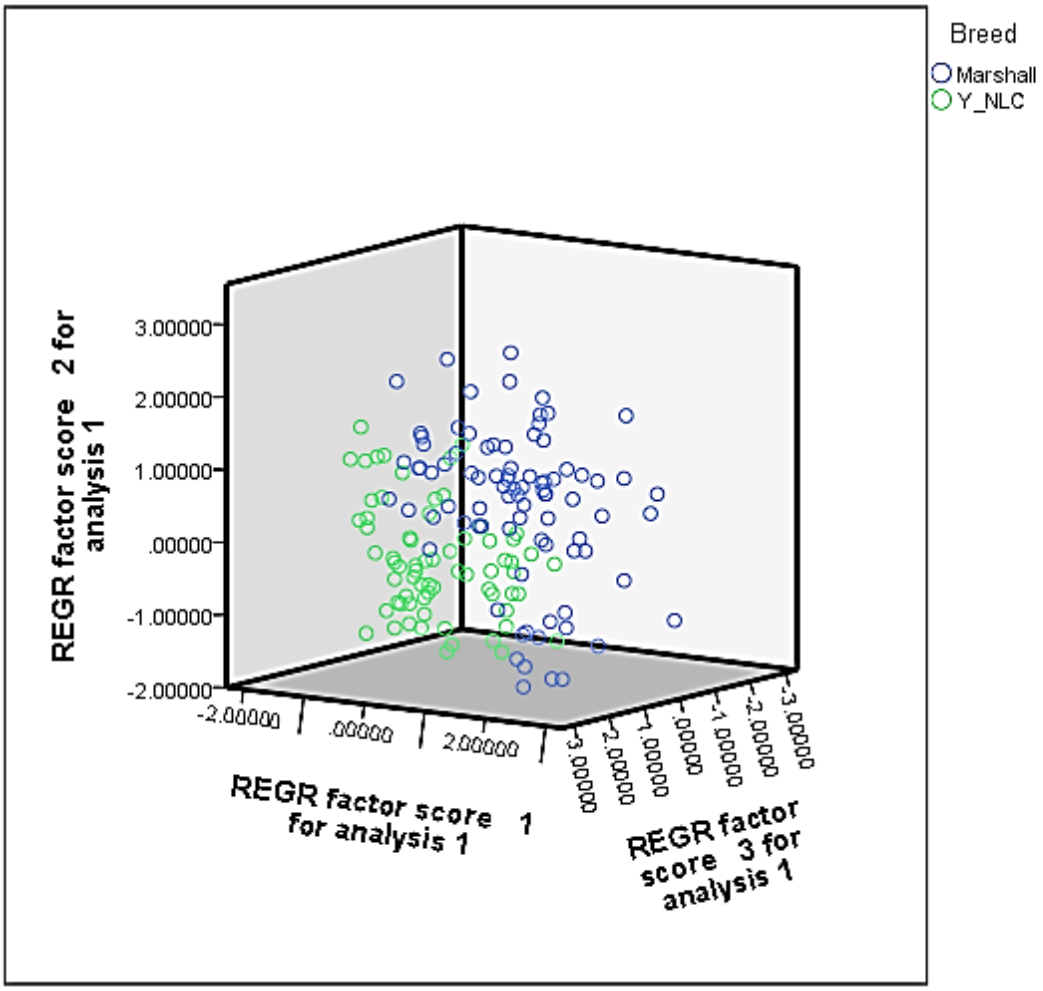


Figure 5.1: Graph showing the effect of genotype on morphometric indices

Figure 5.1 further explained the results from the Principal component that the genotype did not influence the morphometric indices. This is an indication that the effect of diet was prominent on the phenotypic expression of the body weight and morphometric parameters. This further substantiated the results as birds fed 15% MOSM had the least values for body weight and all the morphometric parameters.

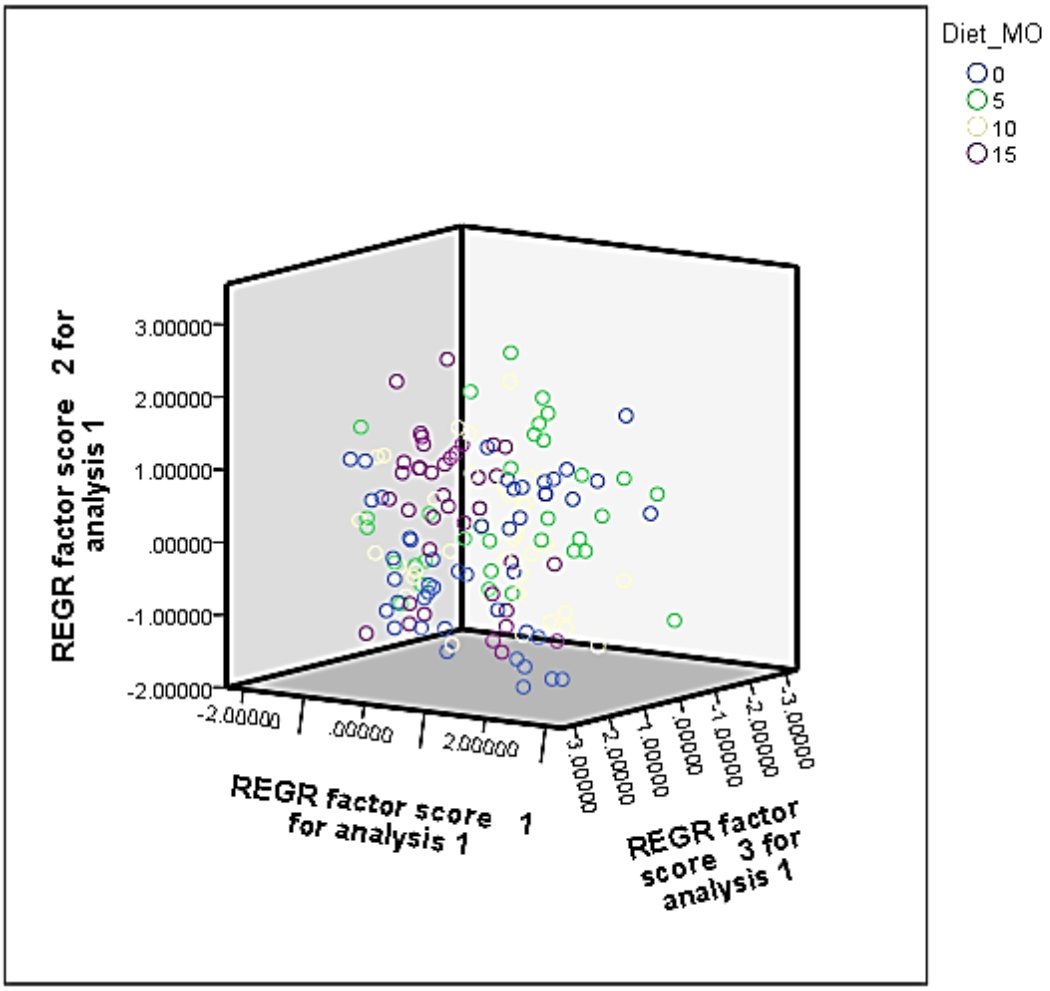


Figure 5.2. Graph showing the effect of diet on morphometric indices

From Figure 5.2, it was observed that the effect of diet (MOSM) on the morphometric parameters were similar in both genotypes. However, there were some similarities in the trend of the results. The figures also showed that for some morphometric traits the effects of feeding some graded levels of MOSM were significantly the same.

5.19. Multivariate Dimension Reduction Principal Component Analysis to identify salient dimensions underlying variation in Body Weight and Linear Measurements over an 8 week period in the YENLC (irrespective of diets)

Principal component analysis of fifty seven original variables in 96 chickens revealed that twelve principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.12), collectively explaining 85.029% of the overall variation. PC1 accounted for 37.11% of total variance while PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11 and PC12 accounted for the successively lower proportions of the explained variance.

Table 5.12: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient dimension underlying variation in Body weight and linear measurements over an 8 week period in the entire set of YENLC

Principal Components	Eigen Value	% of Variance	Cumulative %
1	21.153	37.110	37.110
2	6.946	12.186	49.296
3	3.542	6.214	55.511
4	3.265	5.728	61.239
5	2.640	4.631	65.870
6	2.379	4.174	70.045
7	2.011	3.529	73.573
8	1.609	2.824	76.397
9	1.352	2.371	78.768
10	1.300	2.281	81.049
11	1.195	2.097	83.146
12	1.073	1.883	85.029

5.20. Rotated Component Matrix and Communalities of the length of body parts of the YENLC

As shown in Table 5.13, Communalities in the whole of the experimental birds ranged between 0.75 and 1.00. PC1 had high loadings (correlations between the components and the variables) on thigh lengths at weeks 5and 4(0.834 and 0.770) while PC2 was orthogonal to PC1 and loaded heavily on body girth week 5 (0.848) and body girth week 6 (0.810). PC3 loaded heavily on body weight week 6 (0.840).

Table 5.13: Analysis showing the Principal Components extracted and their communalities of the length of body parts of the YENLC

	Component												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Communalities**
BW0	-.043	.029	.033	.148	.213	-.056	.137	.912	.073	-.052	.059	-.071	.941
BW1	.080	.117	.215	.091	.240	.066	.070	.847	-.030	.055	-.021	.055	.867
TL_1	.317	-.069	.383	-.108	.152	.199	.137	.165	.239	.544	.052	-.005	.727
WL_1	.127	.011	.092	.187	.150	.764	-.100	.149	.184	.212	.084	.071	.789
SL_1	-.080	.162	.267	.380	.141	.181	.251	.591	-.067	.221	.075	.126	.789
BL_1	.044	.123	.120	-.060	.236	.036	.161	.035	.830	.058	.045	.089	.821
KL_1	.085	.199	.122	.508	.060	.349	.276	.353	.041	.342	-.012	.113	.777
BG_1	.048	.049	.055	.030	.101	.008	.865	.141	.105	.023	.223	.004	.848
BW2	.116	.144	.731	.115	.235	.155	.126	.288	.086	.103	-.081	.156	.809
TL_2	.411	-.036	.492	-.114	.270	.242	.068	.165	.347	.287	.034	-.029	.794
WL_2	.336	.133	.209	.250	.093	.761	.042	-.018	.176	-.116	-.013	.013	.872
SL_2	.084	.059	.322	.628	.343	.244	.206	.323	.148	.081	.037	-.165	.889
BL_2	-.076	.022	.090	-.073	.255	.160	.119	-.031	.865	.029	.061	.035	.880
KL_2	.338	.095	.229	.531	.194	.473	.193	.154	-.012	.073	.155	-.176	.840
BG_2	-.004	.011	.164	.124	.194	.074	.849	.118	.263	-.026	-.015	.121	.904
BW3	.258	.042	.729	.172	.194	.074	.304	.093	.025	.177	-.072	.090	.819
TL_3	.709	.218	.316	.087	.178	.008	-.026	.040	-.053	.126	.017	-.191	.748

Table 5.13: Analysis showing the Principal Components extracted and their communalities of the length of body parts of the YENLC (contd)

	Component												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Communalities**
SL_3	.194	-.010	.172	.691	.322	.122	.215	.247	-.007	-.007	.007	-.207	.814
BL_3	.242	.660	.045	.247	.018	.007	-.045	.074	.432	.028	-.056	-.293	.841
KL_3	.038	-.059	.272	.190	.664	.361	.132	-.028	-.022	.024	.191	-.194	.780
BG_3	.154	.333	.263	.198	.244	-.086	.711	.102	-.097	.117	-.225	-.050	.902
BW4	.185	-.005	.748	.226	.354	-.033	.234	.102	.036	.151	-.062	.089	.872
TL_4	.770	.299	.233	.257	-.092	-.001	.119	.118	.006	.213	.021	-.055	.888
WL_4	.617	.422	.015	.405	-.113	.294	.043	-.064	-.151	-.060	-.106	-.161	.891
SL_4	.429	.356	.082	.715	.031	.111	.000	.171	-.064	-.018	-.066	-.182	.912
BL_4	.314	.748	.051	.200	-.037	.000	.033	.026	-.005	.189	.251	-.185	.838
KL_4	.156	.197	.310	.210	.727	.318	.093	.106	.066	.056	-.012	-.186	.894
BG_4	.156	.807	.173	.125	-.066	.059	.147	.008	-.077	-.190	-.202	.049	.836
BW5	.148	.097	.829	.221	.280	.093	.151	.051	.080	.142	-.117	.056	.924
TL_5	.834	.168	.252	.266	.047	.035	.022	.114	.167	.097	-.009	.054	.914
WL_5	.627	.480	.043	.309	.120	.305	.030	-.019	-.192	-.075	-.156	-.039	.898
SL_5	.365	.445	.159	.714	.091	.118	-.028	.171	-.009	-.115	-.021	.002	.933
BL_5	.208	.810	.121	.249	.032	.007	.054	.116	.009	.187	.295	.012	.916
KL_5	.096	.071	.199	.100	.852	.143	.099	.238	.172	.019	.000	.037	.908
BG_5	.186	.848	.168	.086	.053	.081	.111	.094	.002	-.178	-.102	.189	.898
BW6	.146	.226	.840	.178	.164	.080	-.022	.033	.158	-.139	.007	-.038	.890
TL_6	.752	.224	.091	.210	.072	.200	-.049	-.052	.123	-.095	.061	.227	.798
WL_6	.502	.478	.102	.160	.390	.305	.076	.008	-.211	-.062	-.085	.098	.832
SL_6	.341	.358	.117	.765	.098	.153	-.022	.054	-.023	-.074	.004	.108	.897
BL_6	.099	.810	.056	.182	.075	.121	-.048	.003	.117	.135	.259	.073	.829

Table 5.13: Analysis showing the Principal Components extracted and their communalities of the length of body parts of the YENLC (contd)

	Component												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Communalities**
BG_6	.256	.670	.244	.126	.299	.027	.052	.076	.091	-.005	-.042	.417	.872
BW7	.422	.030	.584	.012	.129	.013	-.018	.059	.034	-.470	.211	-.074	.813
TL_7	.716	.142	.277	.210	.128	.108	-.018	-.037	.164	-.011	.235	.162	.792
WL_7	.645	.127	-.091	.278	.049	.305	.083	-.125	-.211	-.373	.082	.078	.833
SL_7	.368	.155	.042	.735	.125	.152	.025	-.115	-.064	-.104	.145	.269	.863
BL_7	.349	.511	-.077	.201	-.118	.073	.134	.090	.167	-.183	.580	.148	.895
KL_7	.134	-.040	.047	.087	.820	.054	.108	.034	.141	-.164	-.007	.259	.831
BG_7	.309	.522	.144	-.030	.297	.063	.080	-.003	.193	-.147	.118	.526	.838
BW8	.044	.347	.705	-.099	.011	.234	-.144	.011	-.120	-.173	.251	-.026	.813
TL_8	.659	.198	.206	.225	.033	.116	.171	-.046	.063	.188	.450	.167	.881
WL_8	.618	.295	.065	.270	.333	.258	.149	.017	-.185	-.068	.085	.066	.796
SL_8	.337	.343	.111	.666	.119	-.020	.119	.052	-.123	.090	.251	.115	.818
BL_8	.418	.496	-.174	.187	-.015	.016	.148	.140	.147	.014	.544	-.021	.847
KL_8	.048	.035	.222	.178	.751	-.139	.101	.152	.184	.202	-.007	.105	.786
BG_8	.147	.247	.295	-.003	.406	-.134	.220	.109	.134	.284	.105	.551	.825

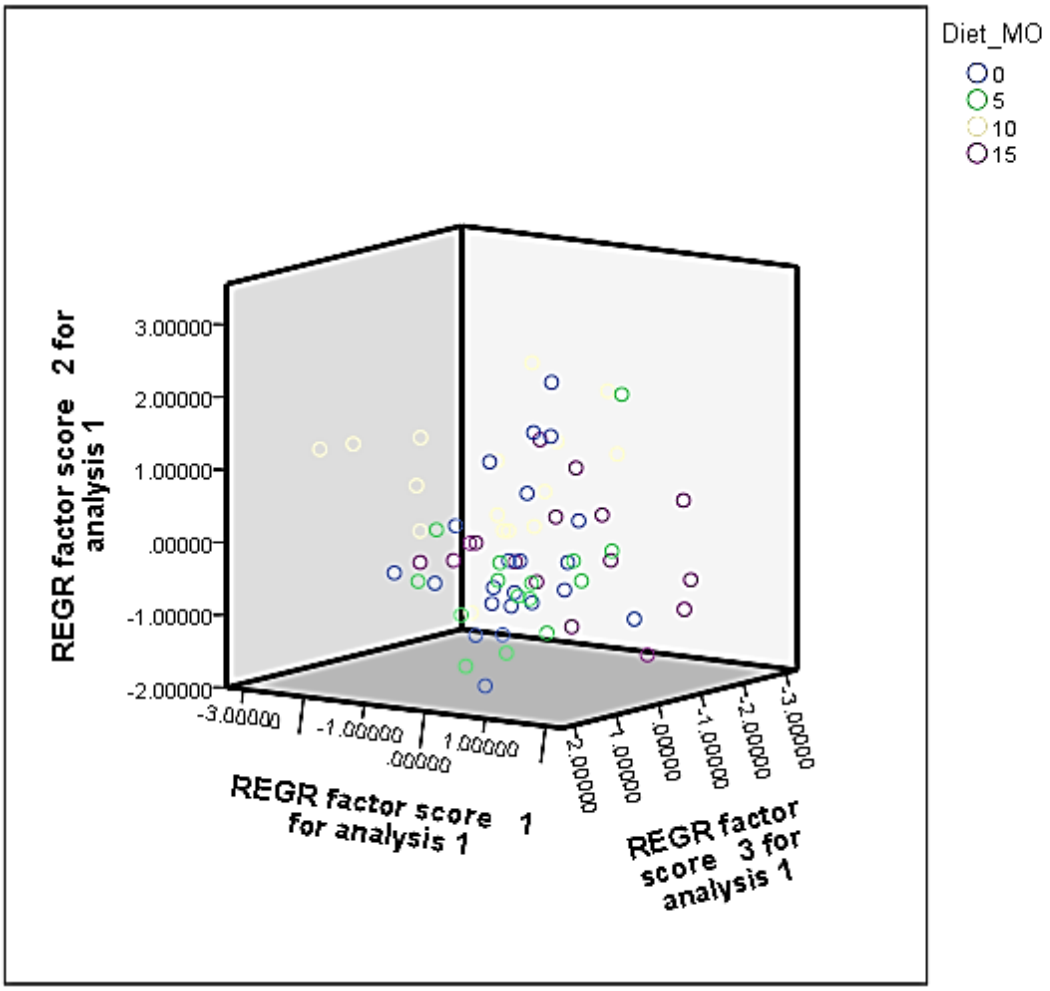


Figure 5.3. Graph showing the effect of MOSM on Morphometric parameters of YENLC

Figure 5.3. showed that the diet did not influence($p>0.05$) the morphometrics parameters in YENLC. The results also substantiated that for most of the traits, the effect of 0% MOSM and 5% MOSM inclusion were similar while the chickens fed 10% and 15% MOSM were significantly different from 0% and 5% MOSM inclusion group.

5.21. Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body Weight and Linear Measurements over an 8 week period in the Marshall broilers (irrespective of diets)

Principal component analysis of fifty seven original variables in 96 chickens revealed that twelve principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.14), collectively explaining 82.523% of the overall variation. PC1 accounted for 38.513% of total variance while PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11 and PC12 accounted for the successively lower proportions of the explained variance.

Table 5.14: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body weight and linear measurements over an 8 week period in the entire set of Marshall

Component	Eigen Value	% of Variance	Cumulative %
1	21.953	38.513	38.513
2	7.067	12.399	50.912
3	3.112	5.459	56.371
4	2.642	4.635	61.006
5	2.335	4.097	65.102
6	2.043	3.584	68.687
7	1.647	2.890	71.577
8	1.628	2.856	74.433
9	1.338	2.347	76.780
10	1.139	1.999	78.779
11	1.126	1.975	80.754
12	1.008	1.769	82.523

5.22. Rotated Component Matrix and Communalities of the length of body parts of the Marshall Broilers

As presented in Table 5.15, for the broiler chickens, PC1 had the highest positive loadings (correlations between the components and the variables) on body weights at weeks 6 and 7(0.942 and 0.932 respectively) while PC2 was orthogonal to PC1 and loaded heavily on thigh length week 5 (0.876). PC3 loaded heavily on keel length weeks 8 (0.723).

Table 5.15: Analysis showing the Principal Components extracted and their communalities of Marshall broilers

	Component												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Communalities**
BW0	-.115	-.067	.015	-.039	.052	-.057	.017	.049	-.065	.848	.109	.040	.765
BW_1	.416	.225	-.070	.084	.023	.072	-.199	.043	.074	.356	.655	.050	.847
TL_1	-.009	.027	.133	.116	.033	.036	.053	-.052	.898	-.005	.000	-.116	.861
WL_1	.231	.206	.219	-.051	.127	.109	.745	.080	-.037	.217	-.166	-.110	.824
SL_1	.255	.086	.176	.302	.358	.190	.152	-.161	-.007	.499	-.285	.218	.786
BL_1	.258	-.212	.212	.190	-.007	.728	.000	-.122	.138	-.042	-.035	.077	.766
KL_1	.131	-.032	.482	-.121	-.030	.102	.113	.537	.151	.113	-.315	-.101	.722
BG_1	.550	.088	.234	.120	.274	.374	-.204	-.081	.141	.068	-.335	.091	.787
BW2	.808	.049	.226	.091	.156	.155	.052	.074	-.016	.154	.175	-.080	.831
TL_2	-.291	.103	-.112	-.061	-.045	.175	-.010	.265	.753	-.096	.036	.107	.803
WL_2	.125	.165	-.061	-.010	.046	.012	.855	.093	.072	-.064	.010	.228	.850
SL_2	.072	.307	-.058	-.041	.131	.023	.142	.080	-.047	.073	.043	.814	.820
BL_2	.326	-.252	.408	.111	.244	.642	.184	.054	.116	.001	-.011	-.052	.874
KL_2	-.132	.183	-.022	.121	.140	-.044	.082	.846	.029	-.039	.090	.147	.842
BG_2	.714	.198	.110	.049	.105	.375	-.088	.085	-.030	.006	-.122	.113	.759
BW3	.889	.055	.117	.140	.179	.140	.086	-.025	-.070	.098	.066	.005	.905
TL_3	-.023	.804	-.224	.010	-.131	.048	.076	.142	.275	-.111	.019	-.020	.831
WL_3	.370	.450	.033	.136	.000	.062	.490	.013	.055	-.170	.359	.021	.764
SL_3	.151	.707	.192	-.101	-.001	-.004	.032	-.037	-.003	.094	-.068	.483	.818
BL_3	.484	.230	.296	-.013	.157	.536	.213	.140	.128	.015	.167	-.097	.805
KL_3	.193	.177	.211	.480	-.086	-.059	.079	.625	.106	.069	-.022	-.080	.774
BG_3	.730	.284	.156	.129	-.175	.348	.029	.067	-.043	-.035	.073	.100	.830
BW4	.900	.088	.165	.131	.172	.118	.109	-.044	-.083	.065	-.038	-.013	.932
TL_4	.185	.839	-.220	.040	.059	.009	.010	.172	.070	-.099	-.021	-.072	.841
WL_4	.128	.667	-.147	.278	.269	-.022	.304	-.023	-.002	-.014	.359	.046	.856
SL_4	.052	.777	.037	.182	.088	.014	.062	.117	-.160	.033	-.085	.184	.734
BL_4	.493	.427	-.007	.089	.566	.234	.155	.089	.116	.059	.059	.020	.861
KL_4	.328	.297	.084	.730	.105	.126	.012	.293	.008	-.048	.082	-.106	.868

Table 5.15: Analysis showing the Principal Components extracted and their communalities of Marshall broilers (contd)

	Component												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Communalities**
BW5	.910	.113	.166	.145	.118	.085	.128	-.069	-.064	-.027	.014	-.027	.938
TL_5	.109	.876	-.030	-.004	.080	-.065	.091	.089	.005	-.006	-.126	-.097	.833
WL_5	.136	.687	-.127	.370	.286	-.011	.235	-.097	.004	.037	.287	.003	.873
SL_5	.214	.725	.218	.063	.111	.011	-.044	-.027	-.121	.111	.029	.290	.750
BL_5	.428	.446	.091	.079	.607	.222	.144	.067	.033	.184	-.019	.022	.875
KL_5	.338	.236	.126	.803	.040	.203	-.033	.139	.037	-.048	.068	-.063	.906
BG_5	.458	.513	-.024	.324	-.073	.207	.111	-.155	-.165	.261	.027	-.042	.760
BW6	.942	.120	.020	.105	.001	.030	.047	-.040	-.028	-.067	.022	.034	.925
TL_6	.189	.758	-.006	-.044	.367	-.060	.047	.128	.141	.144	.033	.168	.839
WL_6	.138	.666	.083	.363	.273	-.212	.095	-.158	.117	.080	.285	.069	.861
SL_6	.297	.463	.436	-.071	.440	-.125	-.149	.038	-.121	.260	.072	.183	.852
BL_6	.352	.416	.147	.158	.635	.061	.105	.138	-.076	.040	.016	.149	.810
KL_6	.292	.024	.521	.608	.114	.106	-.120	.003	.132	.122	-.099	.158	.833
BG_6	.409	.388	.244	.386	.346	-.038	-.011	-.155	-.076	.026	.035	.065	.684
BW7	.932	.145	.109	.100	.056	-.082	.087	.044	.013	-.010	.048	.032	.934
TL_7	.449	.581	.295	.164	.207	-.006	.076	.087	.008	-.195	.124	.011	.763
WL_7	.166	.606	.341	.382	.141	-.126	.070	-.151	.031	-.145	.349	.024	.865
SL_7	.496	.197	.653	-.050	.349	.022	.060	.032	-.133	.029	.021	.054	.863
BL_7	.639	.323	.271	.044	.407	.065	.138	.044	.035	-.129	.009	.258	.863
KL_7	.395	-.139	.679	.269	-.019	.137	-.004	.058	.153	.076	-.133	.048	.781
BG_7	.712	.204	.231	.188	.289	-.005	.094	-.177	.022	-.101	.046	.208	.817
BW8	.897	.179	.082	.077	.033	-.125	.072	.135	.020	-.033	.023	-.027	.893
TL_8	.361	.639	.344	-.022	.127	.097	.103	.118	.014	-.153	.103	.080	.749
WL_8	.209	.580	.370	.274	-.141	-.199	.080	-.077	-.037	-.229	.237	.116	.787
SL_8	.445	.177	.602	.064	.220	.317	.048	-.072	-.147	.014	.042	-.130	.792
BL_8	.511	.399	.370	.016	.218	.076	.266	.154	-.148	-.230	.040	.162	.808
KL_8	.178	-.133	.723	.215	-.047	.296	.040	.128	.054	-.037	.011	-.048	.734
BG_8	.699	.262	.345	.219	.050	.218	.068	-.045	-.147	-.186	.124	.083	.859

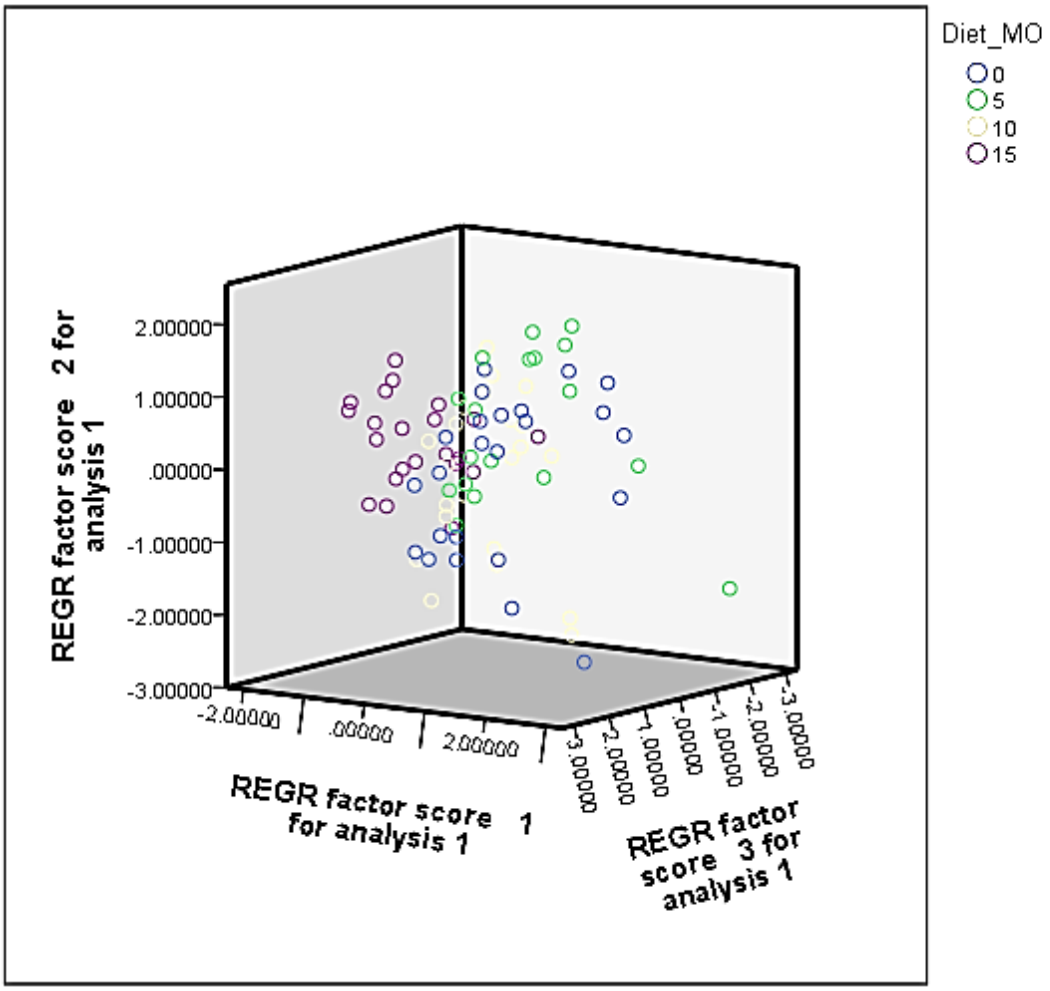


Figure 5.4: Graph showing effect of MOSM on Principal Components of Marshall Broilers

Figure 5.4 above showed that the inclusion of MOSM at 15% had much effect on the body weight and morphometric traits of Marshall Broilers when compared with other levels of inclusion.

5.23. Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body Weight and Linear Measurements over a 8 week period in the birds fed 0% MOSM

Principal component analysis of fifty seven original variables in 48 chickens revealed that seven principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.16), collectively explaining 89.692% of the overall variation. PC1 accounted for 69.831% of total variance while PC2, PC3, PC4, PC5, PC6 and PC7 accounted for the successively lower proportions of the explained variance.

Table 5.16: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body weight and linear measurements over an 8 week period in the entire set of birds fed 0% MOSM

	Eigen Value	% of Variance	Cumulative %
1	39.803	69.831	69.831
2	3.836	6.731	76.561
3	2.211	3.879	80.440
4	1.787	3.136	83.576
5	1.282	2.249	85.824
6	1.138	1.996	87.820
7	1.067	1.872	89.692

5.24. Rotated Component Matrix and Communalities of the length of body parts of the birds fed 0% MOSM

For the chickens in the control diet (0% MOSM), PC1 had the highest positive loadings (correlations between the components and the variables) on body length at week 2 (0.890) while PC2 was orthogonal to

PC1 and loaded heavily on thigh length week 4(0.902). PC3 loaded heavily on wing length week 2 (0.786) (Table 5.17)

Table 5.17: Analysis showing the Principal Components extracted and their communalities of all the birds in the control diet (0%)

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW0	.601	.139	.091	.262	.534	-.125	.215	.804
BW1	.848	.392	.172	.162	.134	-.056	.052	.953
TL_1	-.286	.117	.051	-.001	-.015	.804	-.111	.757
WL_1	.393	-.046	.749	.238	.132	.189	.093	.836
SL_1	.221	.136	-.016	-.032	.891	-.089	.142	.891
BL_1	.785	.178	.289	.138	.239	.099	.045	.820
KL_1	.269	-.010	.099	.047	.217	.099	.825	.822
BG_1	.759	.354	.100	.145	.291	-.061	.239	.877
BW2	.871	.373	.110	.144	.011	-.058	-.016	.934
TL_2	.094	.247	.081	.252	-.115	.766	.282	.819
WL_2	.393	.237	.786	-.056	-.061	.134	-.076	.858
SL_2	.176	.399	.610	.238	.012	-.198	.300	.748
BL_2	.890	.081	.238	.151	.220	.132	-.001	.944
KL_2	.133	.456	.262	.565	-.070	.315	.185	.752
BG_2	.807	.396	.153	.202	.076	-.116	.119	.905
BW3	.868	.410	.124	.109	.026	-.050	.035	.954
TL_3	.273	.821	.007	.166	-.114	.178	.124	.837
WL_3	.562	.584	.458	.012	-.136	-.062	.021	.890
SL_3	.512	.610	.284	.300	.126	-.056	.217	.871
BL_3	.782	.443	.186	.047	.164	.141	.182	.925
KL_3	.517	.447	.125	.595	-.145	.200	.094	.907
BG_3	.754	.533	.169	.090	-.054	-.129	.170	.939
BW_4	.887	.393	.103	.110	.045	-.088	.018	.974
TL_4	.156	.902	-.024	.028	-.069	.090	.167	.880
WL_4	.293	.861	.160	.039	.178	.141	-.134	.923
SL_4	.425	.788	.116	.213	.105	.002	.168	.900
BL_4	.612	.656	.113	.006	.260	.215	.103	.942
KL_4	.419	.713	.051	.455	.070	.157	-.056	.926

Table 5.17: Analysis showing the Principal Components extracted and their communalities of all the birds in the control diet (0%) (contd)

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW_5	.868	.424	.148	.060	-.041	-.102	.001	.971
TL_5	.472	.745	.101	.101	.002	.071	.075	.810
WL_5	.355	.822	.093	.138	.252	.089	-.146	.922
SL_5	.568	.703	.061	.242	.099	-.055	.182	.925
BL_5	.692	.561	.081	.040	.316	.177	.115	.946
KL_5	.441	.517	.118	.610	.145	.097	-.095	.887
BG_5	.729	.578	.146	.077	.137	-.050	.109	.925
BW_6	.819	.466	.151	.042	-.144	-.120	.069	.951
TL_6	.606	.643	.204	.195	.111	.098	.078	.889
WL_6	.386	.778	.154	.236	.202	.125	-.133	.908
SL_6	.768	.470	.148	.180	.185	-.037	.116	.915
BL_6	.723	.590	.139	.056	.219	.098	.029	.951
KL_6	.723	.217	.120	.549	.220	.018	.028	.935
BG_6	.776	.490	.218	.140	.209	.051	.045	.958
BW_7	.836	.449	.144	.114	-.082	-.104	.048	.954
TL_7	.621	.690	.160	.139	.044	-.003	-.012	.908
WL_7	.483	.724	.124	.220	.170	-.006	-.206	.893
SL_7	.840	.370	.142	.133	.161	-.050	.028	.909
BL_7	.711	.566	.240	.047	.161	.025	.116	.926
KL_7	.825	.160	.135	.344	.116	.021	.094	.865
BG_7	.747	.523	.226	.055	.119	-.029	.054	.904
BW_8	.796	.494	.119	.097	-.119	-.076	.067	.926
TL_8	.674	.584	.155	.105	.097	.132	.099	.867
WL_8	.572	.719	.172	.129	-.037	-.067	-.032	.898
SL_8	.794	.373	.105	.144	.292	.059	.104	.900
BL_8	.717	.541	.211	.049	.096	-.012	.227	.914
KL_8	.821	.175	.133	.317	.146	.131	.175	.892
BG_8	.785	.534	.167	.119	.034	-.013	.046	.947

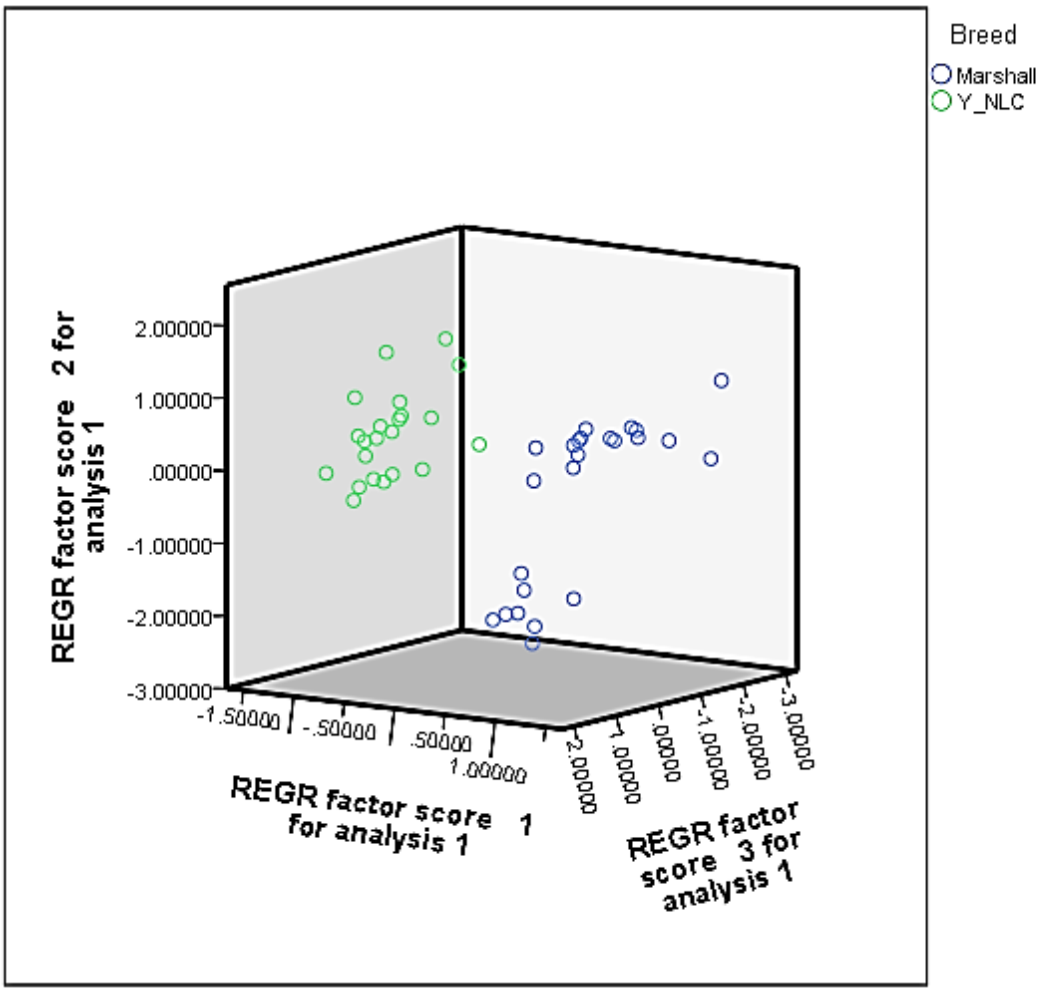


Figure 5.5. Graph showing the effect of 0% MOSM on Genotype

Figure 5.5 showed that the diet significantly influenced the genotype as the genotypic response were different to the diet hence the divergence of the genotype from each other. This implied that the expression of these phenotypic traits at 0% MOSM inclusion was different per genotype. This showed that genotypes significantly affected the expression of these biological traits.

5.25. Multivariate Dimension Reduction Principal Component Analysis to identify salient dimensions underlying variation in Body Weight and Linear Measurements over a 8 week period in the birds fed 5% MOSM

Principal component analysis of fifty seven original variables in 48 chickens revealed that seven principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.18), collectively explaining 90.251% of the overall variation. PC1 accounted for more than half of the total variation (69.848%) while PC2, PC3, PC4, PC5, PC6 and PC7 accounted for the successively lower proportions of the explained variance.

Table 5.18: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient dimension underlying variation in Body weight and linear measurements over an 8 week period in the entire set of birds fed 5% MOSM

	Eigenvalues	% of Variance	Cumulative %
1	39.813	69.848	69.848
2	3.585	6.289	76.137
3	2.238	3.927	80.064
4	2.190	3.843	83.907
5	1.377	2.415	86.322
6	1.176	2.064	88.386
7	1.063	1.865	90.251

5.26. Rotated Component Matrix and Communalities of the length of body parts of the birds fed 5% MOSM

For the chickens fed 5% MOSM, PC1 had the highest positive loadings (correlations between the components and the variables) on body length at week2 (0.910) and body girth at week 2 (0.882) while PC2 was orthogonal to PC1 and loaded heavily on thigh length week 4 (0.862) and thigh length week 5(0.860). PC3 loaded heavily on wing lengths at weeks 7 and 8 (0.570 and 0.553) (Table 5.19).

Table 5.19: Analysis showing the Principal Components extracted and their communalities of all the birds fed 5% MOSM

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW0	.605	.565	.005	.239	-.093	.002	.132	.768
BW_1	.829	.463	.154	.103	-.027	.030	.126	.953
TL_1	-.232	.076	-.050	-.851	.039	.097	-.014	.797
WL_1	.117	.270	.019	.053	.096	.835	.152	.819
SL_1	.182	.605	-.173	.163	.481	.185	.272	.796
BL_1	.860	.078	.062	-.303	.157	.140	.077	.891
KL_1	-.121	-.018	.060	-.089	.869	.105	.005	.792
BG_1	.871	.372	.008	.019	.031	.083	.000	.906
BW_2	.827	.473	.107	.139	-.055	.074	.140	.966
TL_2	-.024	.009	-.025	-.950	.006	-.048	-.030	.907
WL_2	.233	.224	.129	-.155	.306	.814	-.127	.918
SL_2	.605	.540	-.068	-.028	.100	.179	.255	.770
BL_2	.910	.099	.138	-.213	.075	.023	.041	.909
KL_2	.033	.157	.057	.020	.913	.123	-.008	.878
BG_2	.882	.389	-.004	.059	.062	.019	.047	.938
BW_3	.866	.334	-.046	.182	-.151	.146	.090	.950
TL_3	.237	.839	.116	-.229	.014	.003	.238	.882
WL_3	.690	.477	.251	-.056	-.012	.167	.217	.846
SL_3	.610	.625	.087	.068	-.009	.095	.286	.866
BL_3	.854	.391	.107	-.045	.069	.084	.080	.914
KL_3	.467	.247	.114	.045	.010	.040	.798	.932
BG_3	.843	.414	.071	.070	.081	.033	.181	.932
BW_4	.855	.343	-.047	.214	-.126	.166	.125	.955
TL_4	.320	.862	.057	-.129	.047	.193	-.035	.906
WL_4	.527	.681	.254	.095	.179	.254	-.097	.920
SL_4	.710	.541	.172	.097	.170	.156	.028	.890
KL_4	.804	.187	.247	.062	.185	.110	.319	.895
BG_4	.662	.510	.149	.135	.026	.247	.147	.822

Table 5.19: Analysis showing the Principal Components extracted and their communalities of all the birds fed 5%

MOSM (contd)

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW_5	.876	.352	.029	.163	-.133	.129	.107	.964
TL_5	.342	.860	.178	-.065	.059	.149	.035	.919
WL_5	.520	.696	.271	.075	.171	.170	.136	.912
SL_5	.695	.537	.130	.160	.137	.123	.017	.848
BL_5	.748	.610	.143	.073	.084	.056	.046	.970
KL_5	.814	.205	.210	.014	.140	.027	.388	.919
BG_5	.638	.532	.157	.181	.049	.247	.204	.853
BW_6	.839	.379	-.015	.185	-.156	.167	.127	.950
TL_6	.444	.834	.109	-.029	-.011	.159	.112	.944
WL_6	.552	.666	.258	.111	.040	.171	.280	.937
SL_6	.602	.616	.172	.292	.146	.078	.056	.887
BL_6	.730	.620	.117	.062	.108	.081	.015	.953
KL_6	.798	.308	.184	.003	-.024	.048	.419	.944
BG_6	.699	.503	.298	.238	-.004	.059	.202	.932
BW_7	.770	.444	.039	.171	-.199	.221	.158	.933
TL_7	.647	.456	.458	-.062	.024	.181	.110	.885
WL_7	.516	.431	.570	.111	.246	.210	.078	.900
SL_7	.769	.365	.308	.231	.139	.108	.071	.908
BL_7	.771	.491	.237	.018	-.057	.170	-.091	.933
KL_7	.756	.229	.352	.108	-.036	.140	.308	.875
BG_7	.793	.388	.213	.224	-.126	.170	.078	.926
BW_8	.760	.452	.011	.164	-.204	.244	.131	.928
TL_8	.659	.484	.414	-.084	.080	.082	.104	.871
WL_8	.576	.439	.553	.161	.131	.072	.254	.943
SL_8	.816	.363	.298	.173	.154	.050	.038	.944
BL_8	.798	.391	.396	.021	-.011	.050	.002	.949
KL_8	.787	.232	.405	.117	.063	-.047	.218	.905
BG_8	.858	.241	.314	.196	.026	.069	.143	.957

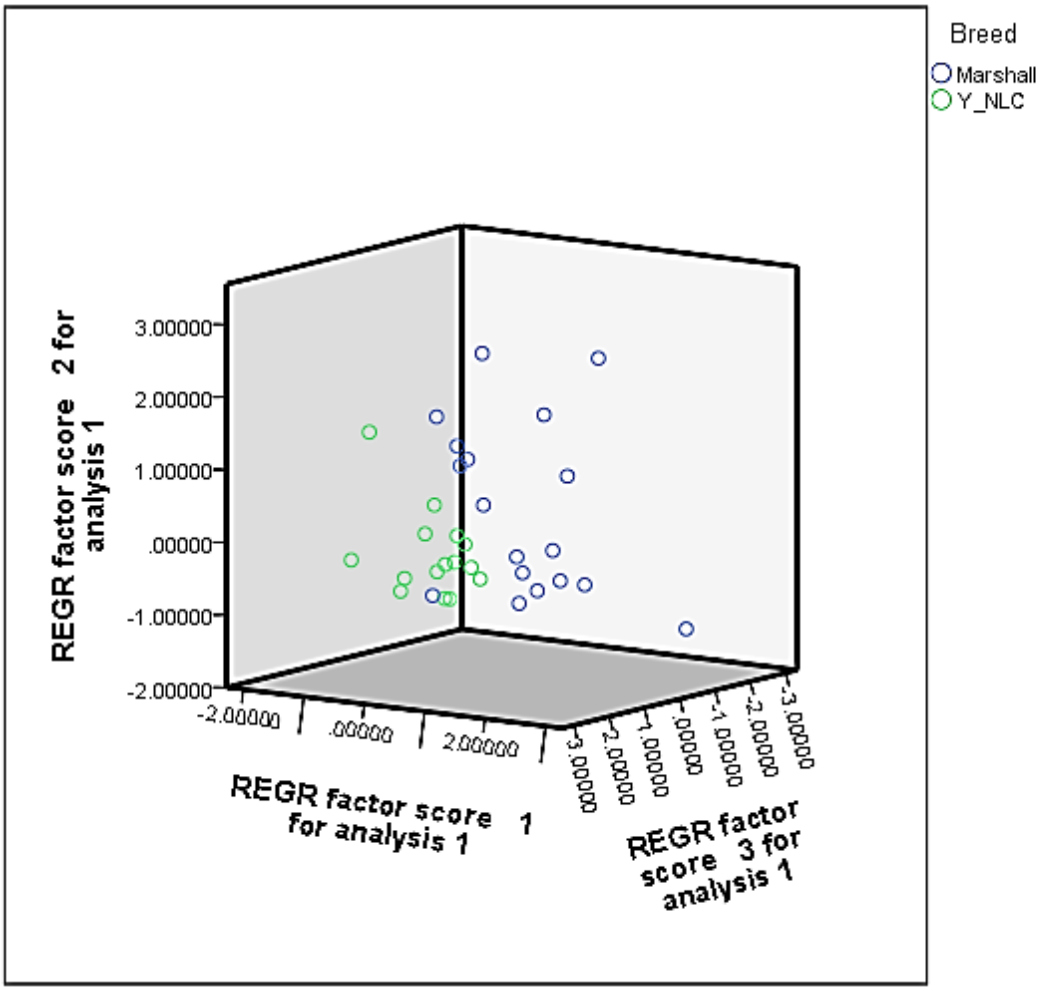


Figure 5.6. Graph showing the effect of 5% MOSM on Genotype

From Figure 5.6, it was observed that the diet (5% MOSM) had effect on the genotype but there were slight interaction at some points between the two genotypes. This implied that the genotypic responses of these birds were different significantly. This inferred that the phenotypic expression of YENLC chickens fed 5% MOSM could not be used to generalize for Marshall Broilers fed the same level of MOSM.

5.27. Multivariate Dimension Reduction Principal Component Analysis to identify salient dimensions underlying variation in Body Weight and Linear Measurements over a 8 week period in the birds fed 10% MOSM

Principal component analysis of fifty seven original variables in 48 chickens revealed that eight principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.21), collectively explaining 88.136% of the overall variation. PC1 accounted for more than half of the total variation (60.312%) while PC2, PC3, PC4, PC5, PC6, PC7 and PC8 accounted for the successively lower proportions of the explained variance.

Table 5.20: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient features underlying variation in Body weight and linear measurements over an 8 week period in the entire set of birds fed 10% MOSM

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	34.378	60.312	60.312
2	5.722	10.039	70.351
3	2.758	4.839	75.189
4	1.869	3.278	78.468
5	1.638	2.874	81.342
6	1.423	2.496	83.838
7	1.298	2.277	86.115
8	1.152	2.021	88.136

5.28. Rotated Component Matrix and Communalities of the length of body parts of the birds fed 10% MOSM

From Table 5.22, the chickens fed 10% MOSM, PC1 had the highest positive loadings (correlations between the components and the variables) on keel length at week 8 (0.892) while PC2 was orthogonal to PC1 and loaded heavily on thigh length week 5 (0.875). PC3 loaded heavily on wing length at week 2 (0.857).

Table 5.21: Analysis showing the Principal Components extracted and their communalities of all the fed 10% MOSM

	Component								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Communalities**
BW0	.783	.337	.103	.235	.176	-.166	.139	.217	.919
BW_1	.865	.411	.057	.050	.156	-.032	.091	.143	.977
TL_1	.090	-.115	-.007	.099	-.005	-.056	.928	-.060	.899
WL_1	-.591	.034	.463	.093	.115	-.044	.295	.001	.675
SL_1	.153	.088	.001	.808	.104	-.114	.228	.014	.760
BL_1	.753	.209	-.073	.076	.254	.276	.081	-.010	.770
KL_1	-.040	.106	.078	.850	-.048	.118	-.028	-.093	.767
BG_1	.858	.331	-.063	.031	.152	.100	.105	.089	.902
BW_2	.877	.366	.107	-.005	.152	-.067	.064	.087	.953
TL_2	.485	.125	.175	.090	.079	.212	.693	.096	.830
WL_2	-.077	.231	.857	.118	.022	.126	.064	-.032	.829
SL_2	.419	.559	.239	.429	.155	.228	.053	.208	.850
BL_2	.751	.087	.004	.111	.184	.427	.152	-.042	.825
KL_2	.286	.266	.532	.511	-.081	.211	-.057	.201	.791
BG_2	.805	.439	.030	-.035	.194	.057	.049	.187	.921
BW_3	.852	.435	.115	-.012	.159	-.041	.033	.117	.970
TL_3	.413	.744	.164	.007	.224	.178	.191	.093	.878
WL_3	.426	.515	.623	-.115	.161	.104	-.001	-.062	.889
SL_3	.456	.751	-.028	.209	-.013	.130	-.071	.220	.887
BL_3	.683	.451	.102	.014	.163	.292	.056	.195	.834
KL_3	.753	-.024	.267	.223	.026	.121	.053	-.188	.742
BG_3	.845	.430	-.010	-.047	.117	.090	-.051	.118	.939
BW_4	.827	.487	.126	.012	.092	-.052	.023	.069	.954
TL_4	.322	.826	.096	-.008	.276	.010	.082	.100	.889
WL_4	.131	.688	.563	.044	.170	-.088	-.042	-.008	.848
SL_4	.223	.831	.089	.307	.245	-.052	-.085	.055	.915
BL_4	.374	.484	.318	.065	.619	.233	.054	.050	.923
KL_4	.765	.126	.196	.255	.157	-.031	.012	-.440	.924

Table 5.21: Analysis showing the Principal Components extracted and their communalities of all the fed 10% MOSM (contd)

	Component								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Communalities**
BW_5	.795	.493	.137	-.023	.099	-.085	.006	.080	.918
TL_5	.311	.875	.022	.045	.120	-.026	.015	.005	.880
WL_5	.188	.782	.451	-.048	.215	-.033	.069	-.123	.920
SL_5	.179	.864	.054	.232	.179	.046	-.108	.055	.884
BL_5	.173	.545	.270	.069	.662	.189	.039	.029	.882
KL_5	.858	.164	.093	.189	.146	-.005	.081	-.327	.943
BG_5	.621	.453	-.184	-.003	.475	-.008	.073	-.231	.910
BW_6	.817	.484	.146	-.044	.158	-.057	.022	.129	.971
TL_6	.296	.858	.085	.005	.110	.136	-.026	-.056	.866
WL_6	.273	.781	.087	-.005	.073	.078	.136	-.321	.826
SL_6	.442	.769	.082	.253	.155	.094	-.115	.041	.905
BL_6	.088	.519	.265	.141	.321	.665	-.034	-.145	.936
KL_6	.872	.243	.028	.123	-.059	.065	.101	-.226	.905
BG_6	.686	.544	-.071	-.031	.191	.216	.140	-.135	.893
BW_7	.798	.527	.148	-.015	.034	.030	-.013	.084	.946
TL_7	.439	.779	.040	-.017	-.032	.164	-.073	-.073	.840
WL_7	.409	.789	.230	.104	.040	.104	.017	-.196	.904
SL_7	.589	.663	.149	.198	.069	.230	-.109	-.013	.917
BL_7	.351	.610	.239	.017	-.045	.550	.053	.172	.889
KL_7	.866	.198	.049	.124	-.074	.221	.080	-.241	.927
BG_7	.687	.481	.117	-.112	-.081	.312	.171	.012	.863
BW_8	.794	.433	.091	.007	-.017	.061	-.060	.043	.835
TL_8	.444	.813	.141	-.011	-.029	.125	.002	.119	.908
WL_8	.580	.679	.098	.081	-.096	.126	.121	-.143	.874
SL_8	.691	.502	.002	.212	.046	.162	.013	.150	.826
BL_8	.335	.684	.250	.026	.025	.408	.119	.164	.851
KL_8	.892	.218	-.024	.125	.005	.159	.073	-.057	.893
BG_8	.775	.536	-.041	-.146	-.016	.052	.119	.092	.937

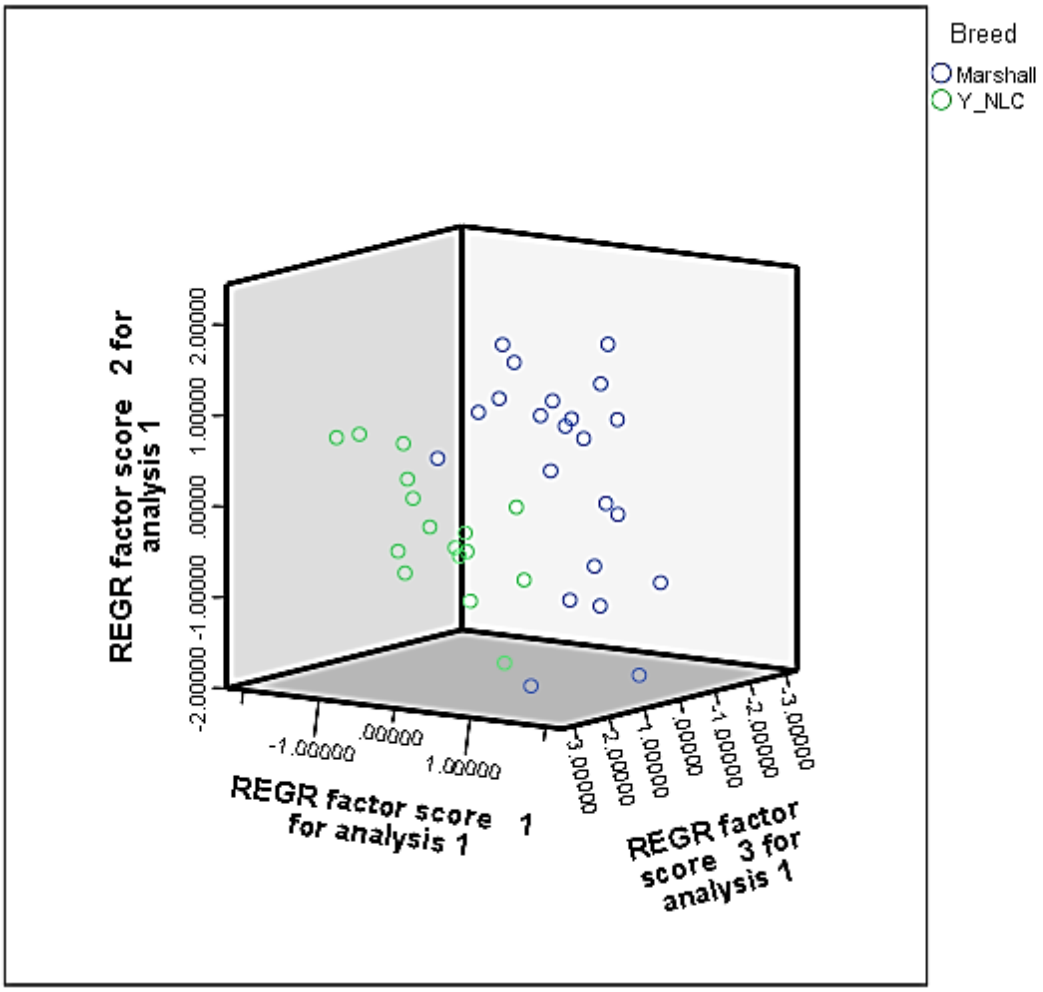


Figure 5.7. Graph showing the nutrigenetic effect of 10% MOSM on YENLC and Marshall Broilers

It was observed from Figure 5.7 that 10% inclusion MOSM had different effects on the two genotypes of birds used for the study.

5.29. Multivariate Dimension Reduction Principal Component Analysis to identify salient dimensions underlying variation in Body Weight and Linear Measurements over a 8 week period in the birds fed 15% MOSM

Principal component analysis of fifty seven original variables in 48 chickens revealed that seven principal components contributed significantly (Eigen value ≥1) to variation in the examined data (Table 5.24), collectively explaining 90.060% of the overall variation. PC1 accounted for more than half of the total variation (72.225%) while PC2, PC3, PC4, PC5, PC6 and PC7 accounted for the successively lower proportions of the explained variance.

Table 5.22: Eigen Values, Percentage of Total Variance and Cumulative Percentage for Multivariate Dimension Reduction Principal Component Analysis to identify salient dimensions underlying variation in Body weight and linear measurements over an 8 week period in the entire set of birds fed 15% MOSM

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	41.168	72.225	72.225
2	2.860	5.018	77.243
3	2.060	3.615	80.858
4	1.742	3.056	83.914
5	1.463	2.567	86.481
6	1.025	1.798	88.279
7	1.015	1.781	90.060

5.30. Rotated Component Matrix and Communalities of the length of body parts of the birds fed 15% MOSM

For the chickens fed 15% MOSM, PC1 had the highest positive loadings (correlations between the components and the variables) on wing length at week 1 (0.866) while PC2 was orthogonal to PC1 and loaded heavily on body weights at weeks 6 and 7 (0.808 and 0.831 respectively). PC3 loaded heavily on body lengths at weeks 1 and 2 (0.916 and 0.827) – (Table 5.25)

Table 5.23: Analysis showing the Principal Components extracted and their communalities of all the birds fed 15% MOSM

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW0	.388	.507	.422	.516	.232	.013	.035	.907
BW_1	.519	.637	.367	.320	.200	.117	.089	.973
TL_1	.042	.151	.296	-.005	.041	.888	.022	.903
WL_1	.145	.128	.202	.092	.830	.068	-.005	.780
SL_1	-.003	.117	.248	.839	.036	.007	.031	.781
BL_1	.071	.213	.916	.136	.068	.135	.098	.940
KL_1	.167	.082	.012	.555	.493	.457	-.158	.820
BG_1	.485	.440	.423	.339	.089	.176	.309	.857
BW_2	.485	.675	.324	.252	.162	.111	.138	.918
TL_2	.373	.490	.328	.211	.304	.432	.275	.887
WL_2	.470	.348	.202	.131	.641	-.074	.238	.873
SL_2	.463	.379	.203	.642	.253	-.057	.223	.928
BL_2	.196	.148	.827	.232	.289	.173	.119	.926
KL_2	.590	.403	-.008	.401	.463	.065	.064	.893
BG_2	.473	.463	.393	.393	.168	.141	.401	.956
BW_3	.505	.671	.319	.264	.160	.054	.186	.940
TL_3	.621	.425	.163	.010	.402	.256	.280	.899
WL_3	.655	.368	.121	.021	.508	.180	-.128	.886
SL_3	.604	.438	.162	.452	.324	.078	.088	.905
BL_3	.582	.376	.417	.164	.297	.118	-.048	.785
KL_3	.574	.361	.347	.360	.398	.046	-.118	.884
BG_3	.543	.590	.355	.208	.288	.148	.110	.929
BW_4	.509	.689	.343	.217	.139	.122	.166	.961
TL_4	.706	.401	.159	.003	.443	.015	.169	.909
WL_4	.775	.429	-.004	.078	.365	.010	.117	.938
SL_4	.642	.432	.201	.354	.369	-.060	-.001	.904
BL_4	.643	.452	.183	.261	.191	-.044	.201	.798
KL_4	.455	.539	.340	.384	.371	.111	-.104	.922

Table 5.23: Analysis showing the Principal Components extracted and their communalities of all the birds fed 15% MOSM (contd)

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Communalities**
BW_5	.364	.791	.257	.135	.313	.093	-.047	.951
TL_5	.701	.451	.222	.087	.361	.101	.151	.916
WL_5	.765	.443	.148	.171	.326	.072	.013	.945
SL_5	.671	.473	.231	.377	.231	.033	.015	.924
BL_5	.572	.546	.284	.361	.013	.010	.219	.884
KL_5	.444	.560	.432	.329	.289	.145	-.100	.920
BG_5	.601	.648	.202	.213	.161	.068	.211	.944
BW_6	.381	.808	.258	.217	.201	.063	.057	.959
TL_6	.752	.430	.179	.194	.106	.187	.212	.911
WL_6	.690	.547	.235	.177	.090	.161	-.130	.913
SL_6	.717	.481	.265	.334	.057	.094	-.019	.940
BL_6	.543	.532	.256	.418	-.165	-.072	-.008	.852
KL_6	.438	.520	.508	.356	.113	.147	-.185	.916
BG_6	.633	.549	.284	.320	-.046	.107	.048	.901
BW_7	.379	.831	.156	.055	.207	.091	-.034	.914
TL_7	.756	.392	.317	.106	.181	.199	-.041	.911
WL_7	.866	.198	.017	-.111	.170	.144	-.241	.909
SL_7	.773	.412	.283	.166	.208	.089	.028	.927
BL_7	.798	.131	.286	.291	-.075	-.093	.168	.863
KL_7	.484	.384	.657	.122	.115	.094	-.235	.905
BG_7	.680	.448	.412	.211	-.060	.167	.136	.928
BW_8	.347	.827	.087	.059	.240	.119	-.005	.888
TL_8	.734	.446	.230	.129	.239	.155	.173	.919
WL_8	.709	.461	.284	.167	.287	.104	-.010	.917
SL_8	.750	.402	.267	.143	.250	.073	.006	.884
BL_8	.760	.193	.214	.235	.295	-.160	.082	.835
KL_8	.484	.436	.562	.170	.284	.078	-.052	.858
BG_8	.524	.439	.504	.291	.088	.172	.187	.878

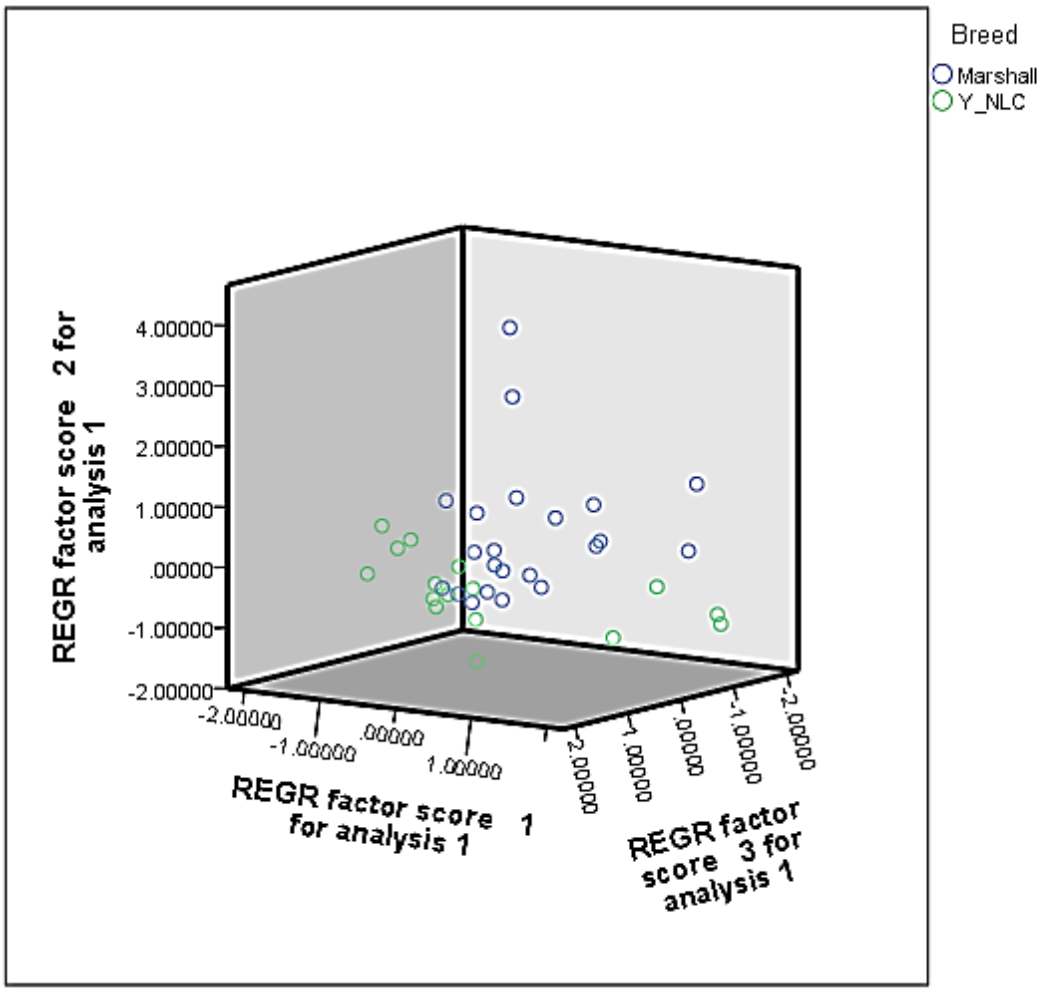


Figure 5.8. Graph showing the effect of 15% MOSM on the genotypes of Chickens

From Figure 5.8, it was observed that the effect of 15% MOSM was different per genotype even though there appeared to be some similaririte in some phenotypic traits.

5.31. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in haematological parameters of the experimental birds irrespective of diets and genotypes

Principal components analysis of twelve original variables in 192 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.26). The two principal components collectively explained 88.159% of overall variation. PC1 accounted for more than half (74.612) of the total variance while PC2 accounted for 13.547% of the variance.

Table 5.24: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of the experimental birds irrespective of diets and genotypes

Principal Components	Eigen Values	% of Variance	Cumulative %
1	8.953	74.612	74.612
2	1.626	13.547	88.159

5.32. Rotated component matrix and communalities of the haematological parameters of the experimental birds irrespective of diets and genotypes

From Table 5.27, communalities were found to be high across the parameters especially RBC with 98.10%.Basophils had the least with 62.4%. PC1 loaded heavily on RBC (0.978) and WBC (0.962) while PC2 loaded heavily on MCHC (0.979).

Table 5.25: Rotated component matrix and communalities of the haematological parameters of the experimental birds irrespective of diets and genotypes

	Component		
	1	**2**	**Communalities**
PCV_(%)	.897	-.283	.884
RBC_(X106_mm3)	.978	-.153	.981
WBC_X106_mm3	.962	-.134	.943
Hb_(gm%)	.917	.296	.928
MCV_(fl)	-.809	-.089	.662
MCH_(µµ_g)_	-.623	.683	.854
MCHC (%)	.115	.979	.971
Monocytes_(%)	.941	-.153	.909
Lymphocytes_(%)	.943	-.151	.912
Basophils_(%)	.780	.122	.624
Eosinophils_(%)	.951	-.194	.941
Heterophils_(%)	.955	-.241	.970

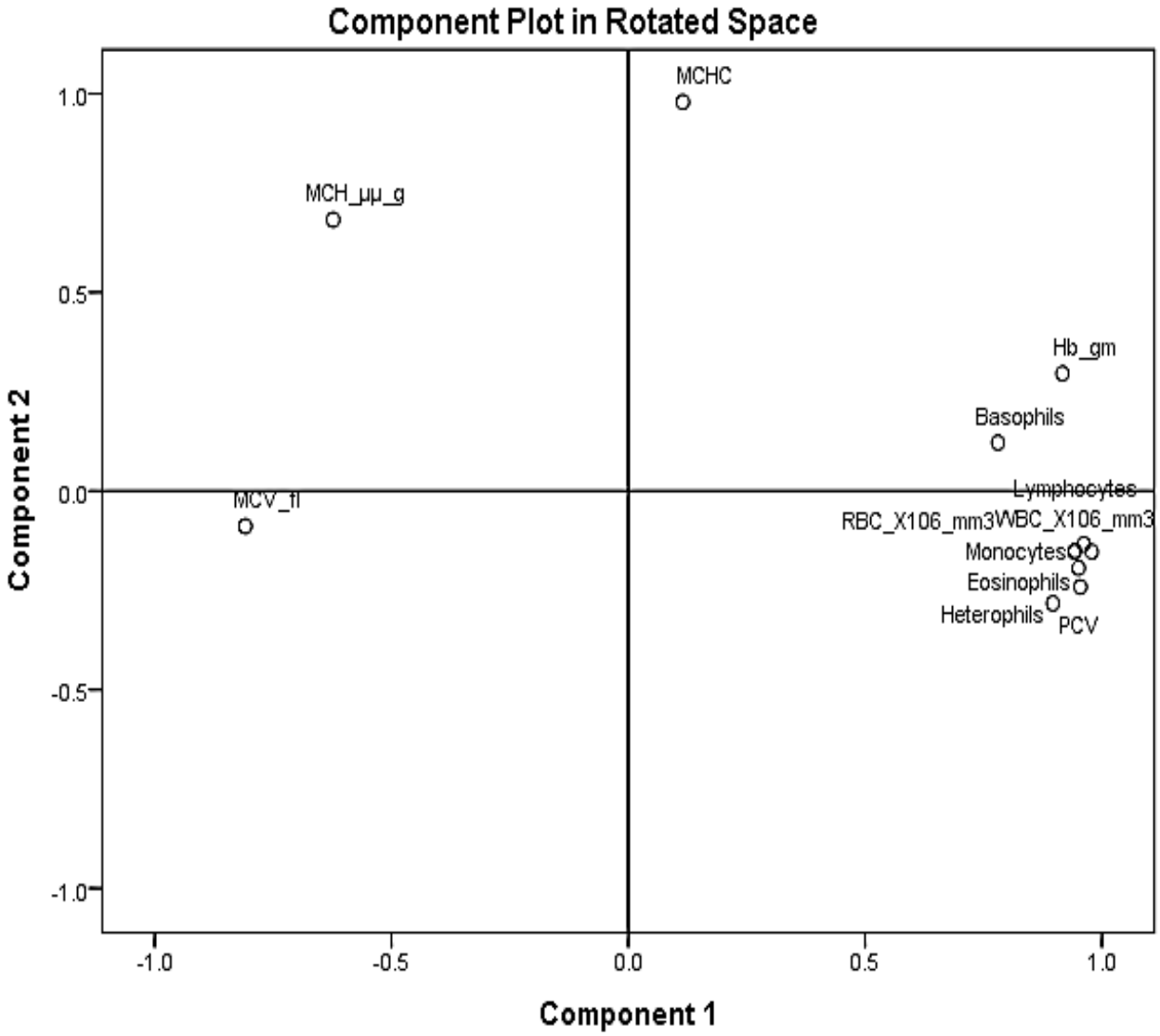


Figure 5.9: Component plot in rotated space showing haematological parameters of the experimental birds irrespective of diets and genotypes

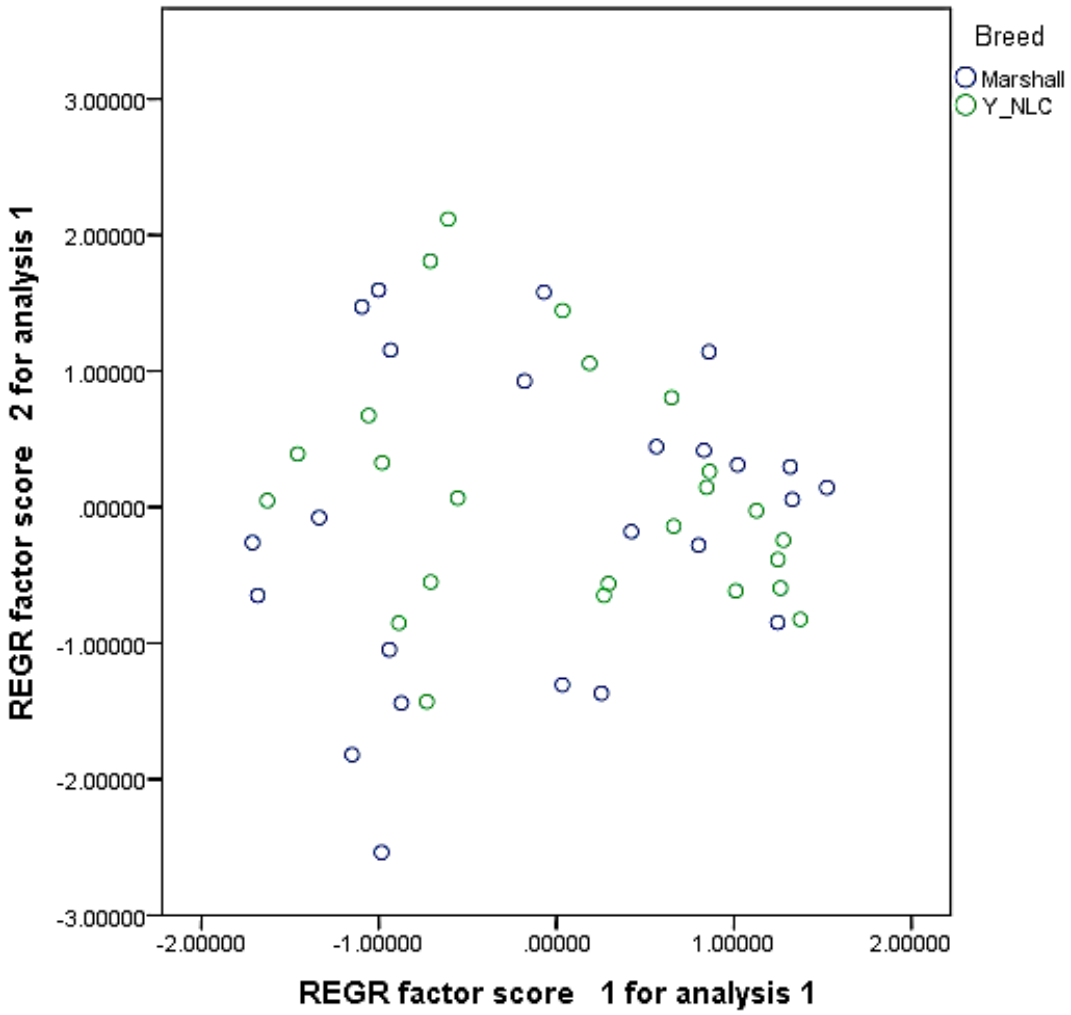


Figure 5.10: Graph showing effect of genotypes haematological parameters of the experimental birds

Figure 5.10 elucidated that genotypes did not influence the haematological parameters of chicken. This implied that feeding graded levels of MOSM would have significant effects on the haaematological responses of the chickens.

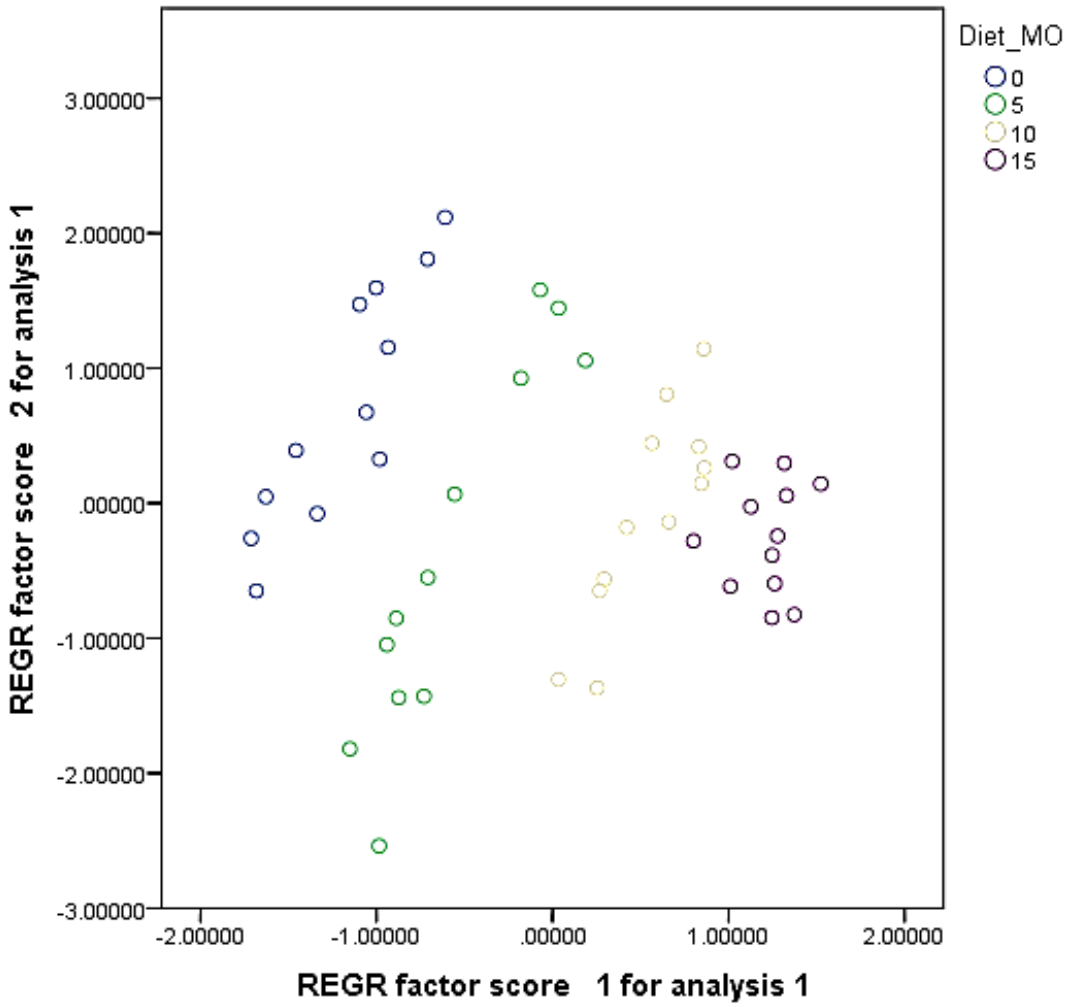


Figure 5.11. Graph showing effect of genotypes haematological parameters of the experimental birds

Figure 5.11 revealed that the various inclusion of MOSM affected the haematological indices of YENLC and Marshall Broilers, however, the trend of the changes of the haematological parameters in the two genotypes to dietsry inclusion of MOSM was the same.

5.33. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in haematological parameters of YENLC irrespective of diets

Principal components analysis of twelve original variables in 96 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.28). The two principal components collectively explained 86.688% of overall variation. PC1 accounted for more than half (74.697) of the total variance while PC2 accounted for 11.990% of the variance.

Table 5.26: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of YENLC irrespective of the diets

Principal Component	Eigen Values	% of Variance	Cumulative %
1	8.964	74.697	74.697
2	1.439	11.990	86.688

5.34. Rotated component matrix and communalities of the haematological parameters of YENLC irrespective of diets

From Table 5.29, communalities were found to be high across the parameters especially RBC and Heterophils with values greater than 95%. Basophils had the least with 53.10%. PC1 loaded heavily on monocytes (0.950) while PC2 loaded heavily on MCHC (0.955).

Table 5.27: Rotated component matrix and communalities of the haematological parameters of YENLC irrespective of diets

	Component		
	1	**2**	**Communalities**
PCV_(%)	.878	-.347	.891
RBC_(X106_mm3)	.947	-.290	.982
WBC_X106_mm3	.942	-.241	.946
Hb_(gm%)	.932	.117	.883
MCV_(fl)	-.797	.119	.649
MCH_(µµ_g)_	-.656	.660	.866
MCHC_(%)	-.029	.955	.914
Monocytes_(%)	.950	-.174	.933
Lymphocytes_(%)	.930	-.170	.894
Basophils_(%)	.661	.306	.531
Eosinophils_(%)	.939	-.247	.943
Heterophils_(%)	.931	-.322	.970

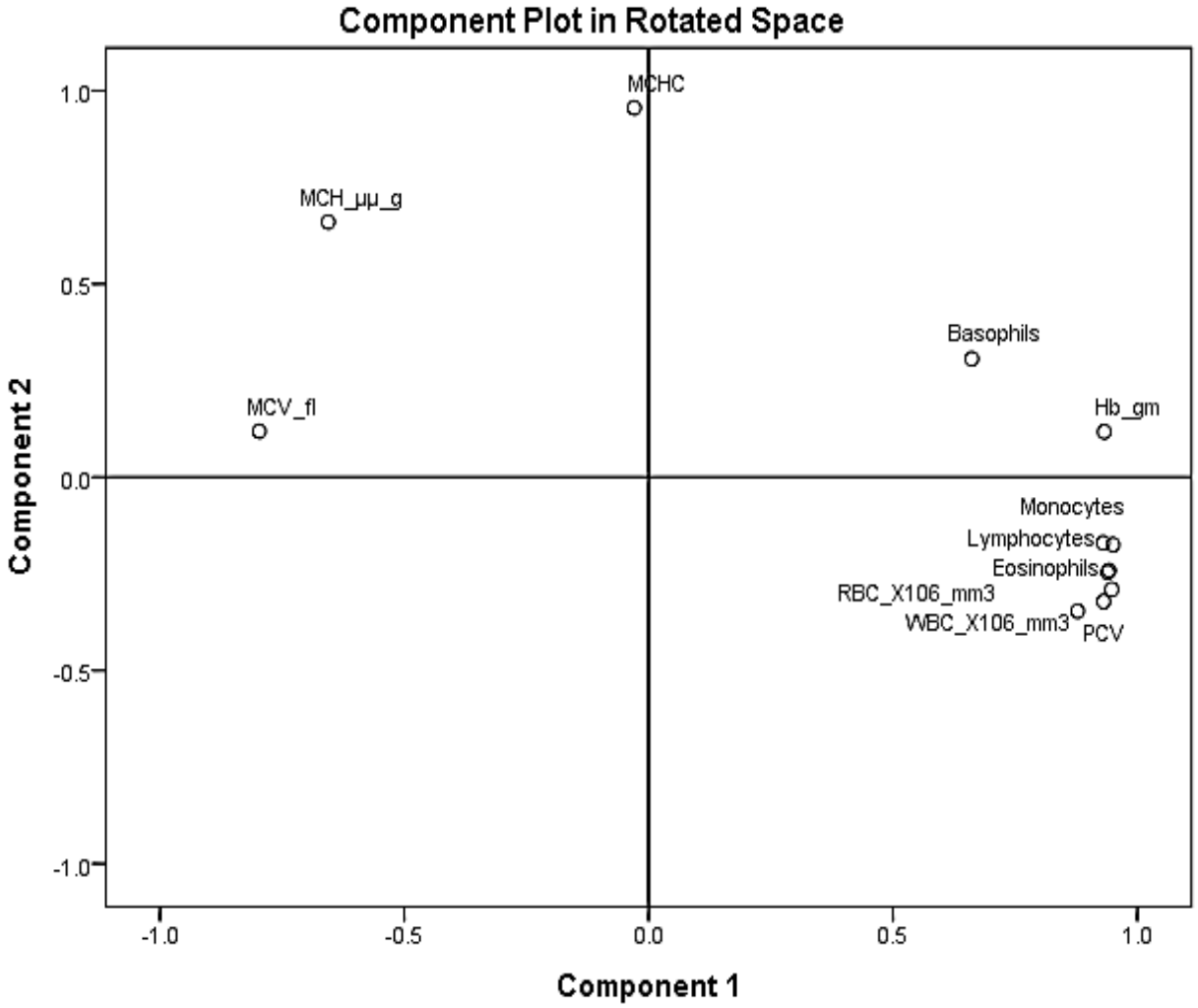


Figure 5.12: Component plot in rotated space haematological parameters of YENLC irrespective of diets

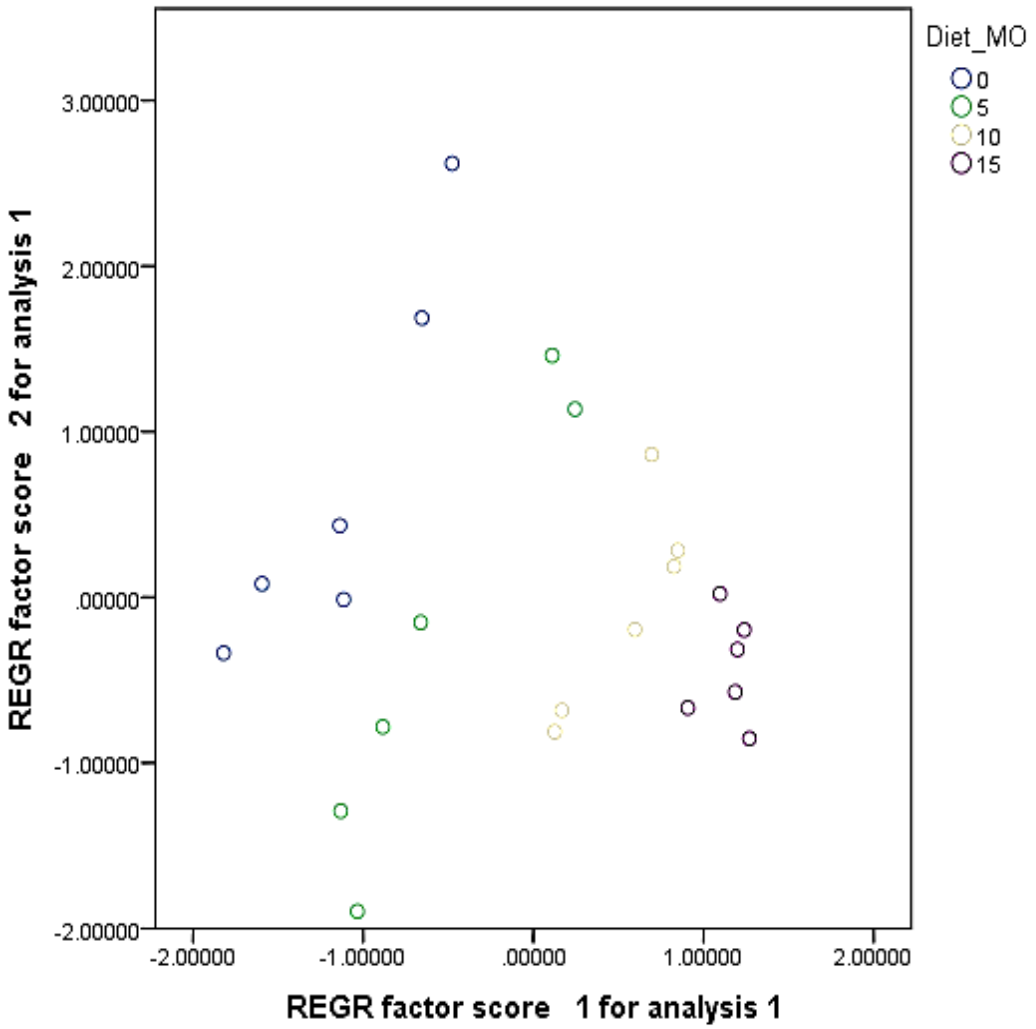


Figure 5.13. Graph showing the effect of MOSM on Haematological Parameters of YENLC

From Figure 5.13, it was observed that the graded levels of MOSM had significantly different effects on YENLC. Thus the diets significantly affected the haematological responses of YENLC.

5.35. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of Marshall broilers irrespective of diets

Principal components analysis of twelve original variables in 96 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.30). The two principal components collectively explained 91.407% of overall variation. PC1 accounted for more than half (76.855%) of the total variance while PC2 accounted for 14.551% of the variance.

Table 5.28: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in haematological parameters of Marshall broilers irrespective of the diets

Principal Component	Eigen Values	% of Variance	Cumulative %
1	9.223	76.855	76.855
2	1.746	14.551	91.407

5.36. Rotated component matrix and communalities of the haematological parameters of Marshall broilers irrespective of diets

From Table 5.31, communalities were found to be high across the parameters especially RBC, Hb, MCHC and Heterophils with values greater than 95%. MCV had the least with 67.80%. PC1 loaded heavily on RBC (0.994) while PC2 loaded heavily on MCHC (0.982).

Table 5.29: Rotated component matrix and communalities of the haematological parameters of Marshall Broilers irrespective of diets

	Component		
	1	**2**	**Communalities**
PCV_(%)	.922	-.186	.884
RBC_(X106_mm3)	.994	.001	.987
WBC_X106_mm3	.971	.001	.943
Hb_(gm%)	.873	.441	.956
MCV_(fl)	-.780	-.263	.678
MCH_(µµ_g)_	-.627	.669	.840
MCHC_(%)	.137	.982	.984
Monocytes_(%)	.945	-.087	.901
Lymphocytes_(%)	.966	-.073	.938
Basophils_(%)	.969	.049	.941
Eosinophils_(%)	.966	-.094	.942
Heterophils_(%)	.978	-.130	.974

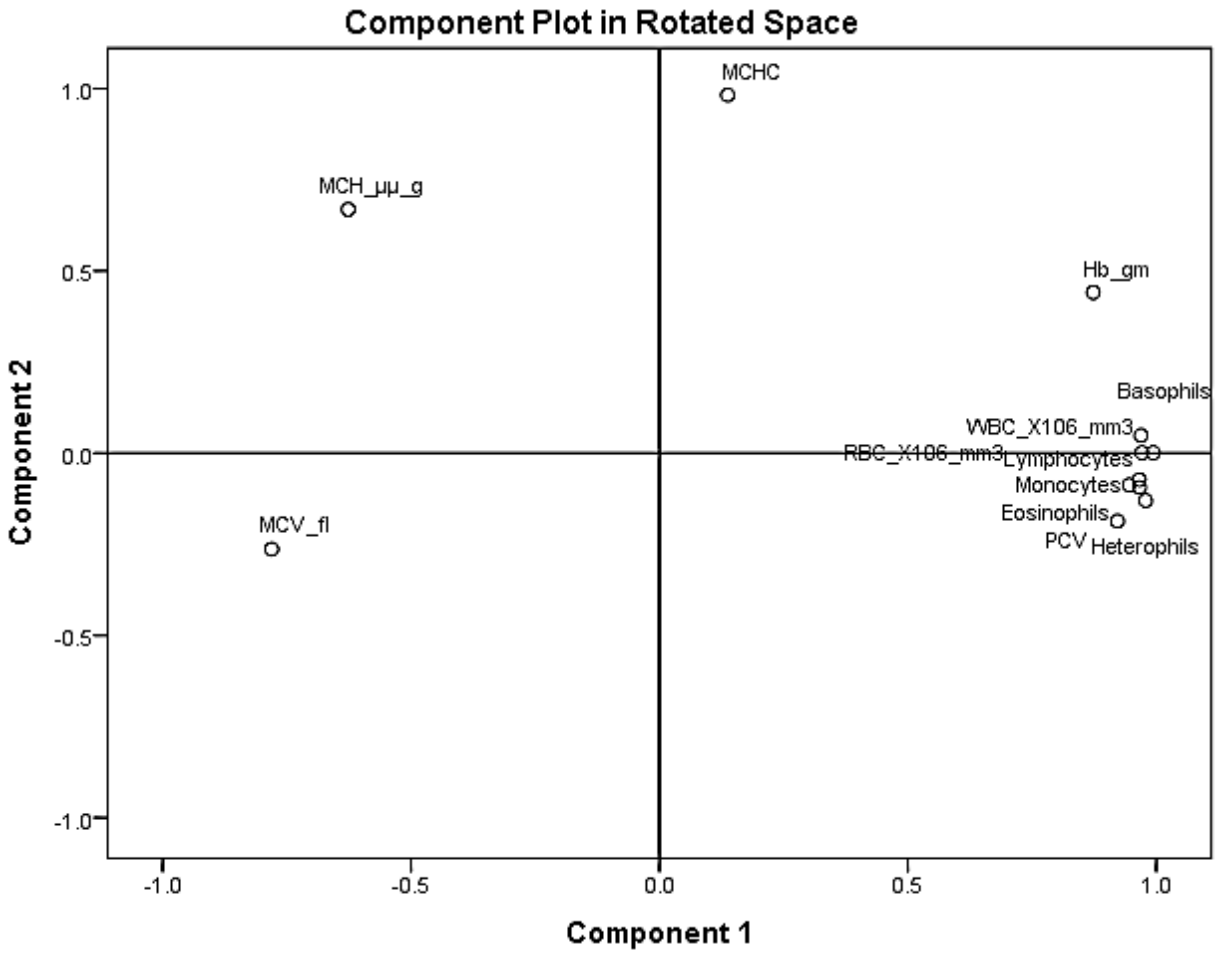


Figure 5.14: component plot in rotated space of the haematological parameters of Marshall Broilers irrespective of diets

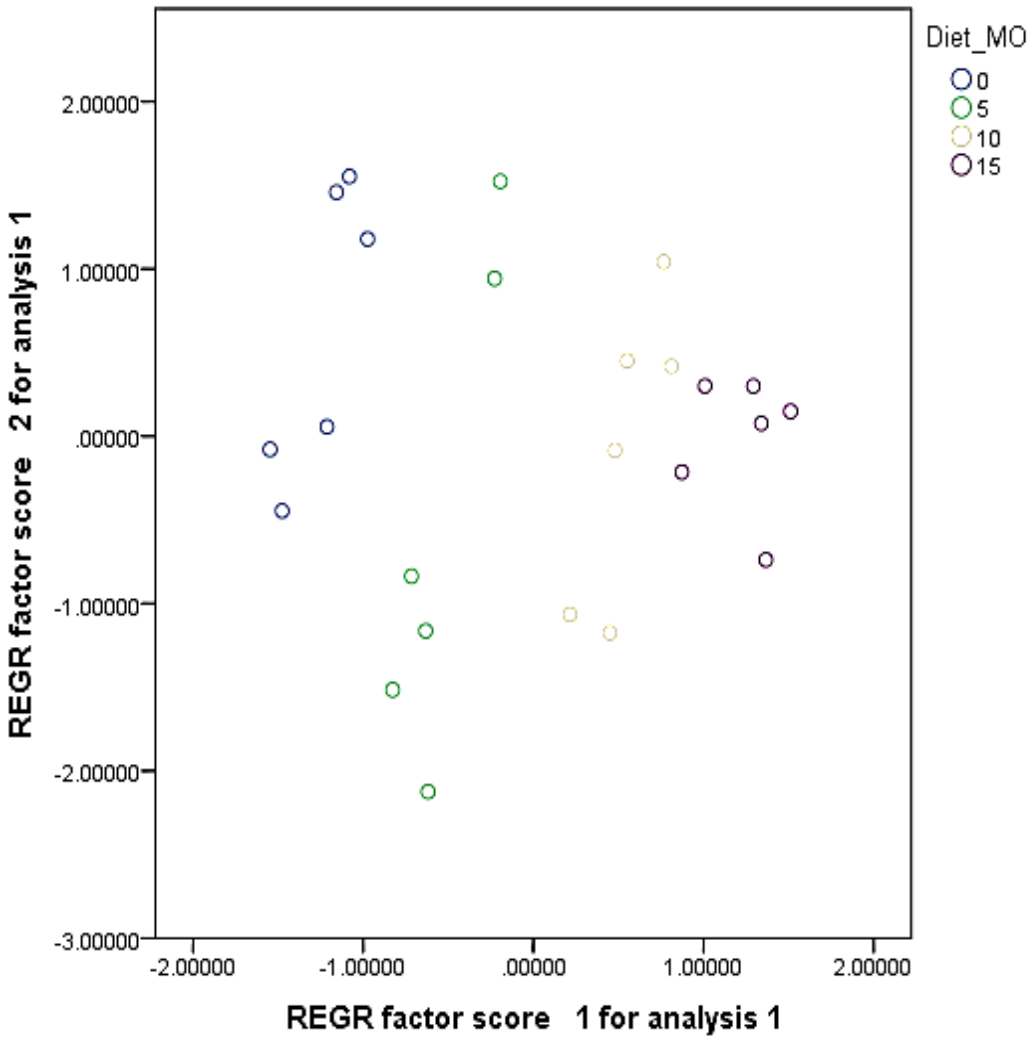


Figure 5.15: Graph showing the effect of MOSM on Marshall Broilers

From Figure 5.15, it was shown that the expression of the haematogical parameters were different as it pertained to the level of inclusion of MOSM. This implied that the various levels of inclusion of MOSM had significant effect on the haematology of Marshall Broilers.

5.37. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of experimental birds fed 0% MOSM

Principal components analysis of twelve original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.32). The three principal components collectively explained 84.323% of overall variation. PC1 accounted for more than half (54.233%) of the total variance while PC2 and PC3 accounted for 21.210% and 8.880% of the variance.

Table 5.30: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of experimental birds fed 0% MOSM

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	6.508	54.233	54.233
2	2.545	21.210	75.443
3	1.066	8.880	84.323

5.38. Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 0% MOSM

From Table 5.33, communalities were found to be high across the parameters especially RBC and Hb with values greater than 95%. Monocytes had the least value with 66.10%. PC1 had high loadings (correlations between the components and the variables) on PCV (0.900) and heterophils (0.909). PC2 was orthogonal to PC1 and loaded heavily on MCV (-0.925).PC3 loaded heavily on MCH (0.815)

Table 5.31: Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 0% MOSM

	Component			
	1	**2**	**3**	**Communalities**
PCV_(%)	.900	.311	.030	.908
RBC_(X106_mm3)	.667	.730	-.003	.977
WBC_X106_mm3	.755	.447	.395	.925
Hb_(gm%)	.550	.699	.404	.954
MCV_(fl)	-.029	-.925	.040	.858
MCH_(µµ_g)	.152	.357	.815	.814
MCHC_(%)	.125	.759	.565	.911
Monocytes_(%)	.108	.653	.472	.661
Lymphocytes_(%)	-.817	.179	.219	.748
Basophils_(%)	-.185	-.045	.830	.724
Eosinophils_(%)	.654	.497	.358	.803
Heterophils_(%)	.909	.090	-.029	.836

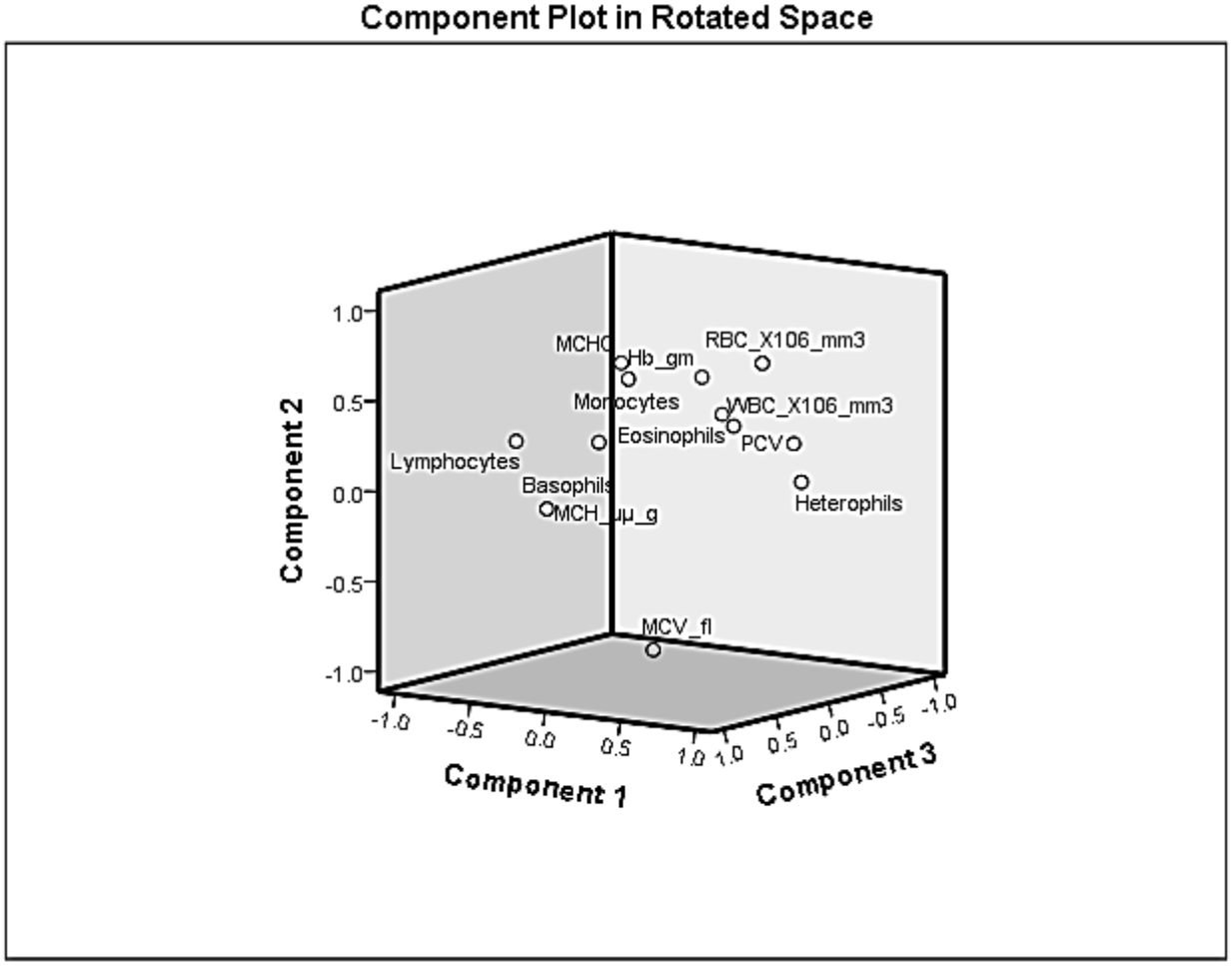


Figure 5.16: Component plot in rotated space of the haematological parameters of the experimental birds fed 0% MOSM

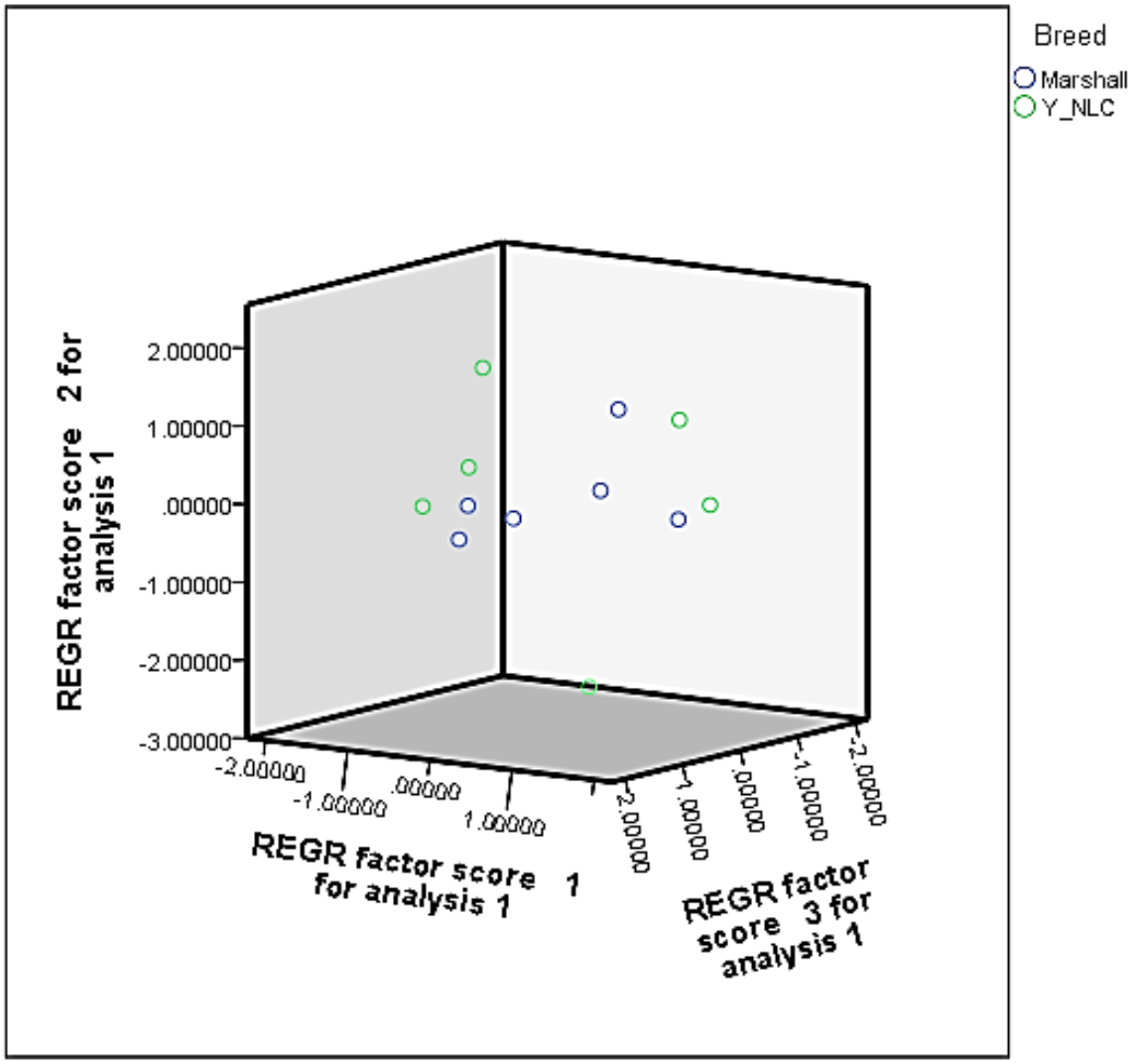


Figure 5.17: Graph showing the effect of 0% MOSM on YENLC and Marshall broilers

Figure 5.17 showed that the effect of the diet was not influenced by the genotype. However, the inclusion of MOSM had significant effect on the haematology hence the similarities of both geneotypes to different haematological parameters measured.

5.39. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of experimental birds fed 5% MOSM

Principal components analysis of twelve original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.34). The three principal components collectively explained 91.096% of overall variation. PC1 accounted for more than half (54.040%) of the total variance while PC2 and PC3 accounted for 25.783% and 11.274% of the variance.

Table 5.32: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in haematological parameters of experimental birds fed 5% MOSM

Principal Component	Eigen Values	% of Variance	Cumulative %
1	6.485	54.040	54.040
2	3.094	25.783	79.822
3	1.353	11.274	91.096

5.40. Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 5% MOSM

From Table 5.35, communalities were found to be high across the parameters especially Hb, MCV, MCH and MCHC with values greater than 95%. Monocytes had the least value with 74.60%. PC1 had high loadings (correlations between the components and the variables) on Hb (0.985), MCH (0.932) and MCHC (0.915). PC2 was orthogonal to PC1 and loaded heavily on MCV (-0.982) and RBC (0.822), this implies that an increase in RBC will result to a decrease in MCV.PC3 loaded heavily on eosinophils (0.942)

Table 5.33: Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 5% MOSM

	Component			
	1	**2**	**3**	**Communalities**
PCV_(%)	.587	-.705	.206	.885
RBC_(X106_mm3)	.512	.822	-.006	.937
WBC_X106_mm3	.896	.125	.289	.902
Hb_(gm%)	.985	.114	.090	.991
MCV_(fl)	-.053	-.982	.122	.981
MCH_(µµ_g)	.932	-.321	.114	.985
MCHC_(%)	.915	.390	.027	.990
Monocytes_(%)	.646	.410	.401	.746
Lymphocytes_(%)	.645	.147	.586	.782
Basophils_(%)	.778	-.106	.520	.887
Eosinophils_(%)	.171	-.123	.942	.932
Heterophils_(%)	.040	.775	.558	.913

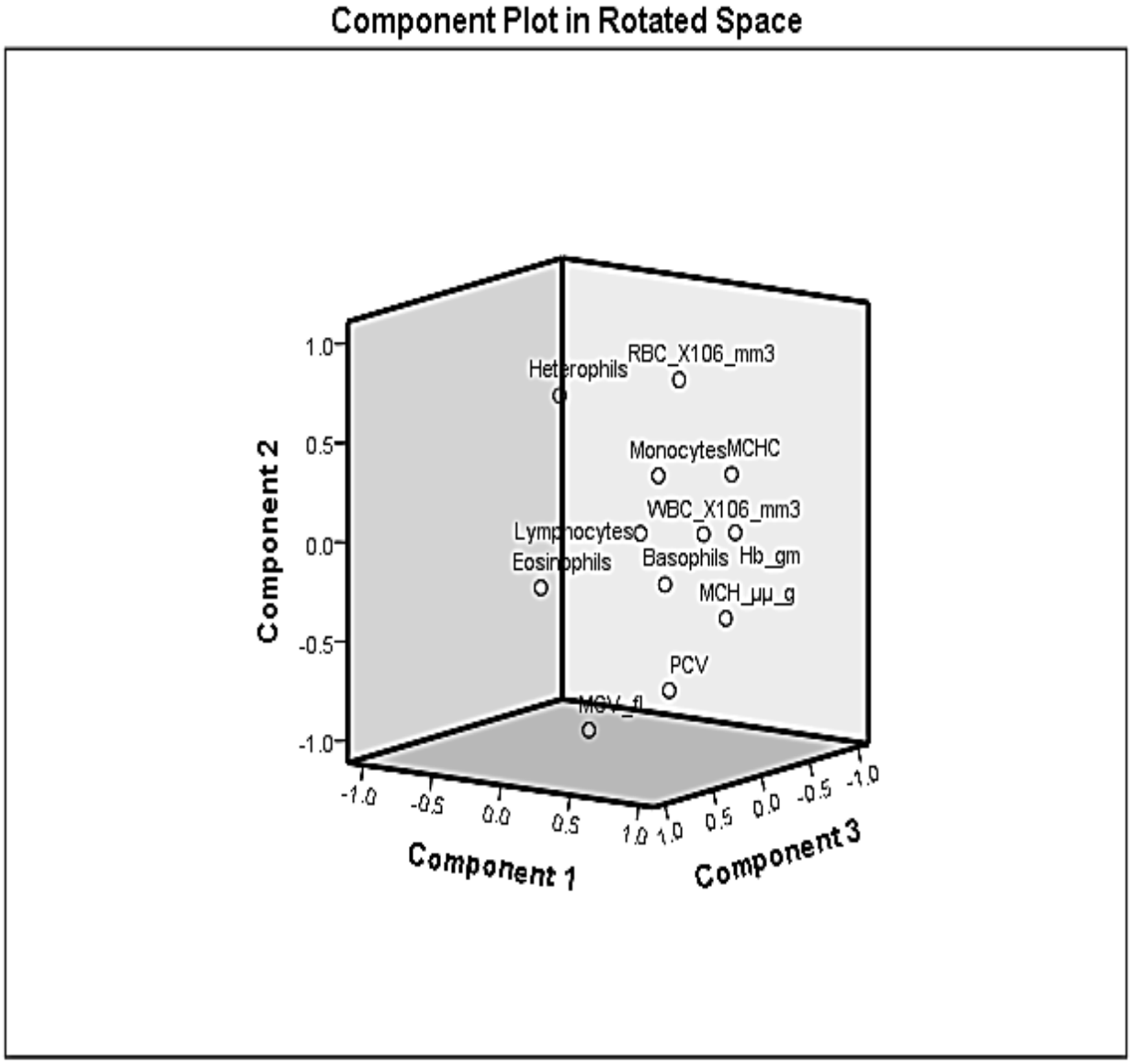


Figure 5.18: Component plot in rotated space of the haematological parameters of the experimental birds fed 5% MOSM

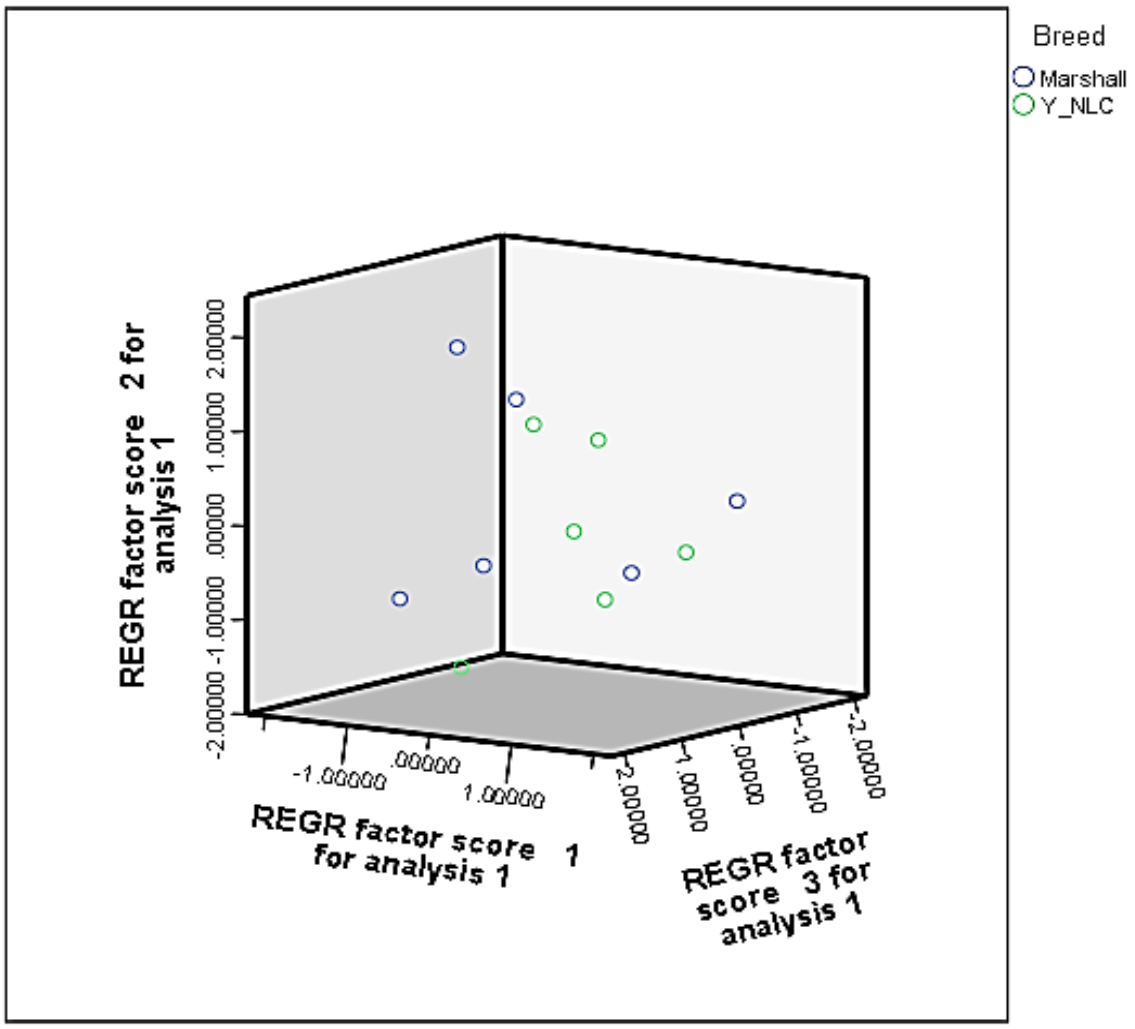


Figure 5.19: Effect of 5% MOSM on YENLC and Marshall Broilers

The results shown in Figure 4.13 showed that the diet did not have a special effect on the genotype of chickens.

5.41. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in haematological parameters of experimental birds fed 10% MOSM

Principal components analysis of twelve original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.36). The three principal components collectively explained 84.414% of overall variation. PC1 accounted for more than half (54.997%) of the total variance while PC2 and PC3 accounted for 20.143% and 9.274% respectively of the variance.

Table 5.34: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in haematological parameters of experimental birds fed 10% MOSM

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	6.600	54.997	54.997
2	2.417	20.143	75.140
3	1.113	9.274	84.414

5.42. Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 10% MOSM

From Table 5.37, communalities were found to be high across the parameters with the exception of monocytes with communality of 0.238. PC1 had high loadings on Lymphocytes (0.880), WBC (0.854) and Eosinophils (0.851). PC2 loaded heavily on MCH (0.929) and MCHC (0.902) while PC3 loaded heavily on PCV (0.767) and MCV (0.744).

Table 5.35: Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 10% MOSM

	Component			
	1	**2**	**3**	**Communalities**
PCV_(%)	.266	.346	.767	.779
RBC_(X106_mm3)	.847	.363	-.288	.932
WBC_X106_mm3	.854	.337	.236	.899
Hb_(gm%)	.417	.897	.133	.996
MCV_(fl)	-.601	-.117	.744	.928
MCH_(µµ_g)_	.014	.929	.355	.989
MCHC_(%)	.378	.902	-.139	.975
Monocytes_(%)	.046	-.016	-.485	.238
Lymphocytes_(%)	.880	.032	-.348	.897
Basophils_(%)	.697	.549	-.065	.792
Eosinophils_(%)	.851	.115	.272	.811
Heterophils_(%)	.832	.437	-.107	.894

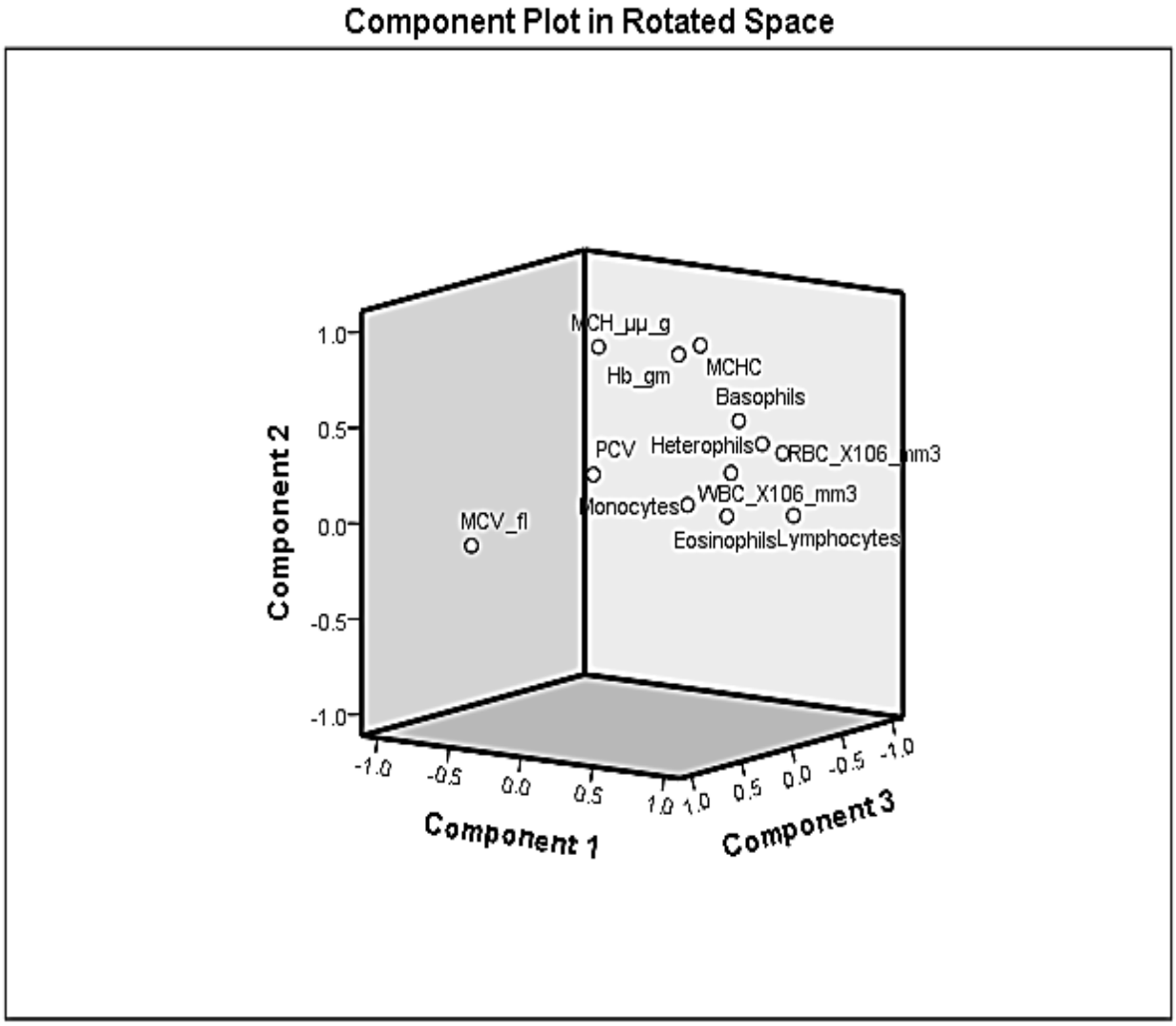


Figure 5.20: Component plot in rotated space of the haematological parameters of the experimental birds fed 10% MOSM

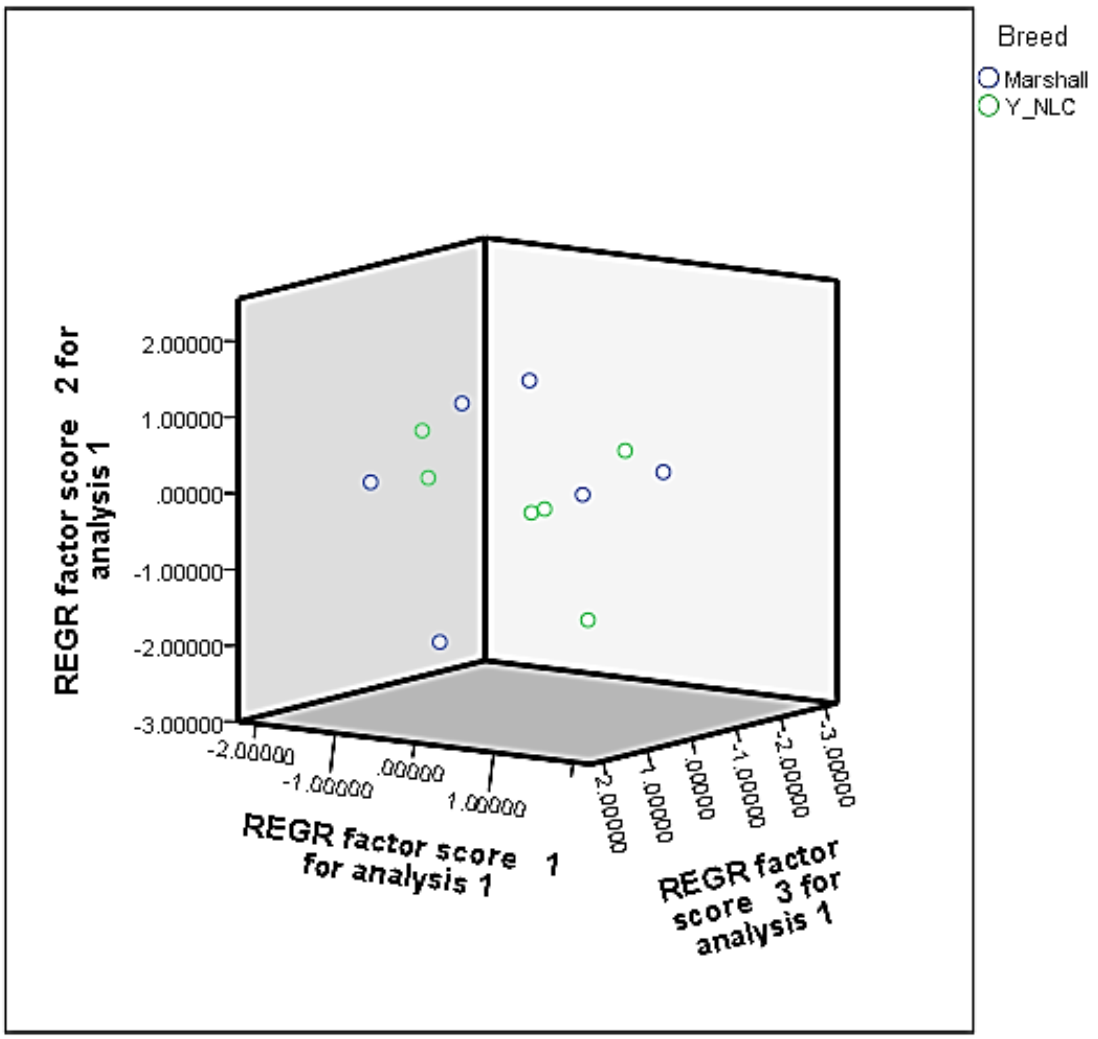


Figure 5.21. Graph showing effect of 10% MOSM on YENLC and Marshall Broilers

Figure 5.21 showed that the inclusion of 10% had the same effects on the two genotypes of chickens examined.

5.43. Multivariate dimension reduction principal component analysis to identify salient factors underlying variation in haematological parameters of experimental birds fed 15% MOSM

Principal components analysis of twelve original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.36). The three principal components collectively explained 82.744% of overall variation. PC1 accounted for most (47.763%) of the total variance while PC2 and PC3 accounted for 21.951% and 13.029% of the variance.

Table 5.36: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient factors underlying variation in haematological parameters of experimental birds fed 15% MOSM

Principal Components	Eigen Values	% of Variance	% of Cummulative Variance
1	5.732	47.763	47.763
2	2.634	21.951	69.715
3	1.563	13.029	82.744

5.44. Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 15% MOSM

From Table 5.37, communalities were found to be high across the parameters especially RBC, MCV, MCH and MCHC with values greater than 95%. WBC had the least value with 57.10%. PC1 had high loadings (correlations between the components and the variables) on RBC (0.954). PC2 was orthogonal to PC1 and loaded heavily on heterophils (0.777) and WBC (0.753).PC3 loaded heavily on MCHC (0.974).

Table 5.37: Rotated component matrix and communalities of the haematological parameters of the experimental birds fed 15% MOSM

	Component			
	1	**2**	**3**	**Communalities**
PCV_(%)	.391	.554	-.562	.776
RBC_(X106_mm3)	.954	.246	.065	.975
WBC_X106_mm3	.056	.753	-.013	.571
Hb_(gm%)	.349	.312	.782	.830
MCV_(fl)	-.893	.055	-.416	.974
MCH_(µµ_g)_	-.906	-.091	.374	.969
MCHC_(%)	-.021	-.176	.974	.981
Monocytes_(%)	-.089	.675	.426	.644
Lymphocytes_(%)	.528	.677	-.369	.873
Basophils_(%)	.553	.575	.063	.640
Eosinophils_(%)	.698	.517	.065	.759
Heterophils_(%)	.462	.777	-.347	.937

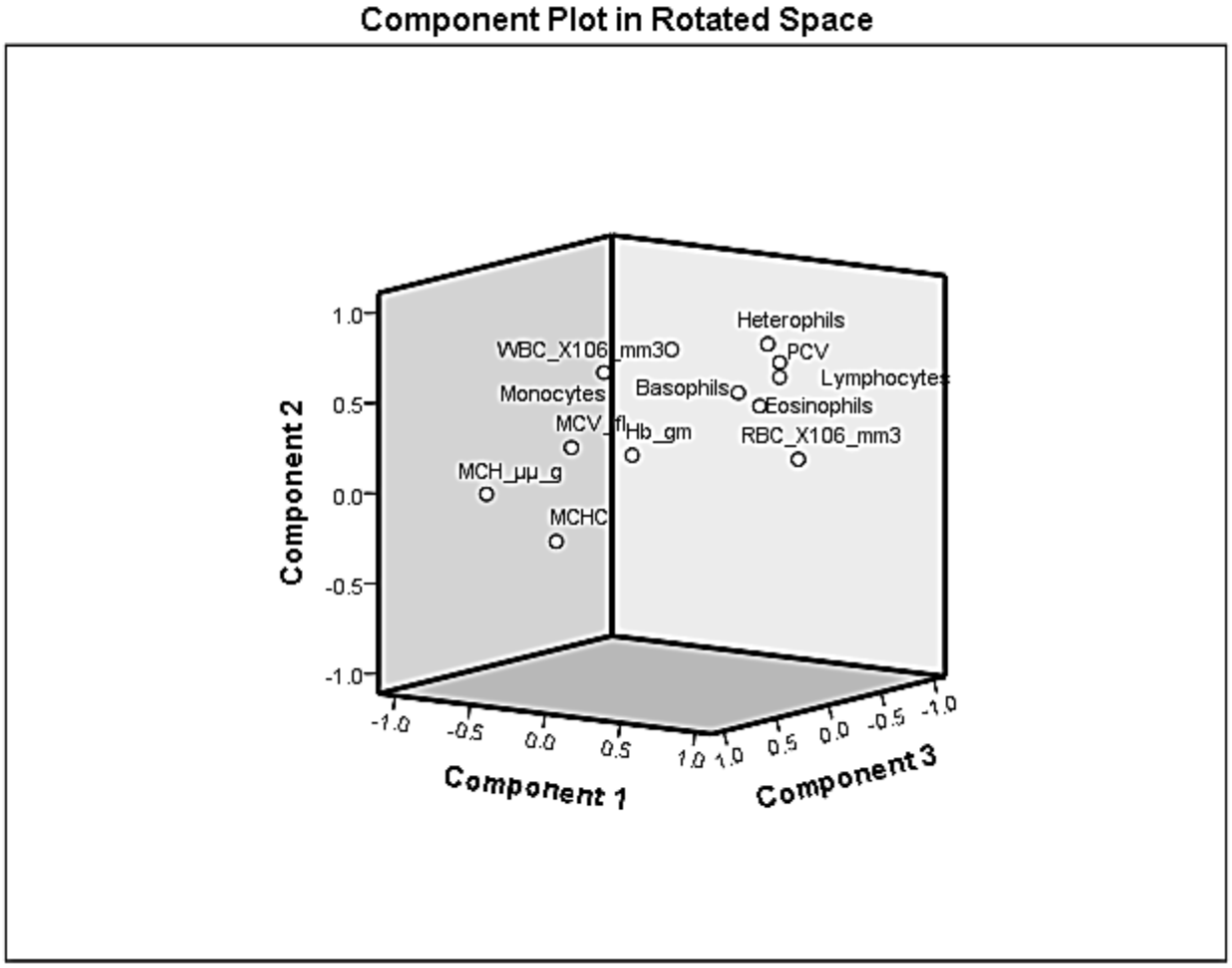


Figure 5.22: Component plot in rotated space of the haematological parameters of the experimental birds fed 15% MOSM

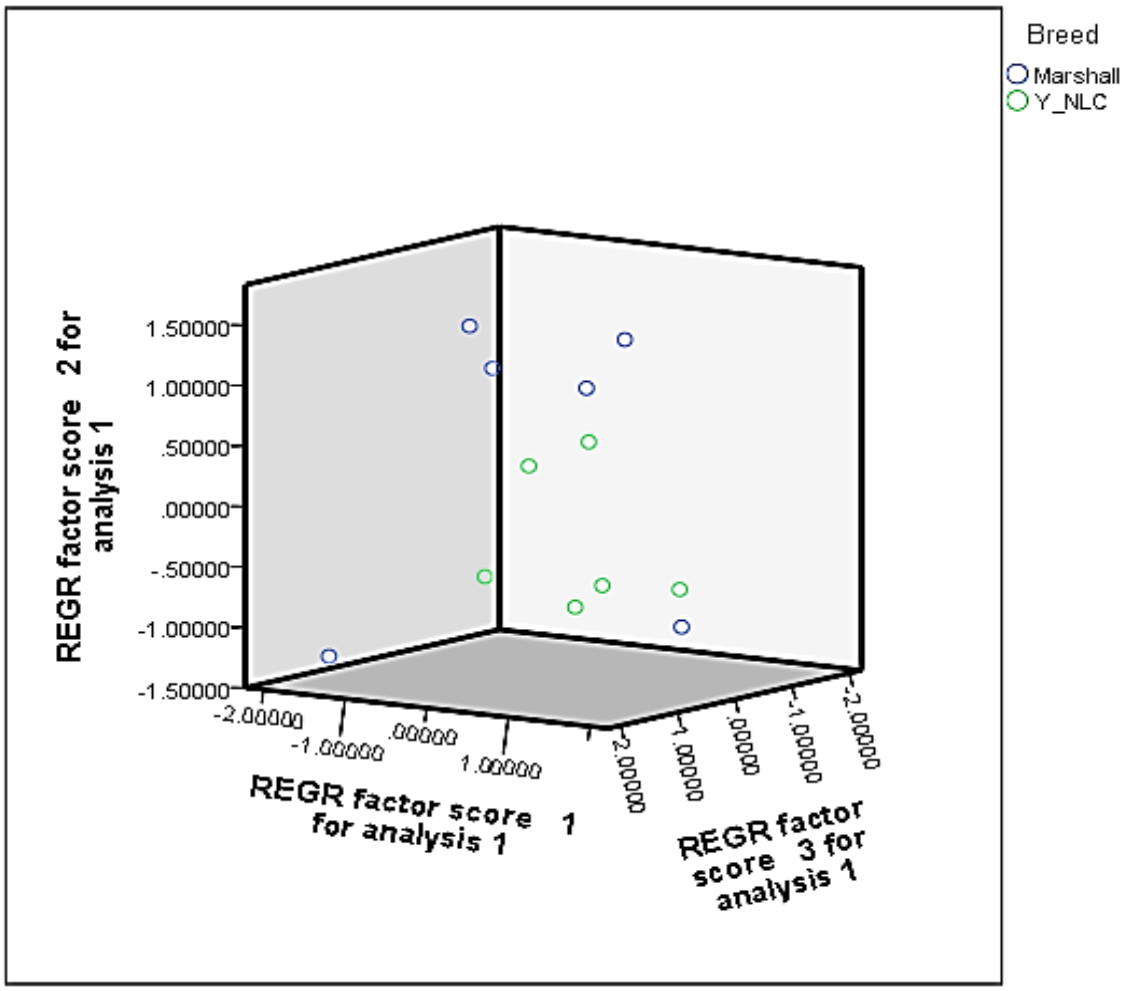


Figure 5.23: Graph showing the effect of 15% MOSM on YENLC and Marshall Broilers.

Figure 5.23 further substantiated that diets (in particular, MOSM) did not have special effect on the haematological parameters of the YENLC and Marshall Broilers.

5.45. Multivariate dimension reduction principal component analysis to identify salient factors underlying variation in serum biochemical parameters of all experimental birds irrespective of genotypes and diets

Principal components analysis of seventeen original variables in 192 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.38). The three principal components collectively explained 82.819% of overall variation. PC1 accounted for more than half (57.107%) of the total variance while PC2 and PC3 accounted for 16.865% and 8.846% of the variance.

Table 5.38: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient factors underlying variation in serum biochemical parameters of all experimental birds irrespective of genotypes and diets

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	9.708	57.107	57.107
2	2.867	16.865	73.973
3	1.504	8.846	82.819

5.46. Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds irrespective of genotypes and diets

From Table 5.39, communalities were found to be high across the parameters especially Ca^{2+}, globulin and albumin-globulin ratio with values greater than 95%. ALT had the least value with 65.20%. PC1 loaded heavily on Ca^{2+} (0.963) and HCO_3^{2-} (0.961). PC2 had high loadings on Globulin (-0.937) and Albumin-Globulin Ratio (0.986) while PC3 loaded heavily on ALP (0.800).

Table 5.39: Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds irrespective of genotypes and diets

	Component			
	1	**2**	**3**	**Communalities**
Na^+_(mg_100ml)	.942	.054	.227	.943
K^+_(mg_100ml)	.941	-.080	.227	.944
Sodium_Potassium	-.833	.223	-.138	.763
Ca^{2+}(mg_100ml)	.963	.004	.204	.969
HCO_3^{2-}(mg_100ml)	.961	-.030	.190	.961
PO_4^{2-}(mg_100ml)	.918	.032	.053	.846
Cl^-(mg_100ml)	.945	-.043	.163	.922
Total_Protein_(mg_100ml}	.670	-.495	.037	.695
Albumin_(mg_dl)	.386	.781	.025	.760
Globulin	.295	-.937	.014	.966
Albumin-Globulin_Ratio	-.023	.986	-.012	.973
Urea_(mg_100ml)	.835	-.163	.337	.838
Cholesterol_(mg_dl)	-.792	-.278	.150	.727
Creatinine_(mg_dl)	.806	.096	.101	.670
ALT_(U_L)	.623	-.117	.500	.652
AST_(U_L)	.057	-.031	.861	.746
ALP	.244	.063	.800	.704

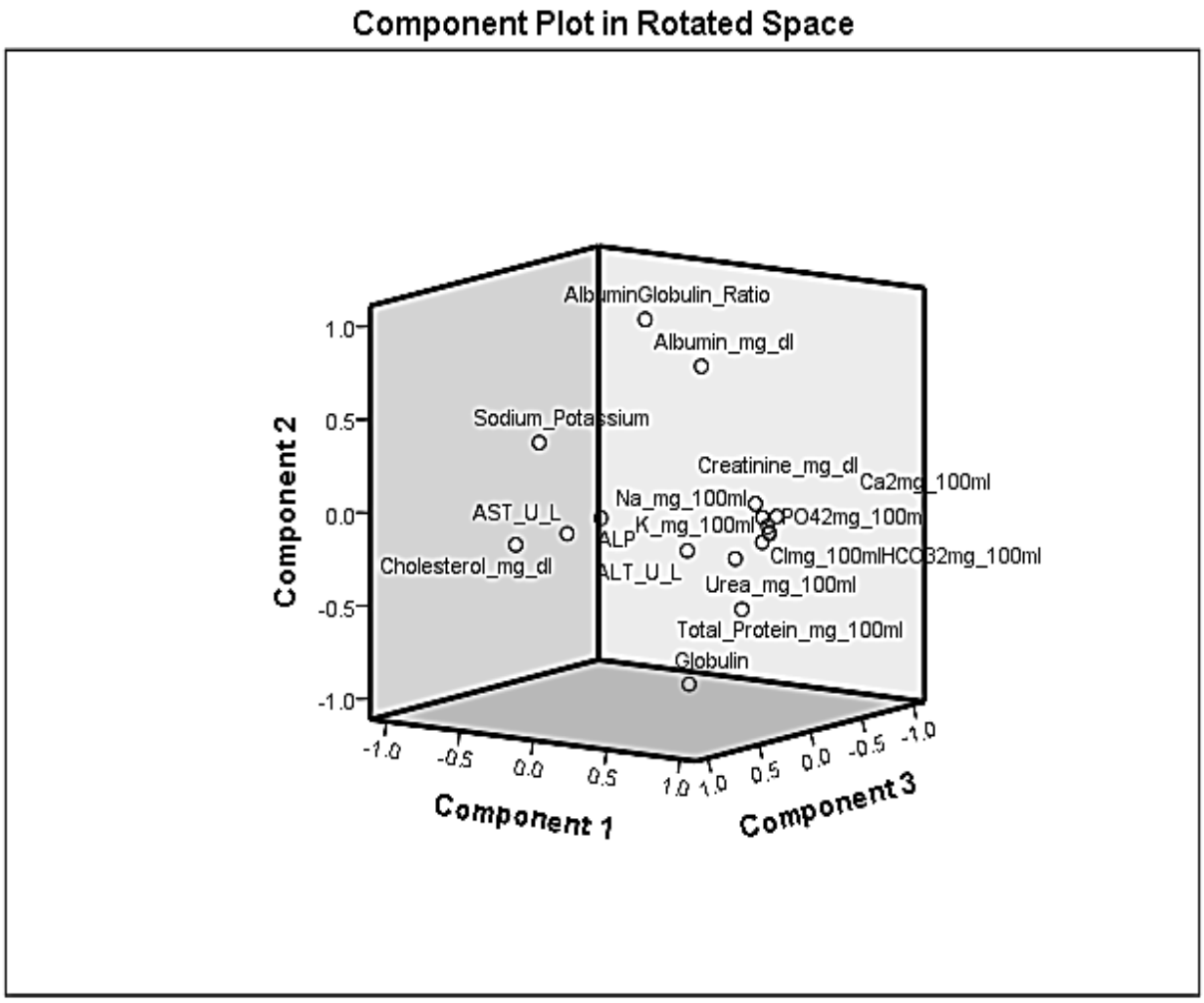


Figure 5.24. Component plot in rotated space showing serum biochemical parameters of YENLC and Marshall Broilers

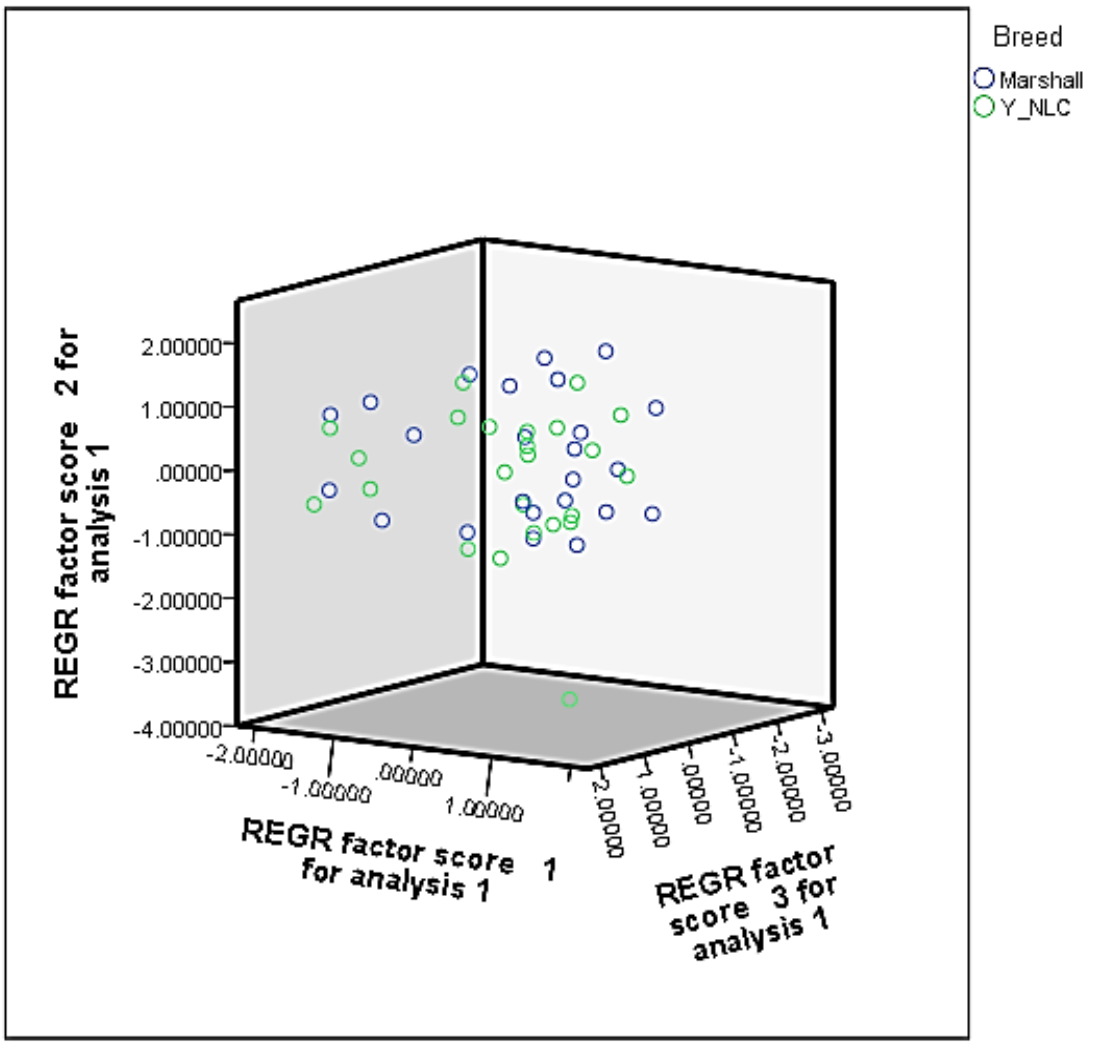


Figure 5.25. Graph showing the effect of genotypes on serum biochemical parameters

Figure 5.25 showed that genotypes did not influence the expression of serum biochemical components in YENLC and Marshall Broilers.

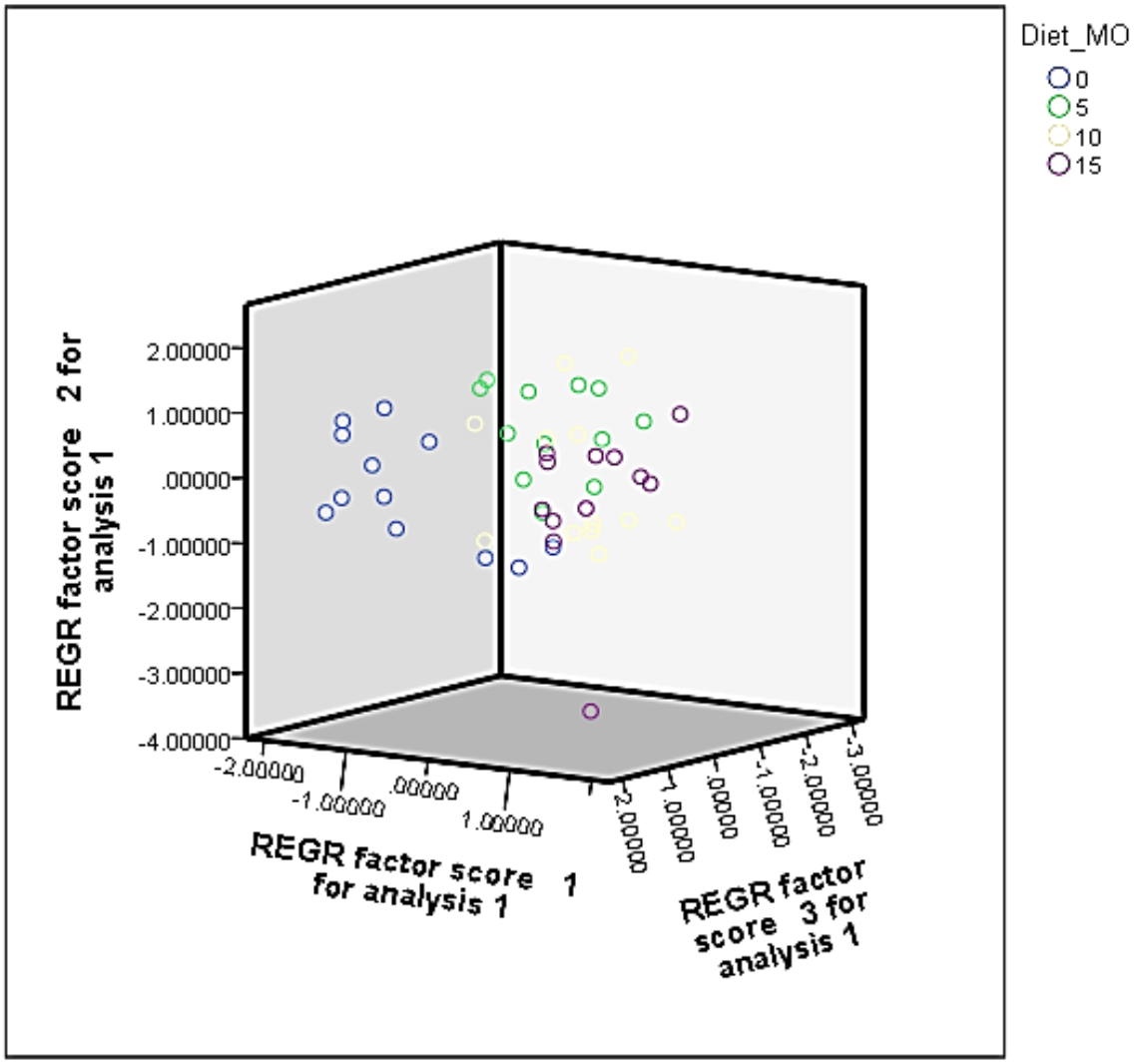


Figure 5.26. Graph showing the effect of MOSM on serum biochemical components in YENLC and Marshall Broilers

Figure 5.26 was able to distinguish the non-inclusion of MOSM from birds fed varying levels of MOSM hence the inclusion of MOSM had effect on the expression of the serum biochemical parameters. This could be as a result of the phytochemicals present in MOSM.

5.47. Rotated component matrix and communalities of the serum biochemical parameters of YENLC irrespective of diets

From Table 5.40, communalities were found to be high across the parameters especially Na^{+}, K^{+}, Ca^{2+}, HCO_3^{2-}, Cl^{-}, globulin and albumin-globulin ratio with values greater than 95%. ALT had the least value with 67.50%. PC1 loaded heavily on cholesterol (-0.913), PO_4^{2-} (0.911) and Na^{+} (0.904). PC2 loaded much on total protein (0.832) while PC3 loaded heavily on Albumin (0.941) and Albumin-Globulin Ratio (0.973)

Table 5.40: Rotated component matrix and communalities of the serum biochemical parameters of YENLC irrespective of diets

	Component				
	1	**2**	**3**	**4**	**Communalities**
Na^+_(mg_100ml)	.904	.313	.018	.227	.967
K^+_(mg_100ml)	.789	.570	-.029	.122	.963
Sodium_Potassium	-.620	-.701	.109	.074	.893
Ca^{2+}(mg_100ml)	.848	.482	.038	.148	.974
HCO_3^{2-}(mg_100ml)	.869	.448	-.022	.113	.970
PO_4^{2-}(mg_100ml)	.911	.254	-.016	-.004	.895
Cl^-(mg_100ml)	.772	.592	.068	.080	.958
Total_Protein_(mg_100ml}	.149	.832	-.291	.024	.800
Albumin_(mg_dl)	.092	.214	.941	.042	.942
Globulin	.040	.436	-.886	-.013	.976
Albumin-Globulin_Ratio	.051	-.208	.973	.030	.993
Urea_(mg_100ml)	.673	.576	-.025	.318	.887
Cholesterol_(mg_dl)	-.913	.121	-.142	.194	.907
Creatinine_(mg_dl)	.852	-.054	.042	-.065	.735
ALT_(U_L)	.726	.368	-.001	.114	.675
AST_(U_L)	-.142	.044	.031	.936	.899
ALP	.537	.023	.070	.672	.746

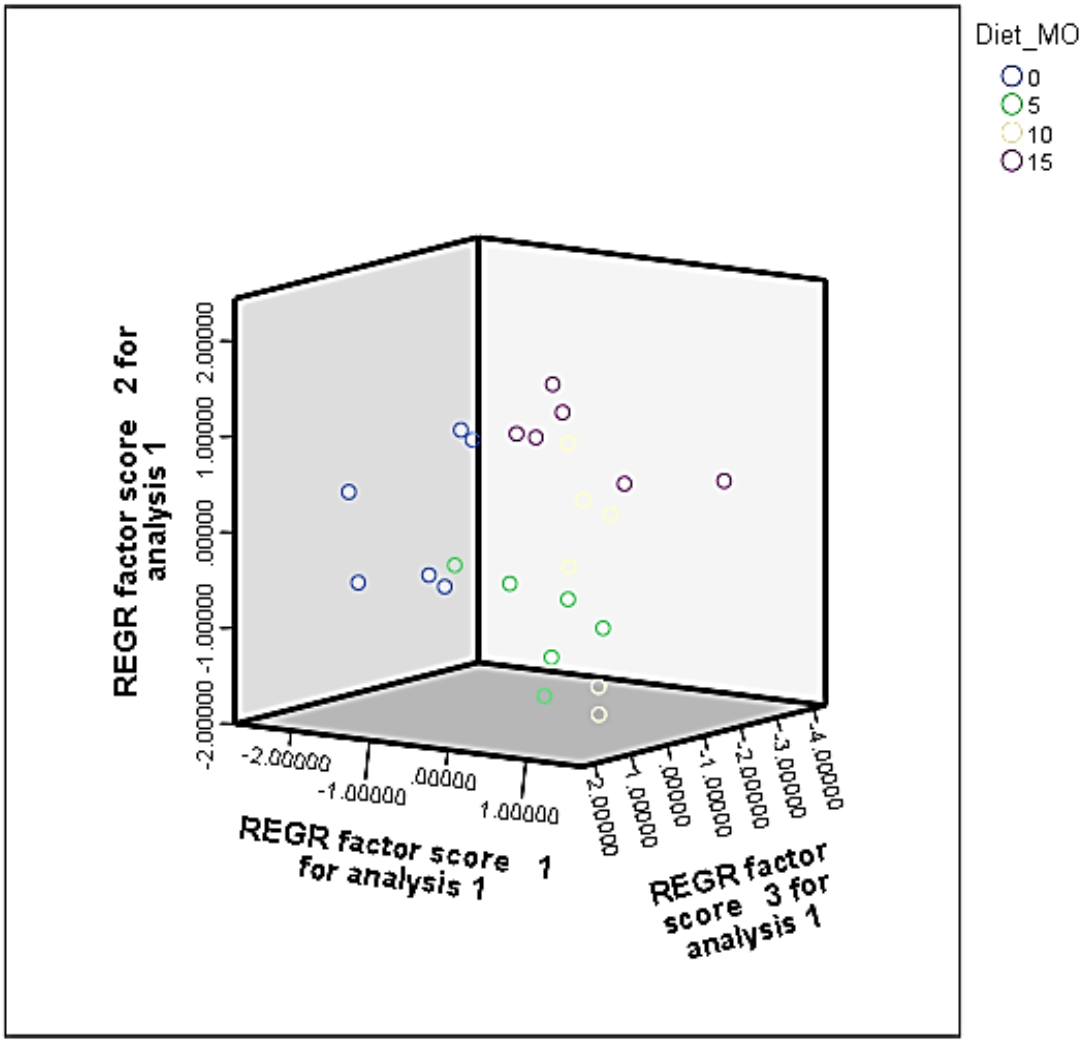


Figure 5.27. Graph showing the effects of MOSM on serum biochemical parameters of YENLC

Figure 5.27 showed that the inclusion of MOSM altered the serum biochemical parameters of YENLC. This showed that the inclusion of MOSM had significant effects on the serum biochemical components of YENLC.

5.48. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in serum biochemical parameters of YENLC irrespective of diets

Principal components analysis of seventeen original variables in 96 chickens revealed that four principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.41). The four principal components collectively explained 89.290% of overall variation. PC1 accounted for more than half (55.978%) of the total variance while PC2, PC3 and PC4 accounted for 18.068%, 9.021% and 6.223% of the variance.

Table 5.41: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in serum biochemical parameters of YENLC irrespective of diets

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	9.516	55.978	55.978
2	3.072	18.068	74.046
3	1.533	9.021	83.067
4	1.058	6.223	89.290

5.49. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in serum biochemical parameters of Marshall broilers irrespective of diets

Principal components analysis of seventeen original variables in 96 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.42). The three principal components collectively explained 86.110% of overall variation. PC1 accounted for more than half (59.803%) of the total variance while PC2 and PC3 accounted for 16.033% and 10.274% of the variance.

Table 5.42: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in serum biochemical parameters of Marshall broilers irrespective of diets

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	10.167	59.803	59.803
2	2.726	16.033	75.836
3	1.747	10.274	86.110

5.50. Rotated component matrix and communalities of the serum biochemical parameters of Marshall broilers irrespective of diets

From Table 5.43, communalities were found to be high across the parameters especially Na^{+}, Ca^{2+}, HCO_3^{2}, globulin and albumin-globulin ratio with values greater than 95%. ALP had the least value with 67.50%. PC1 loaded heavily on Ca^{2+} (0.956) and HCO_3^{2-}(0.953).PC2 had the highest loadings on Globulin (0.926) while PC3 loaded heavily on AST (0.856).

Table 5.43. Rotated component matrix and communalities of the serum biochemical parameters of Marshall broilers irrespective of diets

	Component			
	1	**2**	**3**	**Communalities**
Na^+_(mg_100ml)	.954	-.012	.220	.958
K^+_(mg_100ml)	.914	.094	.316	.943
Sodium_Potassium	-.762	-.220	-.324	.735
Ca^{2+}(mg_100ml)	.956	.037	.234	.971
HCO_3^{2-}(mg_100ml)	.953	.059	.219	.959
PO_4^{2-}(mg_100ml)	.915	.009	.078	.843
Cl^-(mg_100ml)	.924	.108	.206	.908
Total_Protein_(mg_100ml}	.775	.530	.033	.883
Albumin_(mg_dl)	.666	-.669	-.021	.891
Globulin	.332	.926	.045	.970
Albumin-Globulin_Ratio	.043	-.989	-.060	.984
Urea_(mg_100ml)	.821	.231	.308	.823
Cholesterol_(mg_dl)	-.827	.202	.105	.736
Creatinine_(mg_dl)	.851	-.006	.241	.783
ALT_(U_L)	.417	.184	.763	.790
AST_(U_L)	.230	.004	.856	.785
ALP	.034	-.015	.821	.675

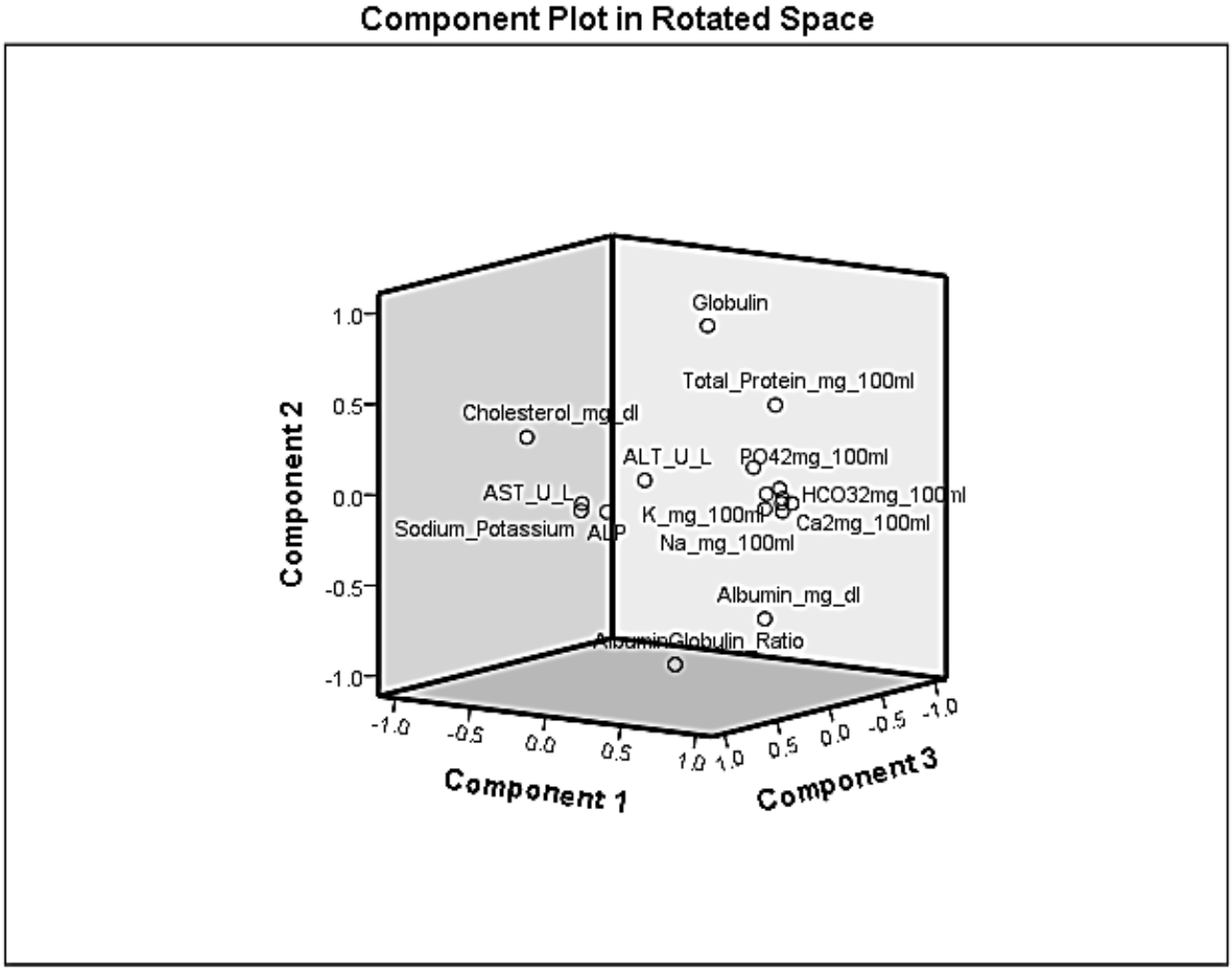


Figure 5.28: Component plot in rotated space of the serum biochemical parameters of Marshall broilers irrespective of diets

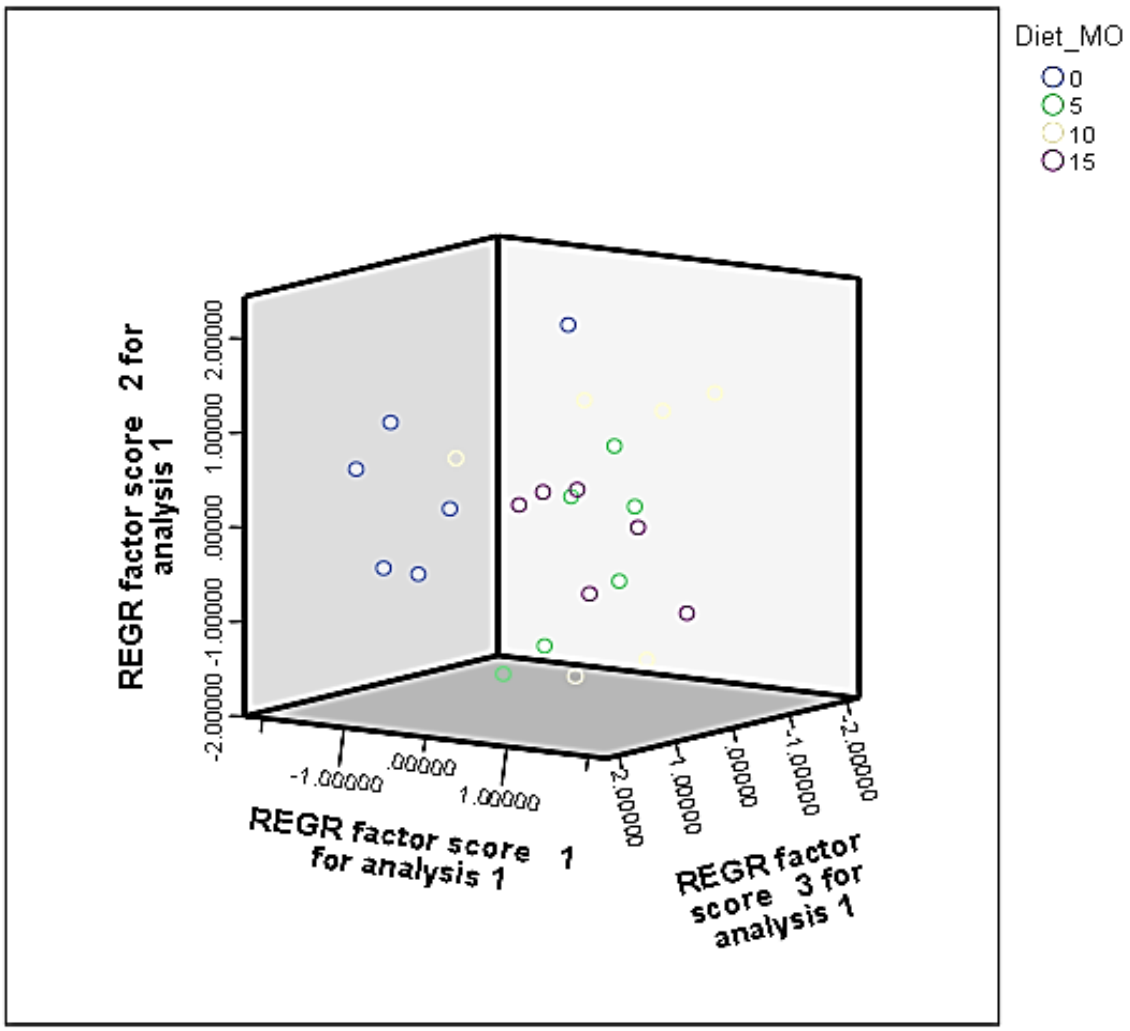


Figure 5.29: Graph showing the effect of MOSM on serum biochemical parameters in Marshall Broilers

Figure 5.29 showed that the serum biochemical components of Marshall Broilers fed the various levels of MOSM were significantly different from the control (0% MOSM).

5.51. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in serum biochemical parameters of experimental birds fed 0% MOSM

Principal components analysis of seventeen original variables in 96 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.44). The three principal components collectively explained 86.274% of overall variation. PC1 accounted for more than half (58.882%) of the total variance while PC2 and PC3 accounted for 18.082% and 9.310% of the variance.

Table 5.44: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in in serum biochemical parameters of the experimental birds fed 0% MOSM

Principal Components	Eigenvalues	% of Variance	Cumulative %
1	10.010	58.882	58.882
2	3.074	18.082	76.964
3	1.583	9.310	86.274

5.52. Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 0% MOSM

From Table 5.45, communalities were found to be high across the parameters especially K^+, Sodium-potassium ratio, Ca^{2+}, globulin and albumin-globulin ratio with values greater than 95%. ALT had the least value with 63.80%. PC1 had the highest loadings on Total Protein (0.956), PC2 loaded heavily on Albumin (-0.852) while PC3 loaded much on Cholesterol (0.919).

Table 5.45: Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 0% MOSM

	Component			
	1	**2**	**3**	**Communalities**
Na^+_(mg_100ml)	.651	.142	-.633	.844
K^+_(mg_100ml)	.615	.650	.424	.981
Sodium_Potassium	-.526	-.647	-.525	.971
Ca^{2+}(mg_100ml)	.808	.566	-.058	.976
HCO_3^{2-}(mg_100ml)	.583	.592	.120	.705
PO_4^{2-}(mg_100ml)	.893	.364	-.014	.931
Cl^-(mg_100ml)	.806	.299	.345	.858
Total_Protein_(mg_100ml}	.956	-.081	.135	.938
Albumin_(mg_dl)	-.342	-.852	.081	.850
Globulin	.952	.248	.086	.975
Albumin-Globulin_Ratio	-.892	-.420	-.004	.971
Urea_(mg_100ml)	.554	.235	.708	.863
Cholesterol_(mg_dl)	-.215	.122	.919	.906
Creatinine_(mg_dl)	.864	.196	-.037	.786
ALT_(U_L)	.354	.703	.139	.638
AST_(U_L)	.117	-.796	-.229	.699
ALP	-.232	-.149	-.836	.775

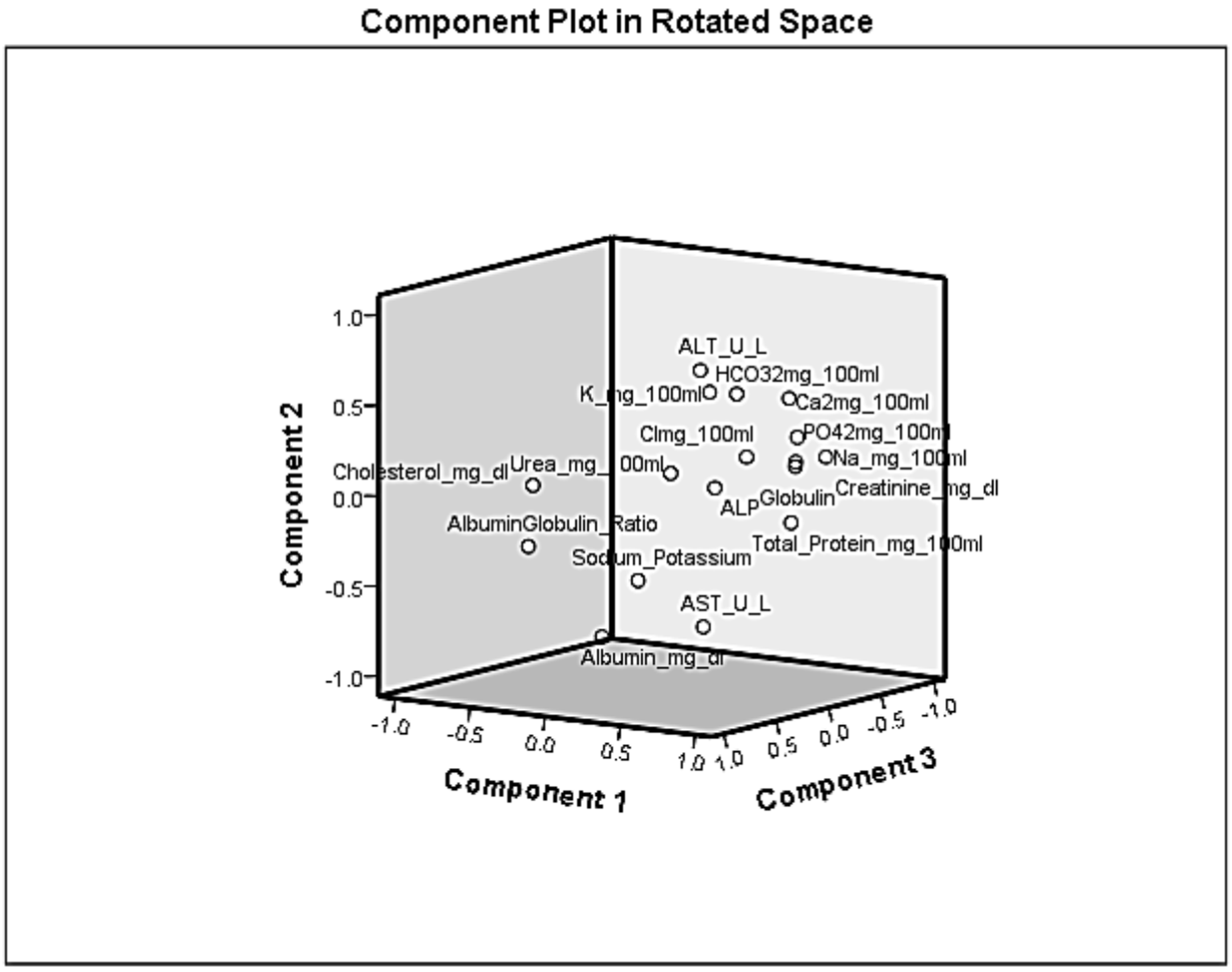


Figure 5.30: Component plot in rotated space of the serum biochemical parameters of the experimental birds fed 0% MOSM

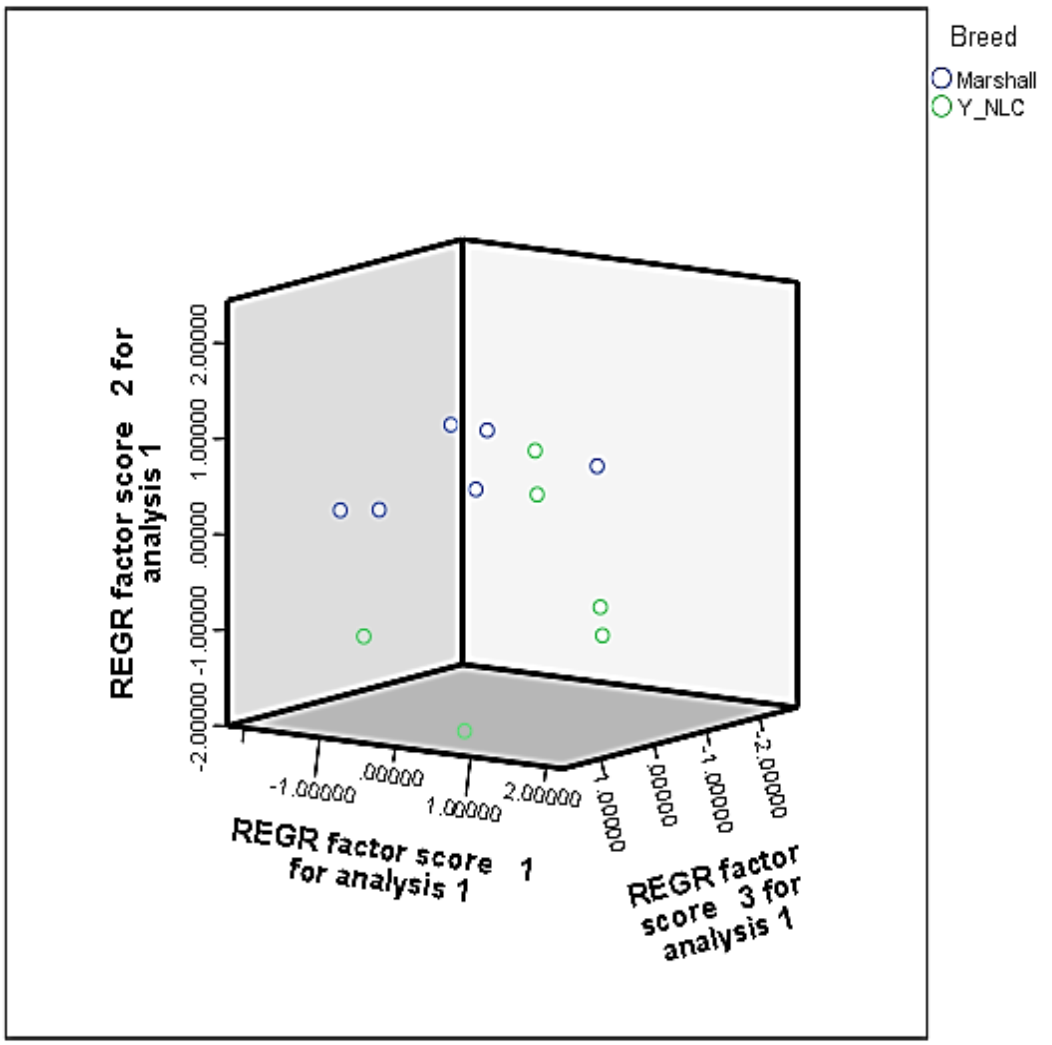


Figure 5.31. Graph showing the effect of 0% MOSM on serum biochemical parameters of YENLC and Marshall Broilers

Figure 5.31 showed that genotype did not influence the expression of the serum biochemical parameters. This could account for the similarities of the genotypes for some of the parameters examined.

5.53. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in serum biochemical parameters of experimental birds fed 5% MOSM

Principal components analysis of seventeen original variables in 96 chickens revealed that four principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.46). The four principal components collectively explained 88.014% of overall variation. PC1 accounted for most (44.982%) of the total variance while PC2, PC3 and PC4 accounted for 18.680%, 14.721% and 9.631% of the variance.

Table 5.46: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in serum biochemical parameters of the experimental birds fed 5% MOSM

Principal Components	Eigen values	% of Variance	Cumulative %
1	7.647	44.982	44.982
2	3.176	18.680	63.662
3	2.503	14.721	78.383
4	1.637	9.631	88.014

5.54. Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 5% MOSM

From Table 5.47, communalities were found to be high across the parameters especially K^+, Ca^{2+}, albumin, globulin and albumin-globulin ratio with values greater than 95%. Cl^- had the least value with 63.30%. PC1 loaded heavily on Na^+(0.925), PC2 loaded heavily on Albumin (0.936) and Albumin-Globulin Ratio (0.968) while PC3 had the highest loading on Sodium-Potassium Ratio (-0.828).

Table 5.47: Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 5% MOSM

	Component				
	1	**2**	**3**	**4**	**Communalities**
Na+_(mg_100ml)	.925	-.049	.176	.170	.919
K^+_(mg_100ml)	.779	.002	.582	.161	.971
Sodium_Potassium	-.242	-.070	-.828	-.072	.755
Ca^{2+}(mg_100ml)	.860	.193	.285	.331	.968
HCO_3^{2-}(mg_100ml)	.893	-.179	.189	.083	.873
PO_4^{2-}(mg_100ml)	.865	-.265	.220	.164	.894
Cl^-(mg_100ml)	-.543	-.193	.511	.197	.633
Total_Protein_(mg_100ml}	.244	-.313	-.086	.882	.944
Albumin_(mg_dl)	.081	.936	-.083	.284	.971
Globulin	.135	-.853	-.012	.492	.989
Albumin-Globulin_Ratio	-.030	.968	-.016	-.232	.992
Urea_(mg_100ml)	.768	-.092	-.437	.122	.804
Cholesterol_(mg_dl)	.106	-.128	.882	-.165	.833
Creatinine_(mg_dl)	.710	.225	.127	.547	.869
ALT_(U_L)	.783	-.206	-.025	-.385	.804
AST_(U_L)	.696	.113	.520	-.418	.942
ALP	.857	.233	-.012	.114	.801

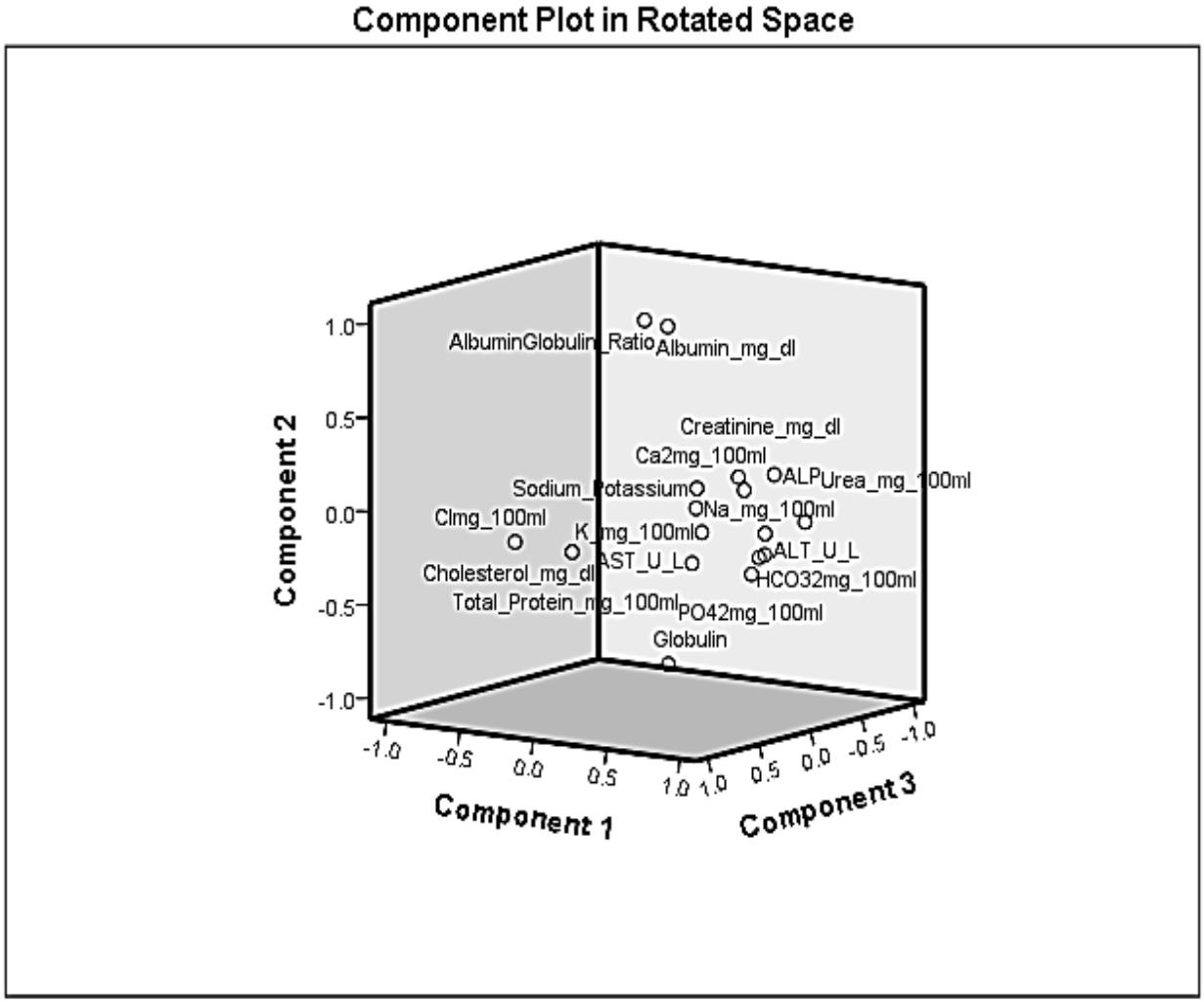


Figure 5.32: Component plot in rotated space of the serum biochemical parameters of the experimental birds fed 5% MOSM

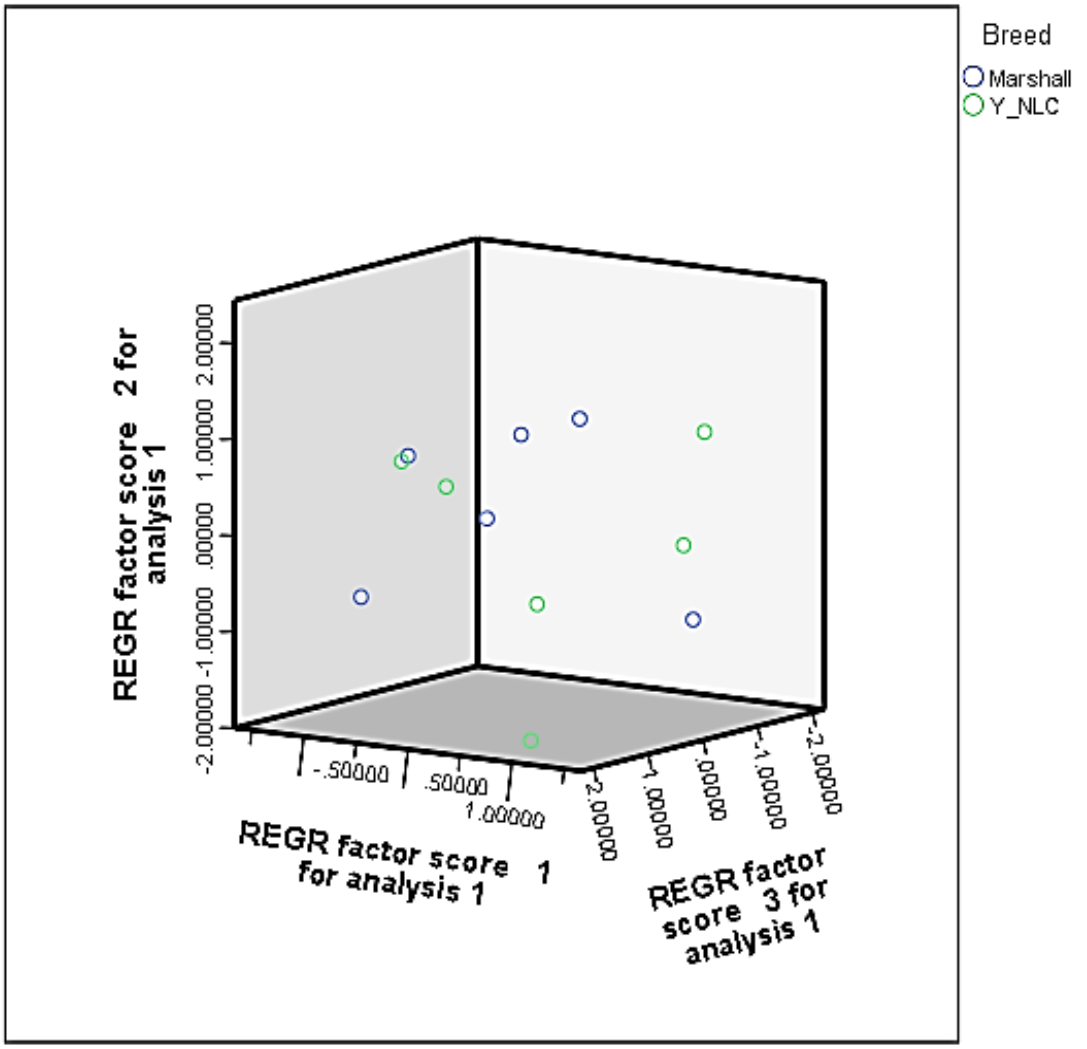


Figure 5.33. Graph showing the effect of 5% MOSM on serum biocchemical indices of YENLC and Marshall Broilers

Figure 5.33 showed that genotype did not influence the expression of the serum biochemical parameters. This could account for the similarities of the genotypes for some of the parameters examined.

5.55. Multivariate dimension reduction principal component analysis to identify salient factors underlying variation in serum biochemical parameters of experimental birds fed 10% MOSM

Principal components analysis of seventeen original variables in 96 chickens revealed that four principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.48). The four principal components collectively explained 91.332% of overall variation. PC1 accounted for most (46.330%) of the total variance while PC2, PC3 and PC4 accounted for 23.944%, 14.401% and 6.656% of the variance.

Table 5.48: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient factors underlying variation in serum biochemical parameters of the experimental birds fed 10% MOSM

Principal Component	Eigenvalues	% of Variance	Cumulative %
1	7.876	46.330	46.330
2	4.071	23.944	70.274
3	2.448	14.401	84.676
4	1.132	6.656	91.332

5.56. Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 10% MOSM

From Table 5.49, communalities were found to be high across the parameters especially K^+, Ca^{2+}, globulin and albumin-globulin ratio with values greater than 95%. Creatinine had the least value with 70.60%.

PC1 had high loadings (correlations between the components and the variables) on Ca^{2+} (0.981). PC2 was orthogonal to PC1 and loaded heavily on K^+ (0.900) and Sodium-Potassium Ratio (-0.903). PC3 loaded heavily on ALT (0.913) while PC4 had the highest loadings on Albumin (-0.728), Globulin (0.710) and Albumin-Globulin ratio (-0.790).

Table 5.49: Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 10% MOSM

	Component			
	1	**2**	**3**	**4**
Na^+_(mg_100ml)	.897	-.277	.068	-.207
K^+_(mg_100ml)	.220	.900	.192	.268
Sodium_Potassium	.114	-.903	-.143	-.317
Ca^{2+}(mg_100ml)	.981	.018	-.035	.103
HCO_3^{2-}(mg_100ml)	.940	.107	.048	.206
PO_4^{2-}(mg_100ml)	.206	.908	-.021	.246
Cl-(mg_100ml)	.858	.396	-.010	.193
Total_Protein_(mg_100ml}	.736	.260	-.277	.491
Albumin_(mg_dl)	.180	-.441	-.338	-.728
Globulin	.560	.398	-.103	.710
Albumin-Globulin_Ratio	-.401	-.445	-.046	-.790
Urea_(mg_100ml)	.594	.588	.238	-.116
Cholesterol_(mg_dl)	.894	.315	.035	.186
Creatinine_(mg_dl)	-.584	.073	.597	-.051
ALT_(U_L)	.031	.188	.913	-.250
AST_(U_L)	-.099	.233	.874	.169
ALP	.295	-.161	.843	.342

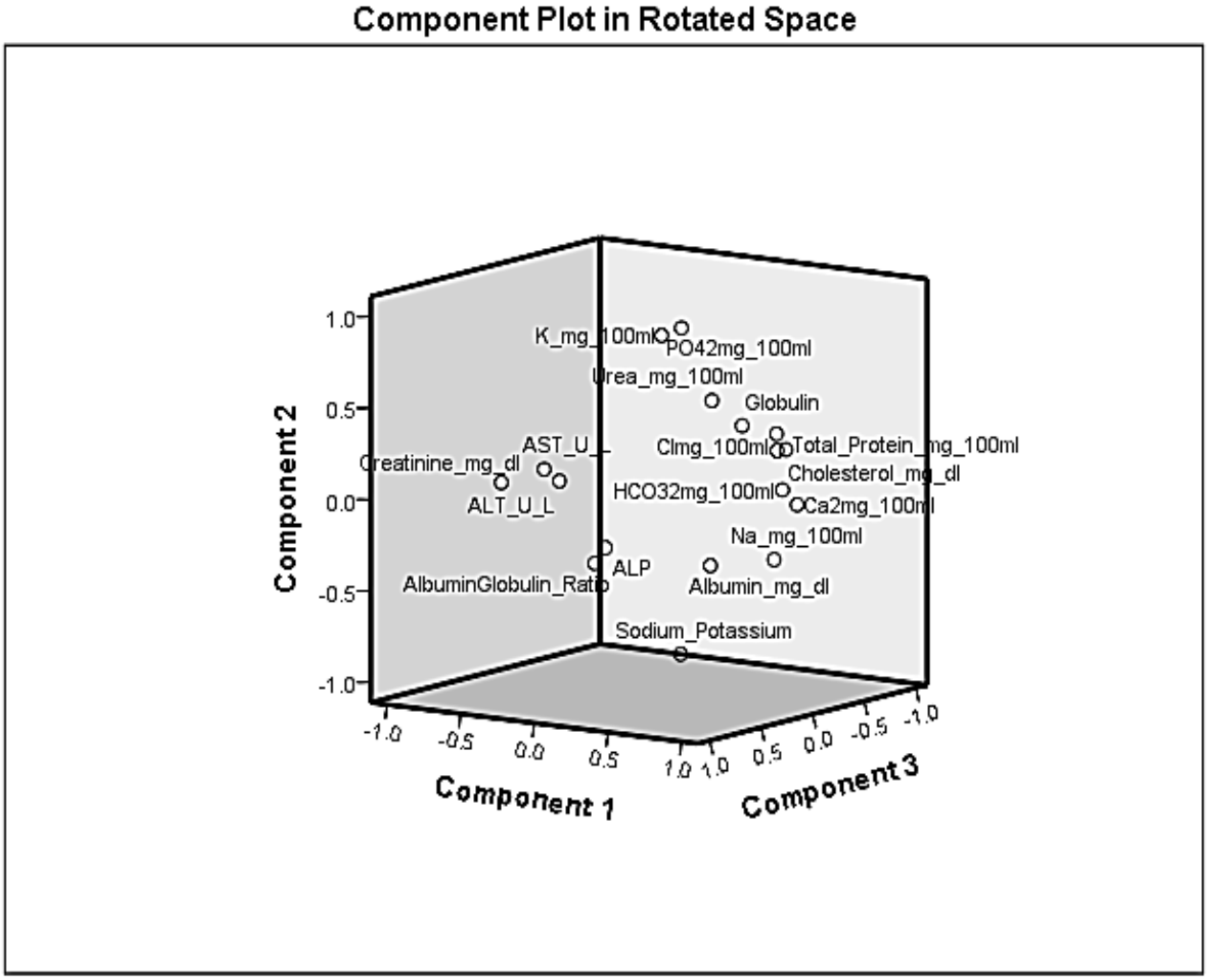


Figure 5.34: Component plot in rotated spaceof the serum biochemical parameters of the experimental birds fed 10% MOSM

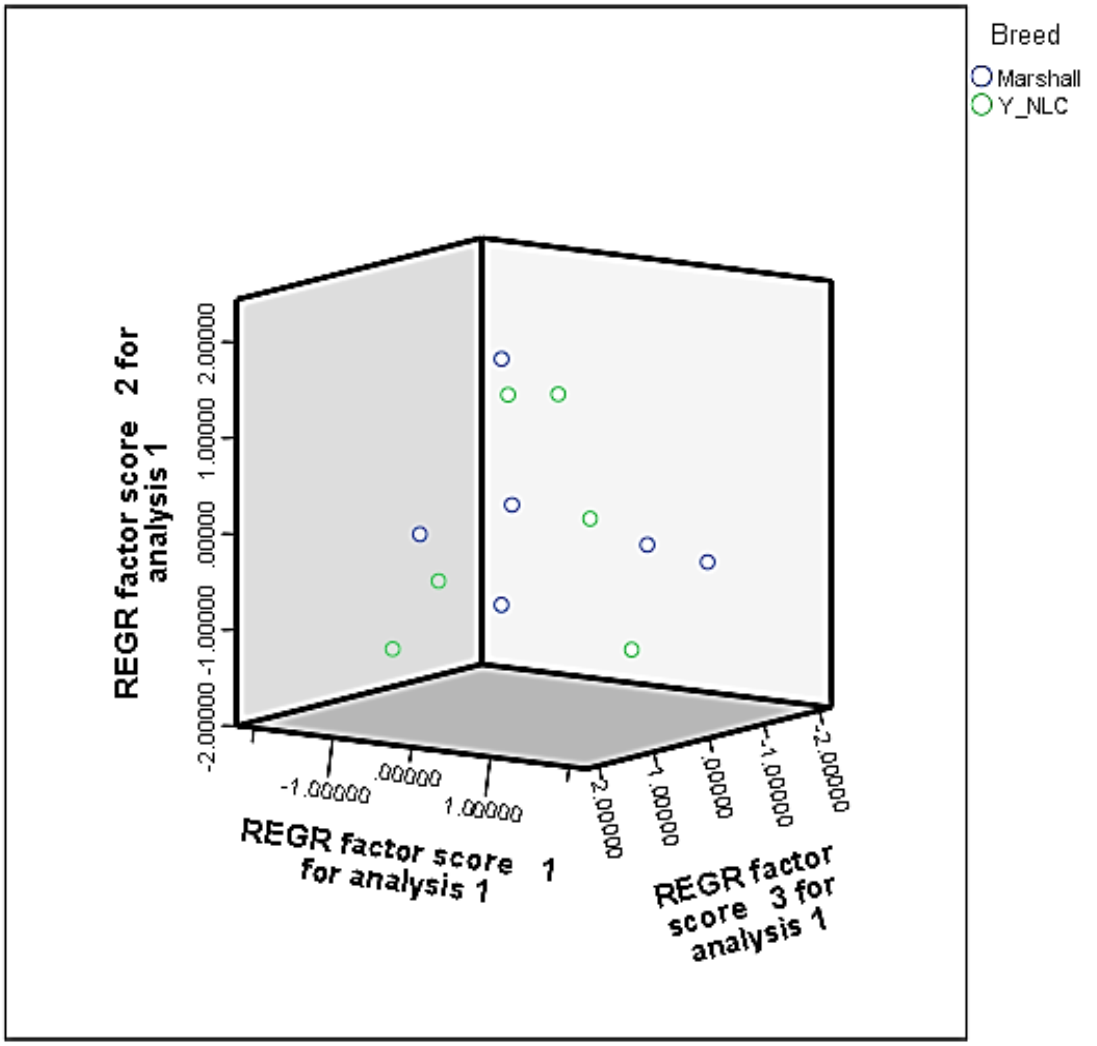


Figure 5.35: Graph showing the effect of 10% MOSM on serum biochemical parameters of YENLC and Marshall Broilers

Figure 5.35 showed that genotype did not influence the expression of the serum biochemical parameters. This could account for the similarities of the genotypes for some of the parameters examined.

5.57. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in serum biochemical parameters of experimental birds fed 15% MOSM

Principal components analysis of seventeen original variables in 48 chickens revealed that five principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 5.50). The five principal components collectively explained 91.332% of overall variation. PC1 accounted for most (34.467%) of the total variance while PC2, PC3, PC4 and PC5 accounted for 19.380%, 13.036%, 12.074% and 7.943% respectively of the variance.

Table 5.50: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in serum biochemical parameters of the experimental birds fed 15% MOSM

Principal Component	Total	% of Variance	Cumulative %
1	5.859	34.467	34.467
2	3.295	19.380	53.848
3	2.216	13.036	66.883
4	2.053	12.074	78.957
5	1.350	7.943	86.901

5.58. Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 15% MOSM

From Table 5.51, communalities were found to be high across the parameters especially K^+, Sodium-Potasium ratio, albumin, globulin and albumin-globulin ratio with values greater than 95%. AST had the least value with 44.50%.

PC1 had high loadings (correlations between the components and the variables) on Albumin (0.960), Albumin-Globulin ratio (0.959) and Globulin (-0.953). PC2 was orthogonal to PC1 and loaded heavily on HCO_3^{2-} (0.903). PC3 loaded heavily on Urea (0.947), PC4 loaded heavily on Na^+ (0.816) while PC5 had the highest loadings on ALT (0.883).

Table 5.51: Rotated component matrix and communalities of the serum biochemical parameters of the experimental birds fed 15% MOSM

	Component					
	1	**2**	**3**	**4**	**5**	**Communalities**
Na^+_(mg_100ml)	-.140	.215	.144	.816	.265	.929
K^+_(mg_100ml)	.259	.157	.326	.795	-.390	.966
Sodium_Potassium	-.330	-.080	-.331	-.669	.531	.949
Ca^{2+}(mg_100ml)	.334	.612	.500	.074	-.151	.974
HCO_3^{2-}(mg_100ml)	.102	.903	.334	.005	-.024	.941
PO_4^{2-}(mg_100ml)	.031	.068	.789	.411	-.146	.927
Cl^-(mg_100ml)	.544	.712	.000	.282	.107	.931
Total_Protein_(mg_100ml}	-.282	-.166	-.641	.652	.043	.927
Albumin_(mg_dl)	.960	.174	-.028	.071	-.033	.870
Globulin	-.953	-.197	-.105	.067	.039	.987
Albumin-Globulin_Ratio	.959	.166	.092	.019	-.099	.986
Urea_(mg_100ml)	.055	-.038	.947	.123	.080	.769
olesterol_(mg_dl)	.559	.527	-.055	-.074	.489	.934
Creatinine_(mg_dl)	.329	.766	-.307	.223	-.006	.706
ALT_(U_L)	-.267	.140	.007	.132	.883	.932
AST_(U_L)	.212	-.351	-.452	-.011	.268	.856
ALP	.155	-.152	-.082	-.137	.870	.941

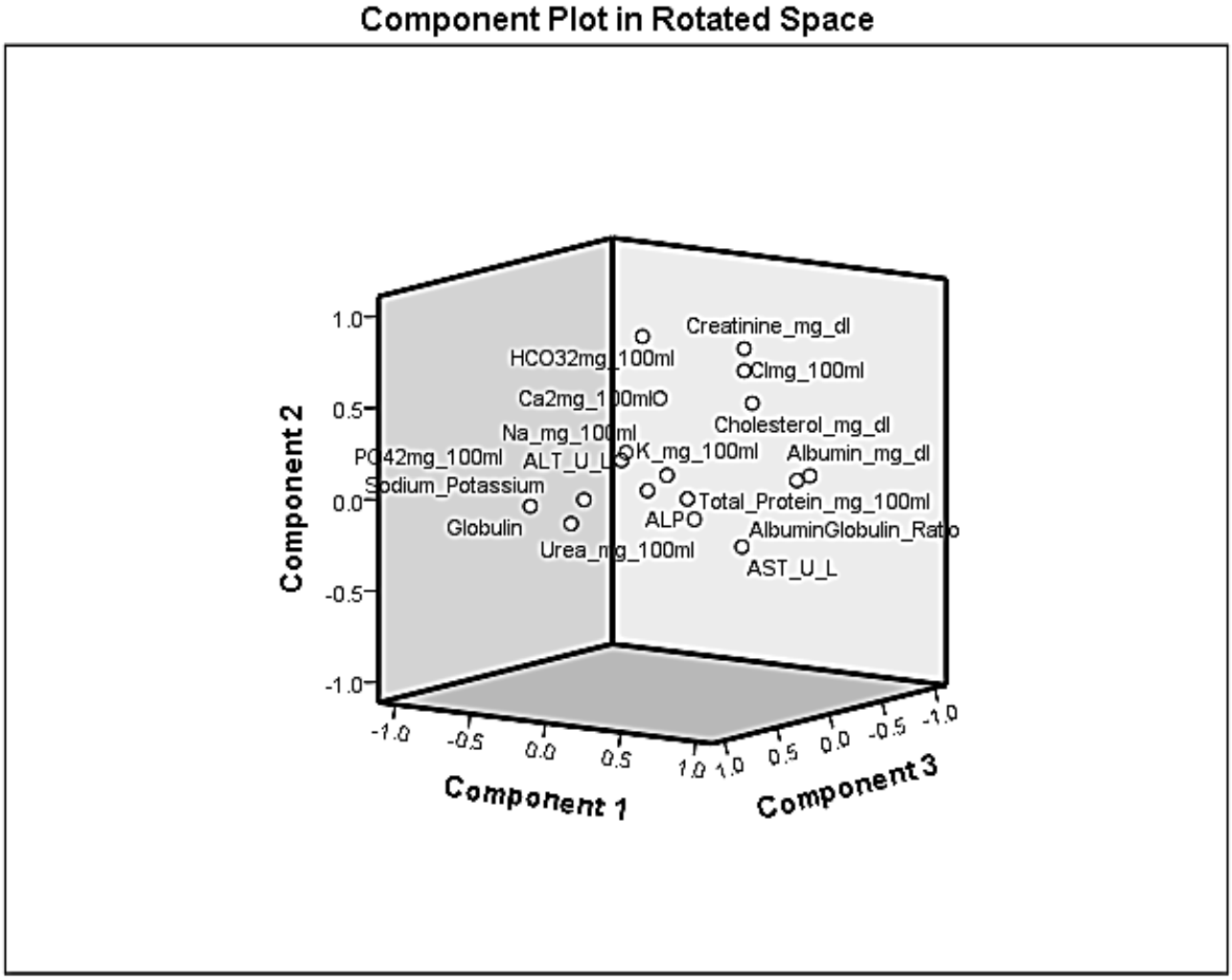


Figure 5.36: Component plot in rotated space of the serum biochemical parameters of the experimental birds fed 15% MOSM

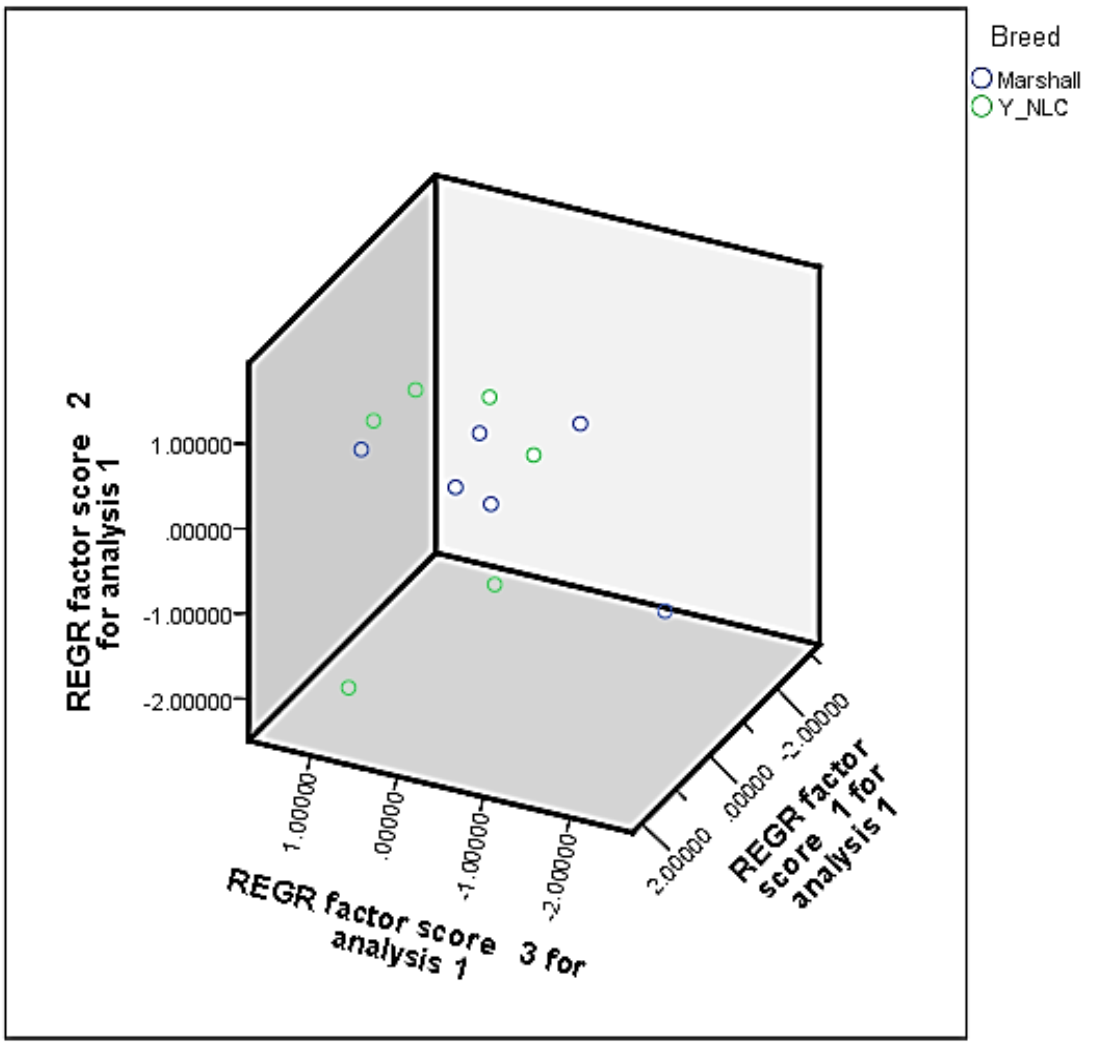


Figure 5.37: Graph showing the effect of 15% MOSM on serum biochemical parameters of YENLC and Marshall Broilers

Figure 5.37 showed that genotype did not influence the expression of the serum biochemical parameters. This could account for the similarities of the genotypes for some of the parameters examined.

5.58. Discussion

The high correlation between body weight and morphometric measurement was in support with the report of Fayeye and Owoeye (2016) and Yahaya *et al*. (2012) who reported high correlation coefficients Isa Brown and Fulani Ecotype chickens and Hubbard and ArborAcre broiler strains.

The knowledge and information on morphometric parameters are highly essential for understanding an animal and its reproductive biology in particular (Danilor 2000).

The result was also in agreement with the report of Ojedapo *et al*. (2011) who reported that growth traits showed increase in all body measurements as growth line. It also agreed with the report of Pingel et al. (1990) that age is a major determinant of growth and physiological development. They also reported that these morphometric relationships could be utilized for the genetic improvement of growth.

The growth pattern also agreed with the findings of Ojedapo *et al*. (2011) that weight of birds can easily be predicted from any given value of six body measurements (body length, drumstick length, shank thickness, keel length, body length and chest girth). The results also agreed with the findings of Adeniji and Ayorinde (1990) and Monsi (1992) that increasing chest girth or keel length through selection will result in corresponding increase in body weight.

The high positive and significant correlation between volume and concentration in the birds in the control diet had been reported. (Bilcik *et al*., 2005; Gebriel *et al*., 2009; Abd El Ghany *et al*., 2011). This showed that the inclusion of MOSM was responsible for the low negative correlation between the two variables. It was also observed from this study that body weight was positively but not significantly correlated with volume and concentration in some and negatively correlated in birds fed 0%, 10% and 15% MOSM and when all the birds were considered. Some other reports have shown positive relationship between these parameters (Gebriel *et al*., 2009; Abd El Ghany *et al*., 2011). Positive correlation between body weight and volume had also been reported by El Sahn (2007). However Makhafola *et al*. (2012) reported that body weight was negatively correlated with ejaculate volume, semen concentration in Naked neck and Ovampo

but positive correlation was reported between body weight and volume in Potchfstroom Koekoek strains of Southern African indigenous cockerels.

For the PCA, Pundir *et al.* (2011) reported that positive and significant correlations among the body measurements in different strains of broilers indicate high predictability among the variables. The positive relationship between bodyweight and most of the body measurements showed that bodyweight can be predicted from body measurements. This was in agreement with the observation reported by Ajayi *et al.* (2008). The values of communalities computed for the two genotypes of chickens confirm that PCA was appropriate for the data sets. The results was in agreement with the observations of Yakubu *et al*., (2009), they reported high range of communalities (0.755-0.987) for body measurements of Arbor Acre broilers. Mendes (2011) reported a communality range of 0.785- 0.987 for body measurements of Ross broilers which was similar to what was obtained in this study but for YENLC and Marshall broilers.

However, the study also agreed with the report of Salako (2006) who studied three strains of chicken, PC1 had the largest share of the total variance and correlated highly with breast width, thigh length and shank length. He however opined that PC1 could be described as the generalized form of broilers. Also, in a principal component analysis of body measurements of broilers, Yakubu *et al*., (2009b) reported that PC1 had high positive loadings on body weight, breast circumference and thigh length of Arbor Acre and termed PC1 "form factor". Mendes (2011) reported that PC1 had the highest correlation with shank length, breast circumference and bodyweight of Ross 308 broilers. Yakubu *et al*., (2009a) also reported that the first principal component accounted for the largest variance in the morphological traits of three Nigerian chicken genotypes.

Ogah *et al*., (2009) presented data that showed PC1 accounting for the largest variance in the body measurements of ducks with high positive loadings on body width, bill width, shank length, body length, head length and neck length. Pinto *et al*., (2006) used PCA to analyze performance and carcass traits measured in a population of Gallus gallus. The study showed that the first principal components explained the highest of the total variation. The first component is however called the generalized weight because the

largest eigen vectors were associated with bodyweight. According to Mendes (2009), the first principal component provides an adequate summary of the data in most cases. This was so because the first component accounted for more than half of the total variations.

CHAPTER 6

GENOTYPE-DIET EFFECT ON REPRODUCTIVE PARAMETERS

6.1. Introduction

It is necessary to evaluate the degrees of associations and the predictive abilities of various reproductive parts of chickens since this will assist in selecting males that could be used in breeding programmes and for sustainable meat and egg production in Nigeria. Oke and Ihemeson (2010) reported that there are differences between genotypes and species in the volume of semen concentration and total number of spermatozoa in an ejaculate. Differences in volume and sperm concentration depend largely on the relative contribution of the various reproductive glands (Hafez, 1987). The reproductive traits of a male chicken consist of the paired testes, the Epididymis, the vas deference and the rudimentary penis (Lake *et al.* 1985). However, basic morphometric data as well as correlation and predictive abilities of the reproductive organs and sperm reserve of the two genotypes (YENLC and Isa Brown chickens) and the influence of MOSM on these parameters are limited. The efficiency of this study will help in improving breeding practices as influenced by the feeding of graded levels of MOSM, since a baseline for assessment of the reproductive organs in relation to the sperm reserves of the genotypes and the effect of MOSM will be established.

Egg morphometric parameters such as egg weight, egg width, albumen and yolk weight are very important in poultry because these factors influence egg quality and grading (Farooq *et al.*, 2001), reproductive fitness of the chickens and embryonic development (Onagbesan *et al.*, 2007).

The effect of feeding and genetic make up of chickens on egg composition and its quality has been established (Kabir *et al*., 2012).

Internal egg quality parameters such as albumen weight and yolk weight are very important from nutritional and cholesterol content for human consumption (Sparks, 2006). Egg characteristics of Nigerian Local chickens (Oke *et al*., 2003), broiler chickens (Mamun, 2005) and pullets (Kabir *et al*., 2012) have previously

been reported. Egg quality traits of various chicken breeds (Islam and Dutta, 2010; Jones *et al*., 2010; Momoh *et al*., 2010) revealed results that are important to poultry breeders.

6.2. Location of the study

The study was carried out at the Livestock Section of the Teaching and Research Farm of the Federal College of Animal Health and Production Technology, Moore Plantation, Ibadan. The experiment lasted for forty weeks.

6.3. Data collection

Data collected from study two were used to estimate the correlation, regression and principal component analyses effect for spermiogramic indices, semen characteristics, egg parameters in Yoruba_Nigeria Local Chickens and Isa Brown Chickens as well as the overall effect on graded levels of MOSM.

Pearson correlations between body weight and morphometric quality traits as well as the haematological and serum biochemical parameters were assessed for the two genotypes of chickens and the four graded levels of MOSM for all the chickens irrespective of the genotypes using SPSS Version 20 (2012).

Predicting late semen and egg parameters of the two genotypes of chickens and for all the chickens in the various dietary treatment.

6.4. Statistical Analysis

Pearson's coefficients of correlation were first estimated for all the traits measured in the study. This was followed by principal component (PC) analysis. Cumulative proportion of variance criterion was employed in determining the number of PCs to extract. The factor matrix was rotated using the varimax criterion for easy interpretation of the PC analysis, which reliability was tested using The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacsy and Bartlett's Test of Sphericity.

Pearson correlation coefficients among the body measurements were calculated for each genotype of birds and each level of MOSM inclusion and the correlation matrix which was the primary data required for PCA generated. Bartletts test of sphericity was used to test if the correlation matrix was an identity matrix (each

variable correlated with itself) or a correlation matrix full of zero. The suitability of the data set to PCA was further tested by KaiserMeyer-Olkin (KMO) measure of sampling adequacy. This tested whether the partial correlations among variables were small. A KMO measure of 0.60 and above is considered adequate (Eyduran *et al*., 2010). Everitt *et al.,* (2001) defined principal component analysis as a method of transforming variables in a multivariate data set, x1, x2, ……..xp into new uncorrelated variables y1, y2,…….yp which account for decreasing proportions of the total variance in the original variables defined as:

y1=a11x1+a12x2+ ……+ a1pxp.

y2=a21x1+a22x2+……+ a2pxp.

yp=ap1x1+ap2x2+..…+ appxp.

The principal components y1, y2…….yp account for decreasing proportions of the total variance in the original variables x1, x2,……xp. Variance maximizing orthogonal rotation was used in the linear transformation of the factor pattern matrix in order to make the interpretation of the extracted principal components easier. The principal components analyses were performed using the factor program of SPSS 22 statistical package.

A forward regression procedure using a stepwise variable selection was used to obtain models of estimation from biometric measurements and from established principal components factor scores (Dahloum et al., 2016):

Y = a + b1X1 + ... + bkXk,

where Y is the dependent variable, a is the regression intercept, bi is the ith partial regression coefficients of the ith measurement or principal component, and Xi and PCi are the ith traits or principal component.

6.5. Phenotypic Correlations of local and Exotic Chickens and Graded Levels of MOSM

Table 6.1 showed the correlations between the various semen quality traits and body weight. Most correlations irrespective of direction ranged from low to moderate and high. However the correlations were highly significant ($p<0.05$).

From the Table 6.2, there was high positive correlation between body weight and spermatozoa reserves in the testes (r=0,917). However, correlations coefficients varied from low to moderate to high for YENLC.

From Table 6.3, there was high positive correlation between body weight and spermatozoa reserves in the testes (r=0.655) and paired testis volume and paired testis weight r=0.573). However, correlations coefficients varied from low to moderate to high for Isa Brown cocks.

From Table 6.4, it was discovered that there was significant positive ($p<0.05$) relationship between body weight and spermatozoa reserves in the testis (r=0.877) and paired testis volume (r=0.815) but significant negative correlation ($p<0.05$) between body weight and semen volume (r=-0.889) and sperm concentration (r=-0.823). Also there was significant positive correlation ($p<0.05$) between paired testis weight and spermatozoa reserves in the testis (r=0.804).

Table 6.5 revealed that there was significant positive ($p<0.05$) relationship between paired testis weight and paired testis volume (r=0.850) and body weight and spermatozoa reserves in the testis (r=0961) and spermatozoa reserves in the epididymis (r=0.805). Also, there was a high positive relationship ($p<0.05$) between spermatozoa reserves in the epididymis and spermatozoa reserves in the testis (r=0.844).

From Table 6.6, it was observed that there was significant positive ($p<0.05$) relationship between paired testis weight and paired testis volume (r=0.946), paired epididymis weight and body weight (r=0.952), body weight and spermatozoa reserves in the testis (r=0.937) and spermatozoa reserves in the testis and paired epididymis weight (r=0.911) but significant negative correlation ($p<0.05$) between paired epididymis weight and semen volume (r=-0.952) and body weight and semen volume (r=-0.922).

From Table 6.7, it was revealed that there was significant positive ($p<0.05$) relationship between body weight and spermatozoa reserves in the testis ($r=0.970$). However, correlations coefficients varied from low to moderate to high for YENLC and Isa Brown cocks fed 15% MOSM.

Table 6.1. Correlations of spermiogramic parameters of birds irrespective of diets and genotypes

	Paired testis weight	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
paired epididymis	.505	1.000								
paired testis vol	.768	.511	1.000							
BW	.579	.618	.684	1.000						
spermatozoa reserves (X109}-TESTIS	.647	.641	.718	.917	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.215	.248	.163	.405	.366	1.000				
Semen Vol	.080	.069	-.106	.161	.204	.637	1.000			
Mass Activity	-.333	-.331	-.351	-.478	-.432	-.179	-.105	1.000		
Sperm Motility	-.131	-.171	-.145	-.164	-.258	-.412	-.322	.109	1.000	
Sperm Conc.	-.315	-.257	-.383	-.449	-.420	-.138	-.060	.241	-.167	1.000

Table 6.2 Correlations of spermiogramic parameters of YENLC irrespective of diets

	Paired testis weight	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
paired epididymis	.505	1.000								
paired testis vol	.768	.511	1.000							
BW	.579	.618	.684	1.000						
spermatozoa reserves (X109}-TESTIS	.647	.641	.718	.917	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.215	.248	.163	.405	.366	1.000				
Semen Vol	.080	.069	-.106	.161	.204	.637	1.000			
Mass Activity	-.333	-.331	-.351	-.478	-.432	-.179	-.105	1.000		
Sperm Motility	-.131	-.171	-.145	-.164	-.258	-.412	-.322	.109	1.000	
Sperm Conc.	-.315	-.257	-.383	-.449	-.420	-.138	-.060	.241	-.167	1.000

Table 6.3. Correlations of spermiogramic parameters of Isa Brown irrespective of diets

	PAIRED TESTIS WEIGHT	paired epididymis	paired vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
PAIRED TESTIS WEIGHT	1.000									
paired epididymis	.227	1.000								
paired vol	.573	.118	1.000							
BW	.028	-.293	.129	1.000						
spermatozoa reserves (X109}-TESTIS	.256	.012	.255	.655	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	-.070	-.175	-.228	.016	-.050	1.000				
Semen Vol	-.065	.034	-.199	-.034	-.057	-.106	1.000			
Mass Activity	.119	.280	.200	-.106	.221	.100	-.215	1.000		
Sperm Motility	.004	-.021	.073	.054	-.192	-.456	.166	-.069	1.000	
Sperm Conc.	-.185	.047	-.310	-.236	-.313	.044	-.240	.105	-.303	1.000

Table 6.4 Correlations of spermiogramic parameters of birds fed 0% MOSM

	PAIRED TESTIS WEIGHT	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
PAIRED TESTIS WEIGHT	1.000									
paired epididymis	-.082	1.000								
paired testis vol	.623	-.086	1.000							
BW	.687	-.372	.815	1.000						
spermatozoa reserves (X109}-TESTIS	.804	-.096	.759	.877	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.538	-.236	.434	.534	.664	1.000				
Semen Vol	-.759	.217	-.721	-.878	-.889	-.571	1.000			
Mass Activity	-.302	.447	-.386	-.548	-.349	-.179	.474	1.000		
Sperm Motility	-.586	-.142	-.528	-.387	-.535	-.413	.396	-.101	1.000	
Sperm Conc.	-.593	.307	-.694	-.823	-.788	-.733	.764	.487	.587	1.000

Table 6.5. Correlations of spermiogramic parameters of birds fed 5% MOSM

	PAIRED TESTIS WEIGHT	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
PAIRED TESTIS WEIGHT	1.000									
paired epididymis	.625	1.000								
paired testis vol	.850	.481	1.000							
BW	.628	.686	.606	1.000						
spermatozoa reserves (X109}-TESTIS	.697	.739	.711	.961	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.549	.405	.668	.805	.844	1.000				
Semen Vol	-.128	.080	-.279	.015	.011	-.261	1.000			
Mass Activity	-.221	-.444	-.186	-.781	-.701	-.488	-.382	1.000		
Sperm Motility	.159	-.133	.090	-.166	-.134	-.117	.054	.075	1.000	
Sperm Conc.	-.195	-.066	-.265	.033	.004	.150	-.182	-.050	-.407	1.000

Table 6.6. Correlations of spermiogramic parameters of birds fed 10% MOSM

	PAIRED TESTIS WEIGHT	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
PAIRED TESTIS WEIGHT	1.000									
paired epididymis	.686	1.000								
paired testis vol	.946	.787	1.000							
BW	.649	.952	.758	1.000						
spermatozoa reserves (X109}-TESTIS	.590	.911	.685	.937	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.615	.815	.620	.820	.857	1.000				
Semen Vol	-.631	-.952	-.721	-.922	-.866	-.743	1.000			
Mass Activity	-.475	-.482	-.514	-.549	-.479	-.317	.458	1.000		
Sperm Motility	-.300	-.406	-.371	-.499	-.572	-.645	.285	.171	1.000	
Sperm Conc.	.121	.262	.232	.211	.188	.235	-.320	.300	-.032	1.000

Table 6.7. Correlations of spermiogramic parameters of birds fed 15% MOSM

	PAIRED TESTIS WEIGHT	paired epididymis	paired testis vol	BW	spermatozoa reserves (X109}-TESTIS	spermatozoa reserves (X109}-EPIDIDYMIS	Semen Vol	Mass Activity	Sperm Motility	Sperm Conc.
PAIRED TESTIS WEIGHT	1.000									
paired epididymis	.571	1.000								
paired testis vol	.699	.731	1.000							
BW	.533	.861	.730	1.000						
spermatozoa reserves (X109}-TESTIS	.581	.846	.797	.970	1.000					
spermatozoa reserves (X109}-EPIDIDYMIS	.056	.256	-.078	.510	.382	1.000				
Semen Vol	-.018	-.092	-.200	-.234	-.149	-.209	1.000			
Mass Activity	-.320	-.553	-.290	-.373	-.317	-.130	.018	1.000		
Sperm Motility	.212	.249	.375	.032	.111	-.666	.097	-.176	1.000	
Sperm Conc.	-.572	-.840	-.761	-.743	-.744	-.149	-.044	.598	-.342	1.000

6.6. Forward stepwise regression analysis to predict some semen traits of the cocks irrespective of genotype for body weights at 24 weeks of age

Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the exotic and local cocks are presented in Tables 6.8 and 6.9, respectively. From table 81, most of the regression equations had low R^2 values ranging from 0.00 to 0.468 but body weight could predict spermatozoa reserves in the testis hence the high R^2 value of 0.840.

However, from Table 6.9, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.853$)

Table 6.8: Simple regression equations to predict some semen traits of the cocks irrespective of genotype from body weights at 24 weeks of age

Independent Variable (x)	Dependent Variables (y)	Regression equation	R^2	SE
BW	Volume	-1.31 + 0.007BW	0.468*	0.298
	Testes Weight	-0.0809 + 0.005BW	0.336*	0.323
	Epididymis Weight	0.061+0.000BW	0.382*	0.222
	Spermatozoa Reserves(testes)	0.087 +0.001BW	0.840*	0.256
	Spermatozoa Reserves (epididymis)	0.003 + 0.00BW	0.164*	0.136

Key: BW (Body Weight), R^2=Variance explained, SE (Associated Standard Error)

Table 6.9: Simple regression equation to predict body weight of the cocks irrespective of genotype from some semen traits at 24 weeks of age

Independent Variables (x)	Dependent Variable (y)	Regression equation	R^2	SE
Volume	BW	211.720 + (-10.069)TW + 80.085EW	0.853*	0.168
Testes Weight		546.067SRT + 260.729SRE + 13.227V		
Epididymis Weight				
Spermatozoa Reserves(testes)				
Spermatozoa Reserves (epididymis)				

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

6.7. Forward stepwise regression analysis to predict some semen traits of the YENLC for body weights at 24 weeks of age

Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the YENLC cocks are presented in Tables 6.10 and 6.11 respectively. From Table

6.10, it was observed that body weight could predict spermatozoa reserves in the testis when compared with the other parameters hence the high R^2 value of 0.823.

However, from Table 6.11, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.824$)

Table 6.10: Simple regression equations to predict some semen traits of the YENLC cocks from body weights at 24 weeks of age

Independent Variable (x)	Dependent Variables (y)	Regression equation	R^2	SE
BW	Volume	-1.039 + 0.006BW	0.596*	0.193
	Testes	1.886 + 0.003BW	0.449*	0.121
	Epididymis	0.009 + 0.0BW	0.252*	0.276
	SRT	0.411 + 0.001BW	0.823*	0.194
	SRE	0.017 + 0.000BW	0.567*	0.408

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 6.11: Simple regression equation to predict body weight of the YENLC cocks from some semen traits at 24 weeks of age

Independent Variables (x)	Dependent Variable (y)	Regression equation	R^2	SE
Volume Testes Epididymis SRT SRE	BW	-34.891 + (-12.716)ES + 7.418V + 691.125SRT + 378.441SRE + (6.760)TS	0.824*	0.173

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

6.8. Forward stepwise regression analysis to predict some semen traits of Isa Brown Cocks for body weights at 24 weeks of age

Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the YENLC cocks are presented in Tables 6.12 and 6.13, respectively. From Table 6.12, it was observed that body weight could not predict well the sperm parameters as the R^2 values are very low.

However, from Table 6.13, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.528$)

Table 6.12: Simple regression equations to predict some semen traits of the Isa Brown cocks from body weights at 24 weeks of age

Independent	Dependent	Regression equation	R^2	SE
BW	Volume	7.304 + 0.003BW	0.017*	0.340
	Testes	9.433 + 0.001BW	0.001*	0.382
	Epididymis	1.436 + 0.000BW	0.086ns	0.14
	SRT	0.117 + 0.001BW	0.0430*	0.27
	SRE	0.263 + (1.576*10-5)BW	0.00ns	0.16

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 6.13: Simple regression equation to predict body weight of the Isa Brown cocks from some semen traits at 24 weeks of age

Independent	Dependent	Regression equation	R^2	SE
Volume	BW	1399.316 + (-5.002)TS + (-315.653)ES + 2.783V	0.528*	0.12296
Testes		+ 320.866SR + 5.812SRE		
Epididymis				
SRT				
SRE				

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

6.9. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of experimental birds irrespective of diets and genotypes

Principal components analysis of ten original variables in 75 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.14). The two principal components collectively explained 61.741%% of overall variation. PC1 accounted for 43.850% of the total variance while PC2 accounted for 17.891% of the variance.

Table 6.14: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of experimental birds irrespective of diets and genotypes

Component	Eigen Value	% of Variance	Cumulative %
1	4.385	43.850	43.850
2	1.789	17.891	61.741

6.10. Rotated component matrix and communalities of the spermiogramic parameters of the experimental birds irrespective of diets and genotypes

From Table 6.15, PC1 had high loadings (correlations between the components and the variables) on spermatozoa reserves in the testes (0.884), body weight (0.876) and paired testis volume (0.869) while PC2 loaded heavily on spermatozoa reserves in the epididymis (0.838).

Table 6.15: Rotated component matrix and communalities of the spermiogramic parameters of the experimental birds irrespective of diets and genotypes

	1	2	Communalities
Paired testis weight	.794	.064	.634
paired epididymis	.715	.150	.534
paired testis vol	.869	-.051	.758
BW	.876	.238	.825
spermatozoa reserves (X109}-TESTIS	.884	.271	.855
spermatozoa reserves (X109}-EPIDIDYMIS	.222	.838	.751
Semen Vol	-.023	.842	.709
Mass Activity	-.540	-.135	.310
Sperm Motility	-.074	-.682	.470
Sperm Conc.	-.565	.099	.329

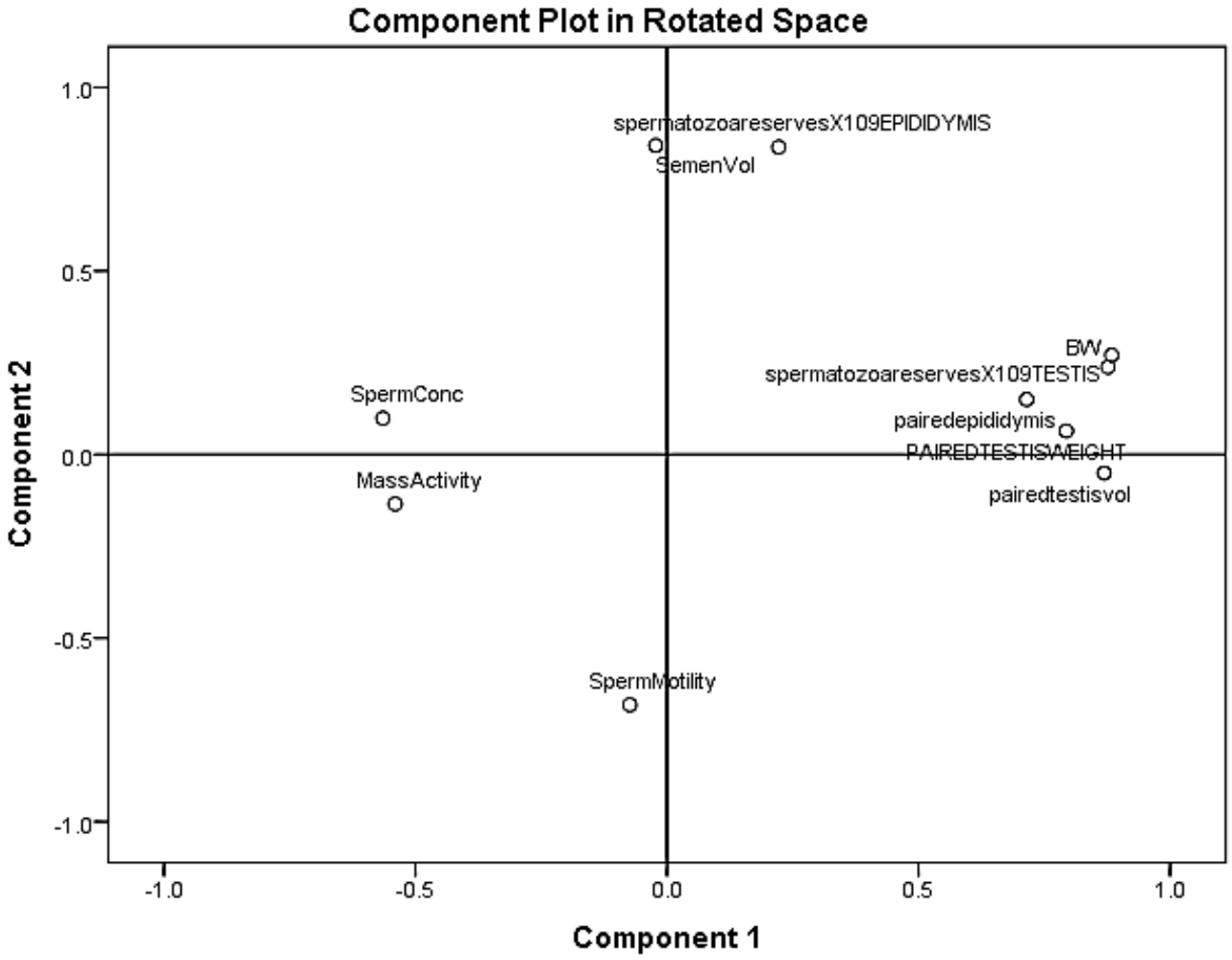


Figure 6.1: Component plot in rotated space of the spermiogramic parameters of the experimental birds irrespective of diets and genotypes

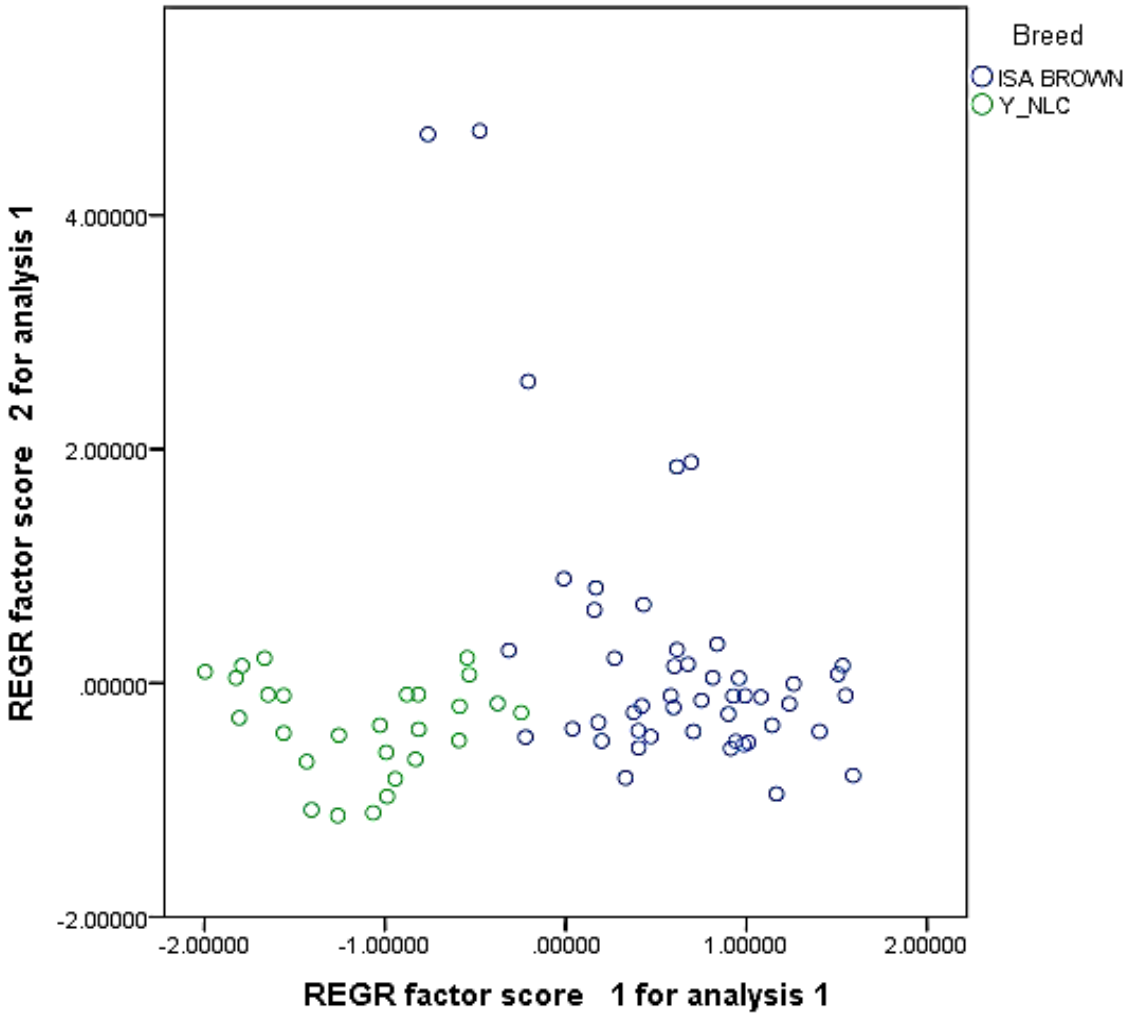


Figure 6.2. Graph showing the effect of genotype on Spermiogramic parameters

The figure above (Figure 6.2) clearly indicated that genotype determined the spermiogramic parameters of YENLC and Isa Brown cocks.

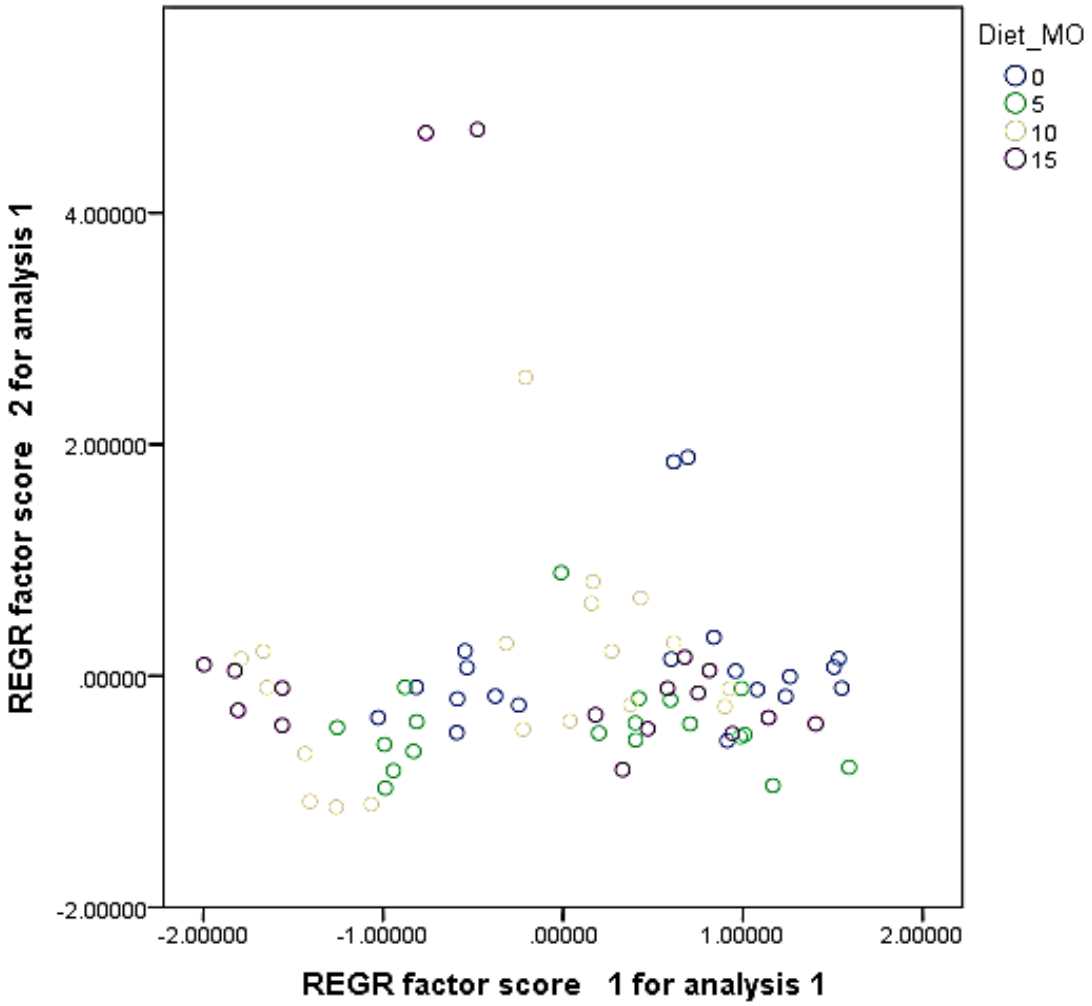


Figure 6.3. Graph showing the effect of MOSM on sperm characteristics of YENLC and Isa Brown Cocks

Figure 6.3 showed that the inclusion of MOSM did not influence sperm characteristics of chickens.

6.11. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of YENLC irrespective of diets

Principal components analysis of ten original variables in 27 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.16). The two principal components collectively explained 61.741% of overall variation. PC1 accounted for most (43.850%) of the total variance while PC2 accounted for 17.891% of the variance.

Table 6.16: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of YENLC irrespective of diets

Component	Eigen Value	% of Variance	Cumulative %
1	4.385	43.850	43.850
2	1.789	17.891	61.741

6.12. Rotated component matrix and communalities of the spermiogramic parameters of YENLC irrespective of diets

From Table 6.17, PC1 had high loadings (correlations between the components and the variables) on spermatozoa reserves in the testes (0.884), paired testis volume (0.869) and body weight (0.876). This implies that as the body weight is increasing, the testis volume and sperm production in the testis will be increasing. PC2 was orthogonal to PC1 and loaded heavily on Spermatozoa reserves in the epididymis (0.838) and semen volume (0.842).

Table 6.17: Rotated component matrix and communalities of the spermiogramic parameters of YENLCirrespective of diets

	1	2	Communalities
Paired testis weight	.794	.064	.634
paired epididymis	.715	.150	.534
paired testis vol	.869	-.051	.758
BW	.876	.238	.825
spermatozoa reserves (X109}-TESTIS	.884	.271	.855
spermatozoa reserves (X109}-EPIDIDYMIS	.222	.838	.751
Semen Vol	-.023	.842	.709
Mass Activity	-.540	-.135	.310
Sperm Motility	-.074	-.682	.470
Sperm Conc.	-.565	.099	.329

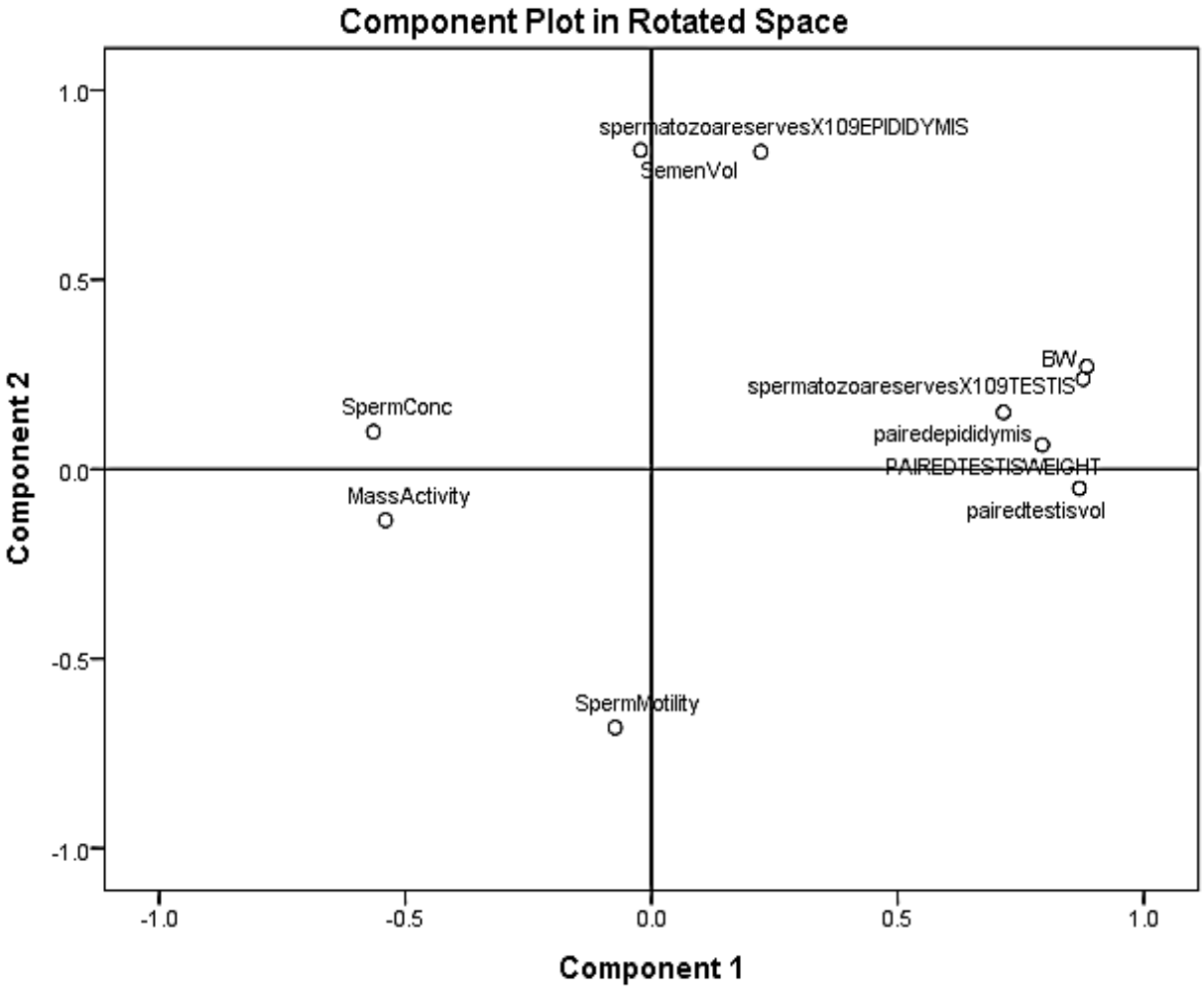


Figure 6.4: Component plot in rotated space of the spermiogramic parameters of YENLC irrespective of diets

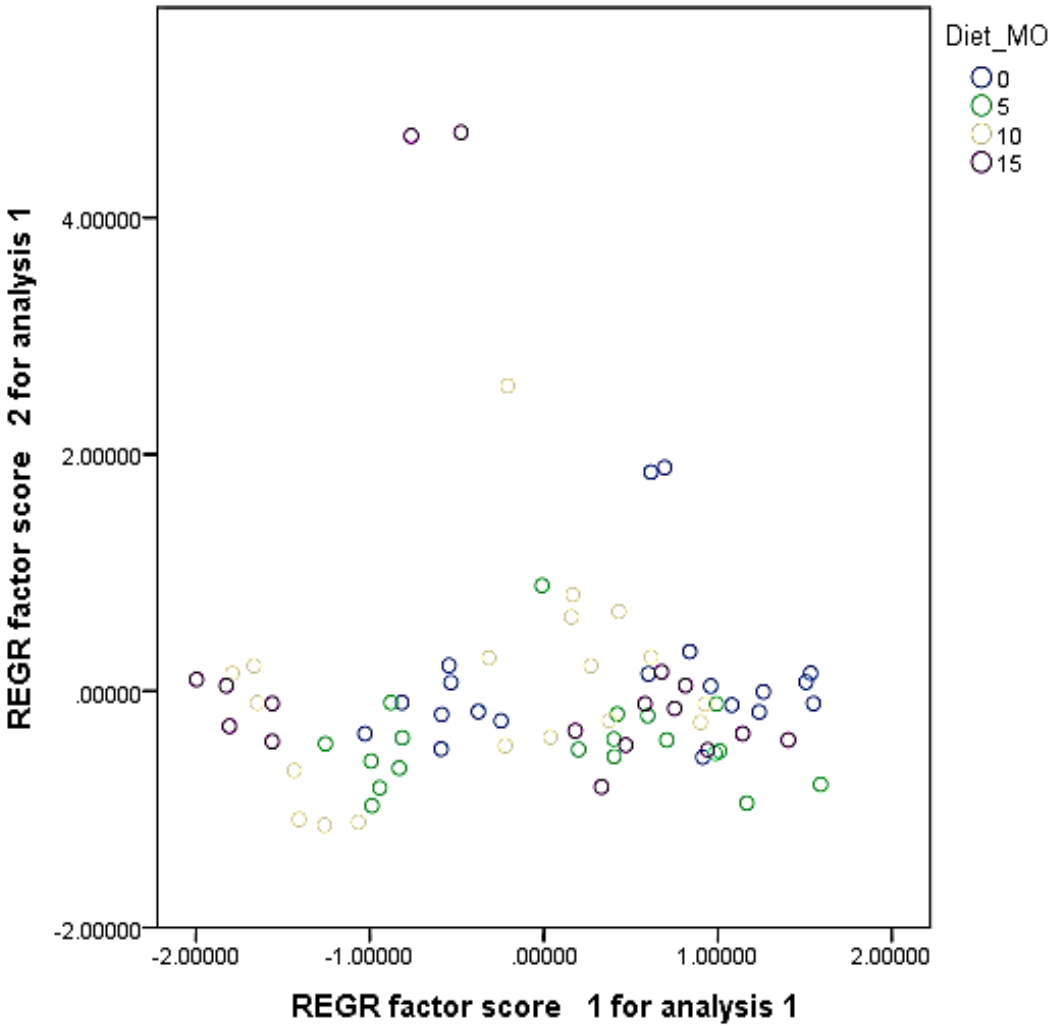


Figure 6.5. Graph showing effect MOSM on Spermiogramic parameters of YENLC

Figure 6.5 showed that the spermiogramic parameters of chickens were influenced by the genotypes but the effect of MOSM was overlapping on different parameters of spermiograms.

6.13. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of Isa Brown Cocks irrespective of diets

Principal components analysis of ten original variables in 48 chickens revealed that four principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.18). The four principal components collectively explained 67.475% of overall variation. PC1 accounted for most (22.648%) of the total variance while PC2, PC3 and PC4 accounted for 17.612%, 16.916% and 10.299% of the variance.

Table 6.18: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of Isa Brown cocks irrespective of diets

Component	Eigen Value	% of Variance	Cumulative %
1	2.265	22.648	22.648
2	1.761	17.612	40.260
3	1.692	16.916	57.176
4	1.030	10.299	67.475

6.14. Rotated component matrix and communalities of the spermiogramic parameters of Isa Brown Cocks irrespective of diets

From Table 6.19, communalities were found to be high across the parameters except in mass motility with 0.456. PC1 had high loadings (correlations between the components and the variables) on body weight (0.876). PC2 was orthogonal to PC1 and loaded heavily on paired testis weight (0.717).PC3 had the highest loading on sperm motility (-0.824). PC4 had the highest loading on semen volume (0.886).

Table 6.19: Rotated component matrix and communalities of the spermiogramic parameters of Isa Brown cocks irrespective of diets

	Component				
	1	**2**	**3**	**4**	**Communalities**
PAIRED TESTIS WEIGHT	.208	.717	-.119	.035	.573
paired epididymis	-.415	.660	.037	.203	.651
paired vol	.338	.663	-.335	-.167	.694
BW	.876	-.152	-.008	-.029	.791
spermatozoa reserves (X109}-TESTIS	.793	.321	.186	.048	.769
spermatozoa reserves (X109}-EPIDIDYMIS	.054	-.134	.791	.001	.646
Semen Vol	-.090	-.137	-.042	.886	.814
Mass Activity	-.076	.569	.242	-.261	.456
Sperm Motility	-.022	-.090	-.824	.164	.715
Sperm Conc.	-.488	-.171	.255	-.553	.638

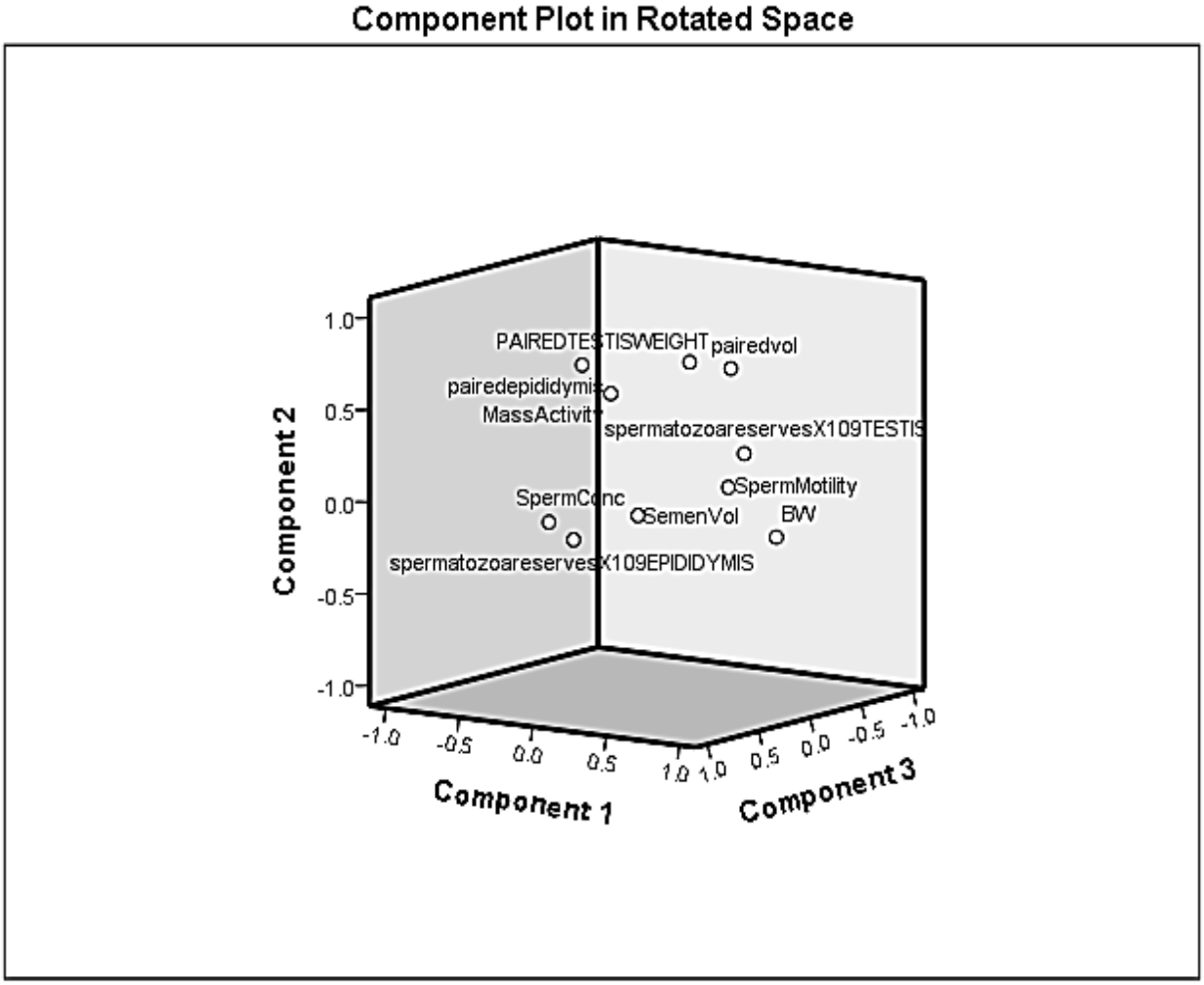


Figure 6.6: Component plot in rotated spaceof the spermiogramic parameters of Isa Brown cocks irrespective of diets

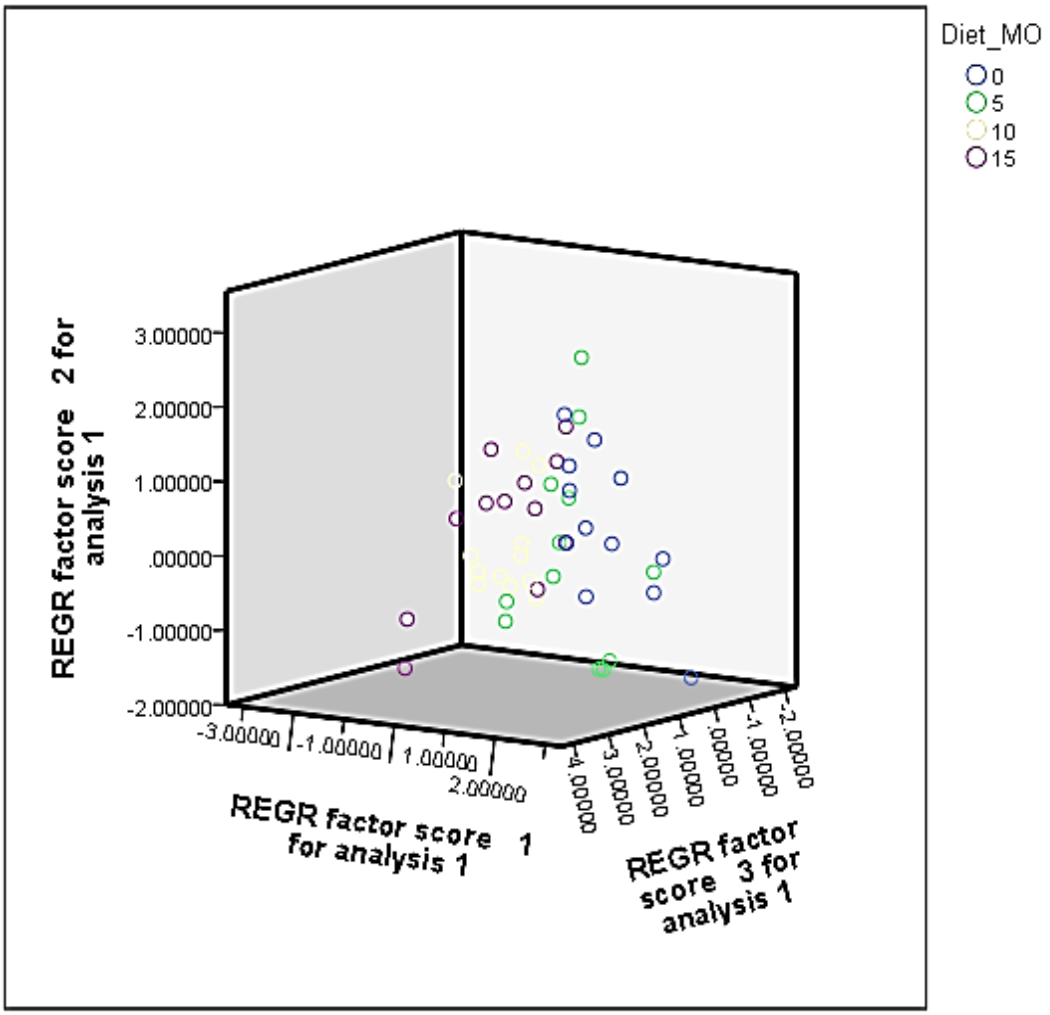


Figure 6.7: Graph showing effects of MOSM on Isa Brown Cocks

Figure 6.7 showed that the Isa Brown cocks fed 15% MOSM had significantly different values for the spermiogramic and semen parameters compared to the other levels of MOSM examined in the study.

6.15. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in spermiogramic parameters of birds fed 0% MOSM

Principal components analysis of ten original variables in 48 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.20). The two principal components collectively explained 74.899% of overall variation. PC1 accounted for more than half (59.285%) of the total variance while PC2 accounted for 15.615% of the variance.

Table 6.20: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimension/features/(meta)factors underlying variation in spermiogramic parameters of birds fed 0% MOSM

Component	Eigen Value	% of Variance	Cumulative %
1	5.928	59.285	59.285
2	1.561	15.615	74.899

6.16. Rotated component matrix and communalities of the spermiogramic parameters of birds fed 0% MOSM

From Table 6.21, communalities were found to be high across the parameters.PC1 had high loadings (correlations between the components and the variables) on sperm reserves in the testis (0.938). PC2 had the highest loading on paired epididymis weight (0.811) and mass activity (0.800).

Table 6.21: Rotated component matrix and communalities of the spermiogramic parameters of birds fed 0% MOSM

	1	2	Communalities
PAIRED TESTIS WEIGHT	.847	-.029	.718
paired epididymis	-.043	.811	.660
paired testis vol	.825	-.145	.702
BW	.838	-.446	.901
spermatozoa reserves (X109}-TESTIS	.938	-.134	.897
spermatozoa reserves (X109}-EPIDIDYMIS	.704	-.127	.511
Semen Vol	-.858	.314	.835
Mass Activity	-.282	.800	.720
Sperm Motility	-.738	-.426	.726
Sperm Conc.	-.853	.304	.820

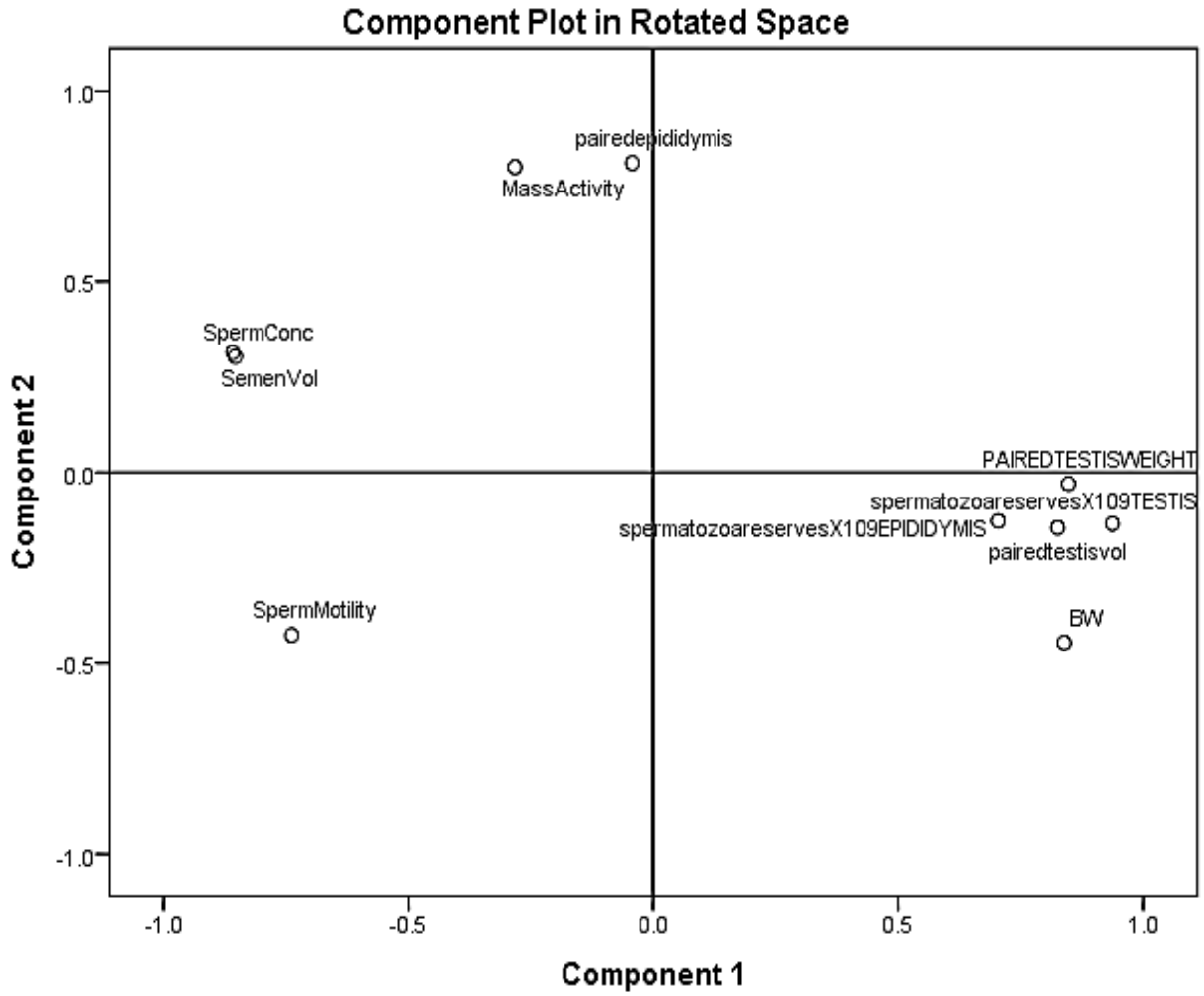


Figure 6. 8: Component plot in rotated spaceof the spermiogramic parameters of birds fed 0% MOSM

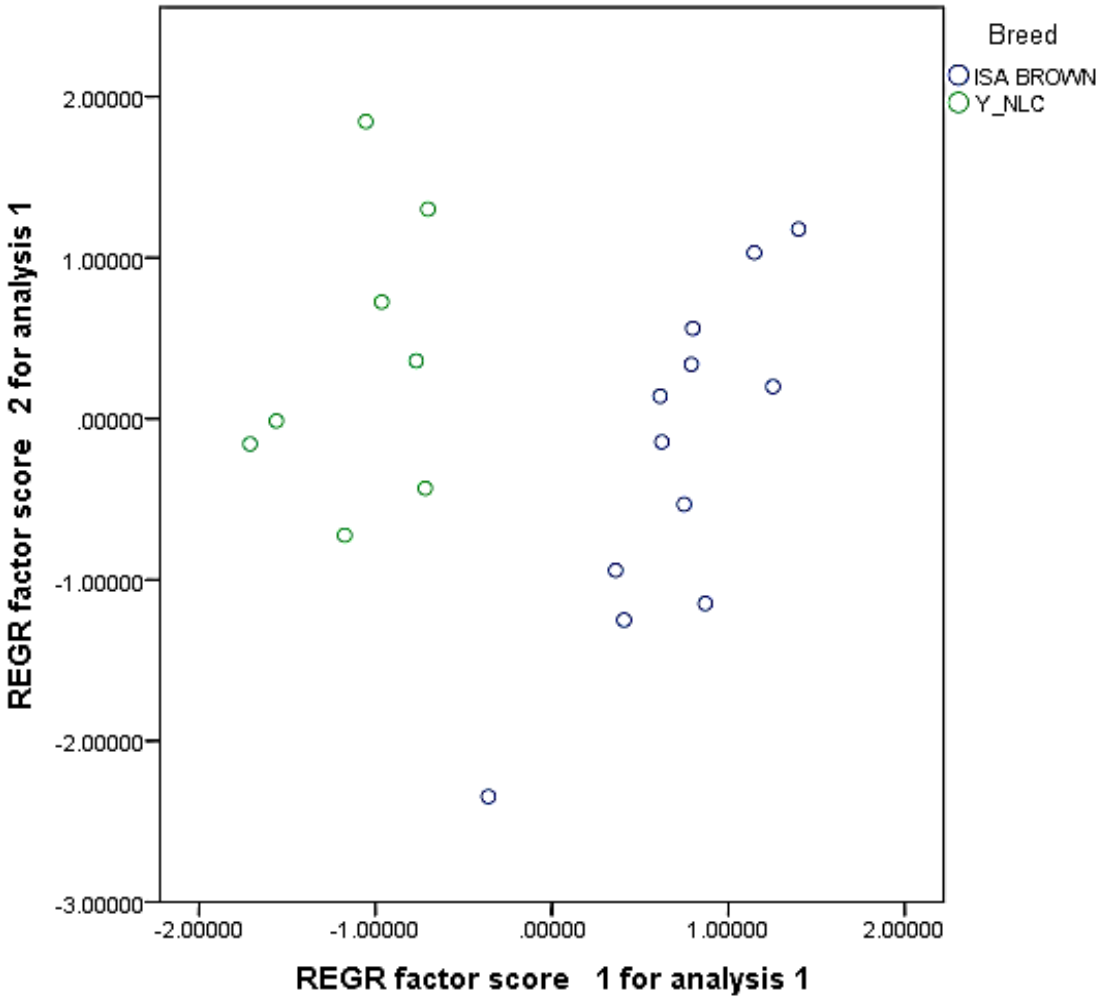


Figure 6.9 Effect of 0% MOSM on spermiogramic paraameters of YENLC and Isa Brown Cocks

Figure 6.9 showed that genotype significantly influenced the spermiogramic parameters and 0% MOSM did not have effect on the parameters.

6.17. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of birds fed 5% MOSM

Principal components analysis of ten original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.22). The three principal components collectively explained 80.209% of overall variation. PC1 accounted for most (48.213%) of the total variance while PC2 and PC3 accounted for 16.890% and 15.105% of the variance respectively.

Table 6.22: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of birds fed 5% MOSM

Component	Eigen Value	% of Variance	Cumulative %
1	4.821	48.213	48.213
2	1.689	16.890	65.104
3	1.511	15.105	80.209

6.18. Rotated component matrix and communalities of the spermiogramic parameters of birds fed 5% MOSM

From Table 6.23, communalities were found to be high across the parameters while spermatozoa reserves in the testes and body weight were greater than 90%. PC1 had high loadings (correlations between the components and the variables) on sperm reserves in the testis (0.973) and body weight (0.935). PC2 had the highest loading on sperm concentration (0.842) while PC3 loaded more on semen volume (-0.892)

Table 6.23: Rotated component matrix and communalities of the spermiogramic parameters of birds fed 5% MOSM

	Component			
	1	**2**	**3**	**Communalitites**
PAIRED TESTIS WEIGHT	.813	.336	.212	.820
paired epididymis	.744	.023	-.202	.596
paired testis vol	.818	.301	.356	.886
BW	.935	-.160	-.223	.949
spermatozoa reserves (X109}-TESTIS	.973	-.093	-.154	.980
spermatozoa reserves (X109}-EPIDIDYMIS	.846	-.221	.158	.790
Semen Vol	-.111	.177	-.892	.839
Mass Activity	-.603	.182	.664	.838
Sperm Motility	-.073	.770	.024	.599
Sperm Conc.	-.049	-.842	.115	.725

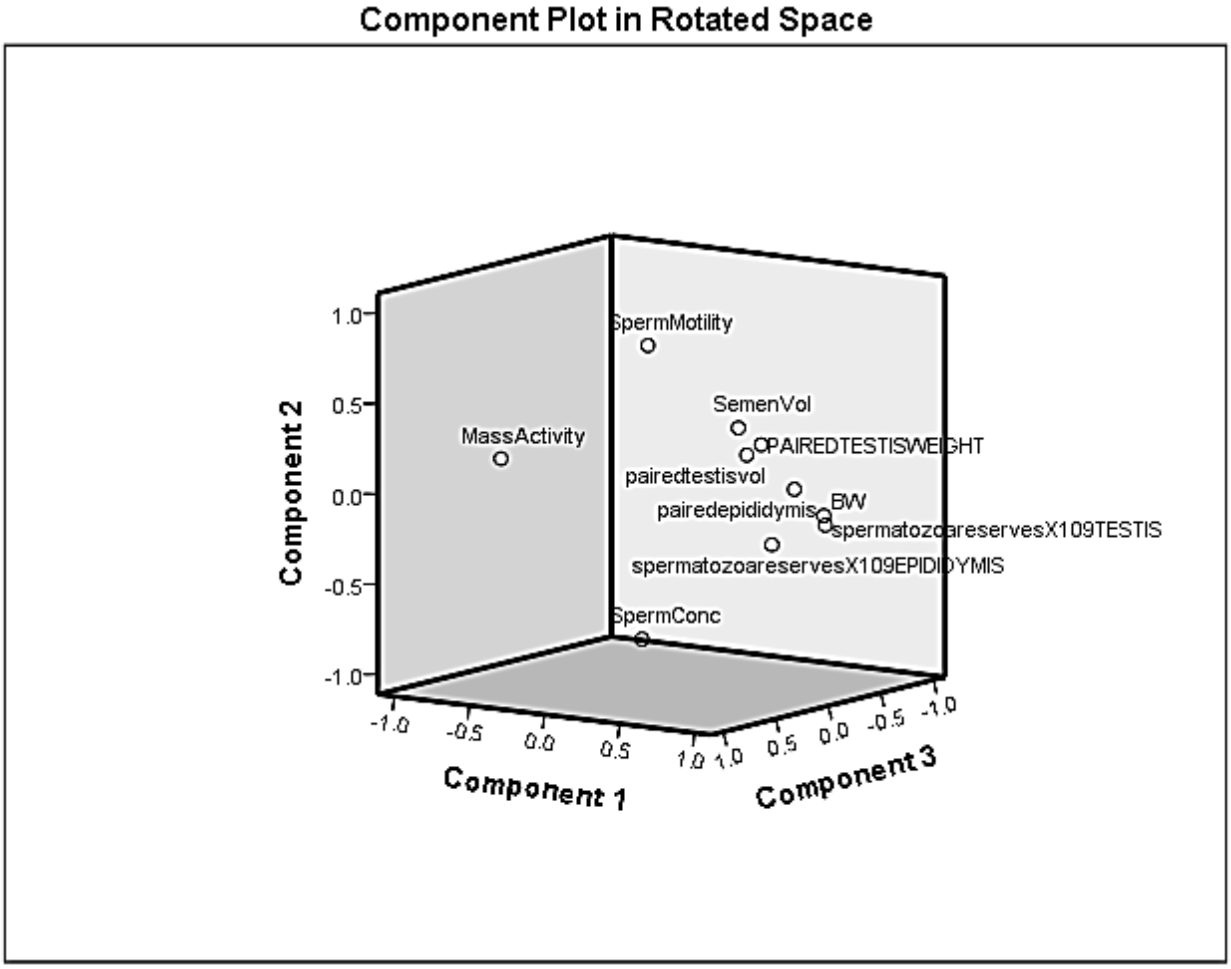


Figure 6.10: Component plot in rotated spaceof the spermiogramic parameters of birds fed 5% MOSM

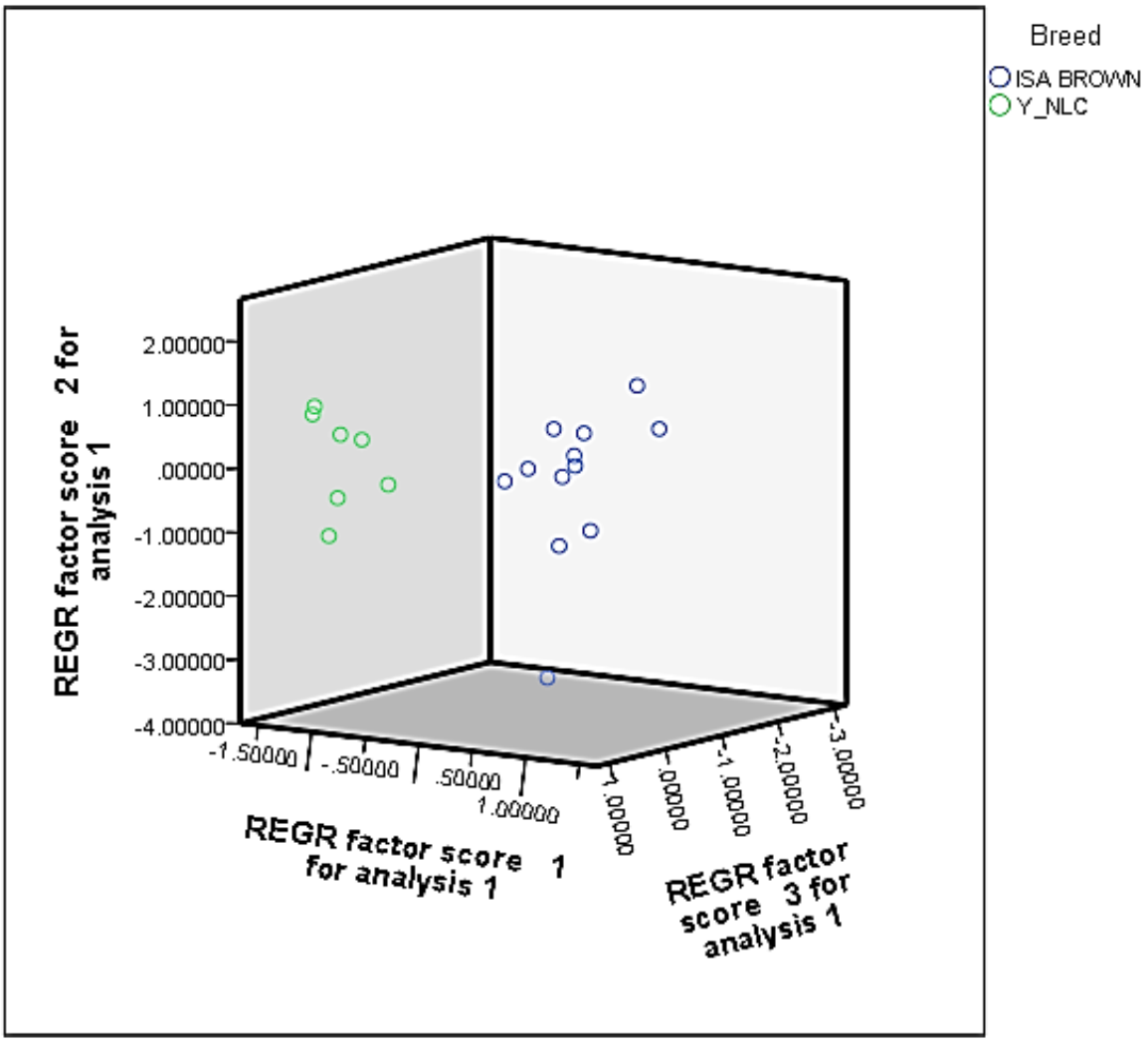


Figure 6.11: Graph showing effect of 5% MOSM on spermiogramic parameters of YENLC and Isa Brown Cocks

Figure 6.11 showed that genotype significantly influenced the spermiogramic parameters and 5% MOSM did not have effect on the parameters.

6.19. Multivariate dimension reduction principal component analysis to identify salient factors underlying variation in spermiogramic parameters of birds fed 10% MOSM

Principal components analysis of ten original variables in 48 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.24). The two principal components collectively explained 76.463% of overall variation. PC1 accounted for more than half (63.375%) of the total variance while PC2 accounted for 13.089% of the variance.

Table 6.24: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of birds fed 10% MOSM

Component	Eigen Value	% of Variance	Cumulative %
1	6.337	63.375	63.375
2	1.309	13.089	76.463

6.20. Rotated component matrix and communalities of the spermiogramic parameters of birds fed 10% MOSM

From Table 6.25, communalities were found to be high across the parameters except sperm motility with 29.4%. PC1 had high loadings (correlations between the components and the variables) on sperm reserves in the testis (0.936), paired epididymis weight (0.961) and body weight (0.961). PC2 had the highest loading on sperm concentration (0.859)

Table 6.25: Rotated component matrix and communalities of the spermiogramic parameters of birds fed 10% MOSM

	Component		
	1	**2**	**Communalities**
PAIRED TESTIS WEIGHT	.782	-.189	.647
paired epididymis	.961	.018	.923
paired testis vol	.859	-.117	.751
BW	.961	-.046	.926
spermatozoa reserves (X109}-TESTIS	.936	-.010	.875
spermatozoa reserves (X109}-EPIDIDYMIS	.878	.110	.783
Semen Vol	-.916	-.069	.843
Mass Activity	-.522	.717	.787
Sperm Motility	-.542	-.022	.294
Sperm Conc.	.281	.859	.817

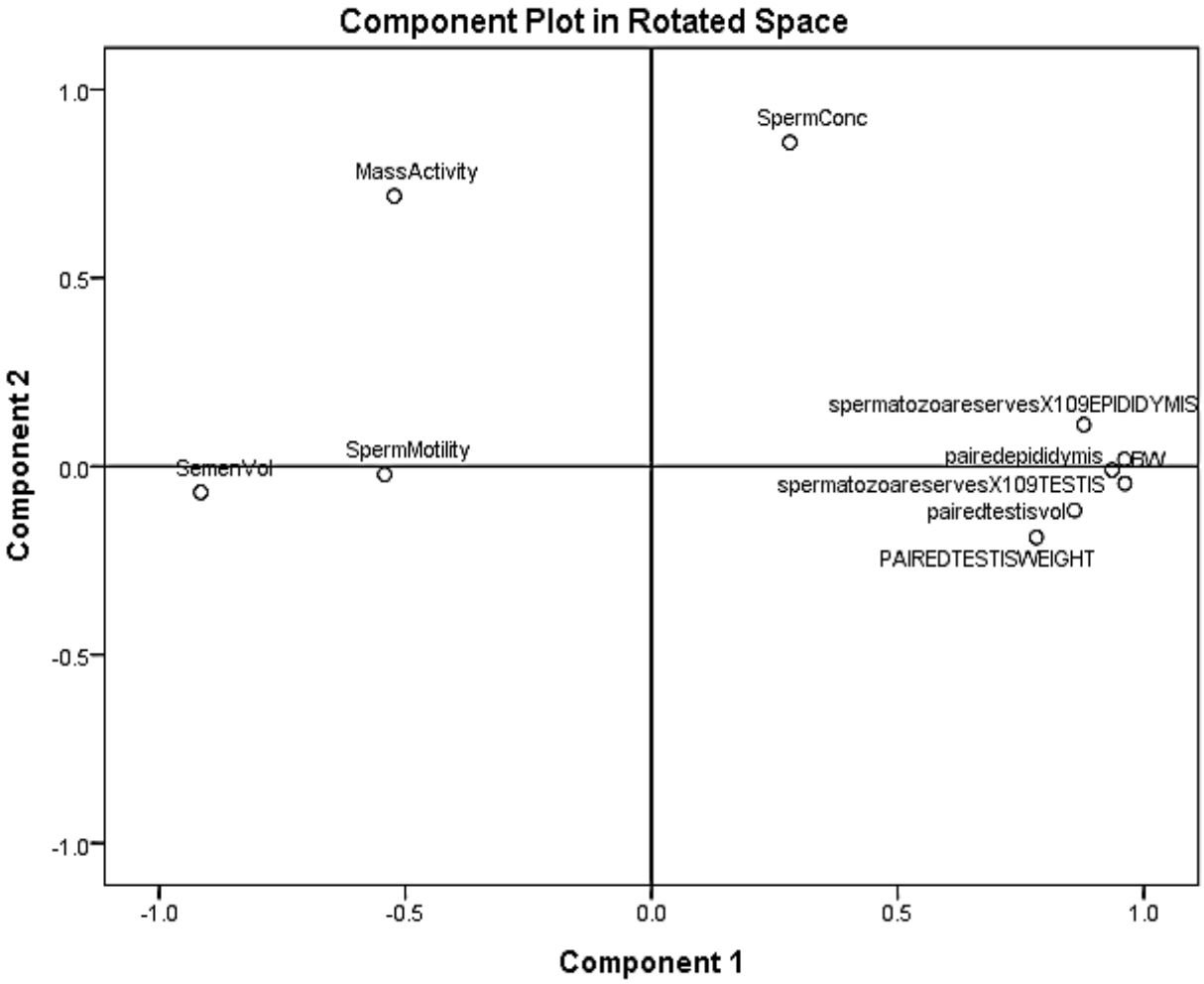


Figure 6.12: Component plot in rotated spaceof the spermiogramic parameters of birds fed 10% MOSM

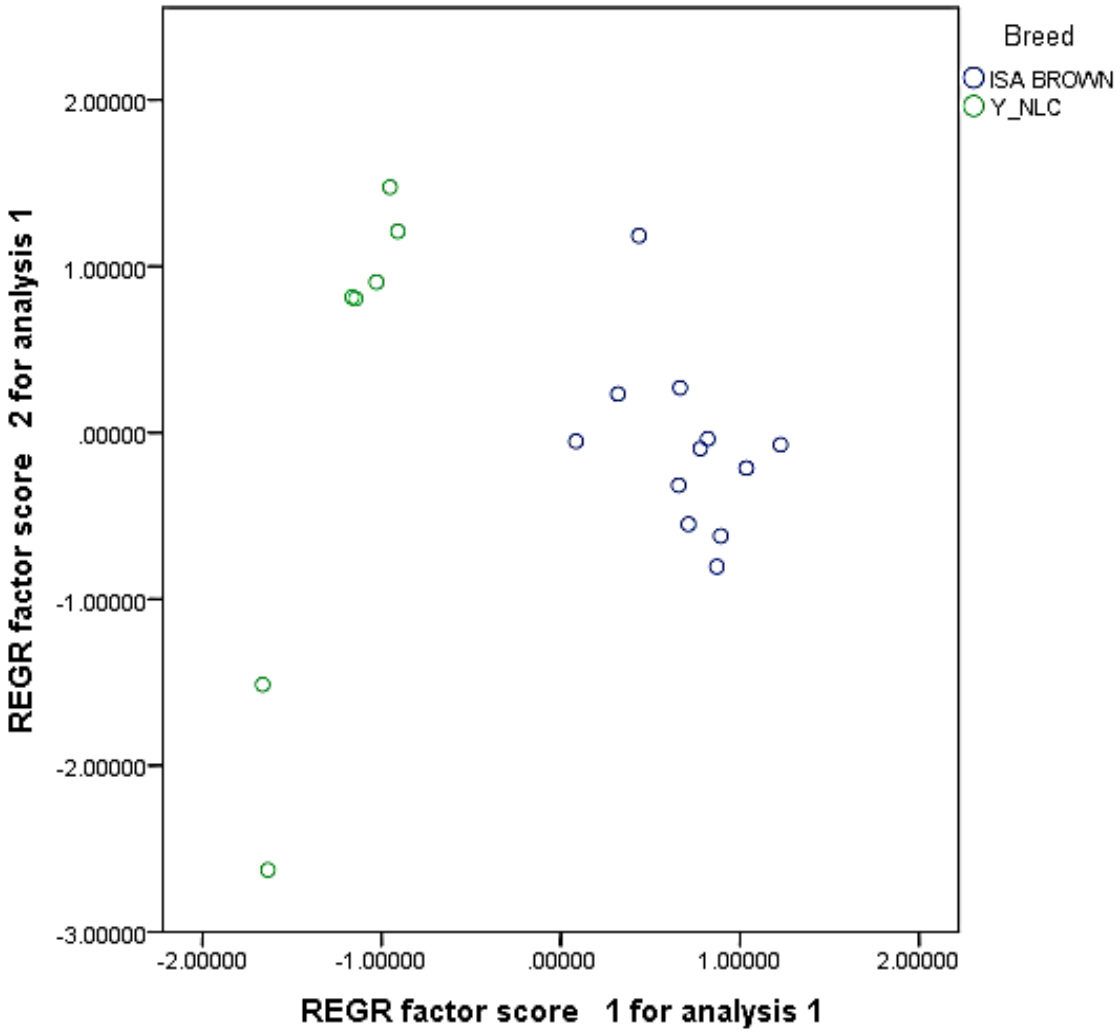


Figure 6.13. Graph showing the effect of 10% MOSM on Spermiogramic parameters of YENLC and Isa Brown Cocks

Figure 6.13 showed that genotype significantly influenced the spermiogramic parameters and 10% MOSM did not have effect on the parameters as the effect was different in different genotypes of chickens.

6.21. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of birds fed 15% MOSM

Principal components analysis of ten original variables in 48 chickens revealed that three principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.26). The three principal components collectively explained 80.525% of overall variation. PC1 accounted for more than half (50.928%) of the total variance while PC2 and PC3 accounted for 19.288% and 10.308% of the variance.

Table 6.26: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in spermiogramic parameters of birds fed 15% MOSM

Component	Eigen Value	% of Variance	Cumulative %
1	5.093	50.928	50.928
2	1.929	19.288	70.216
3	1.031	10.308	80.525

6.22. Rotated component matrix and communalities of the spermiogramic parameters of birds fed 15% MOSM

From Table 6.27, communalities were found to be high across the parameters. PC1 had high loadings (correlations between the components and the variables) on body weight (0.911), spermatozoa reserves in the testis (0.918) and paired epididymis weight (0.934). PC2 had the highest loading on spermatozoa reserves in the epididymis (-0.929) while PC3 had the highest loadings on the semen volume (-0.856)

Table 6.27: Rotated component matrix and communalities of the spermiogramic parameters of birds fed 15% MOSM

	Component			
	1	**2**	**3**	**Communalities**
PAIRED TESTIS WEIGHT	.717	.158	.018	.539
paired epididymis	.934	-.041	-.064	.879
paired testis vol	.862	.299	.241	.891
BW	.911	-.283	.165	.938
spermatozoa reserves (X109}-TESTIS	.918	-.160	.149	.890
spermatozoa reserves (X109}-EPIDIDYMIS	.254	-.929	.066	.932
Semen Vol	-.128	.128	-.856	.765
Mass Activity	-.561	.048	.441	.512
Sperm Motility	.271	.869	-.080	.835
Sperm Conc.	-.904	-.086	.220	.873

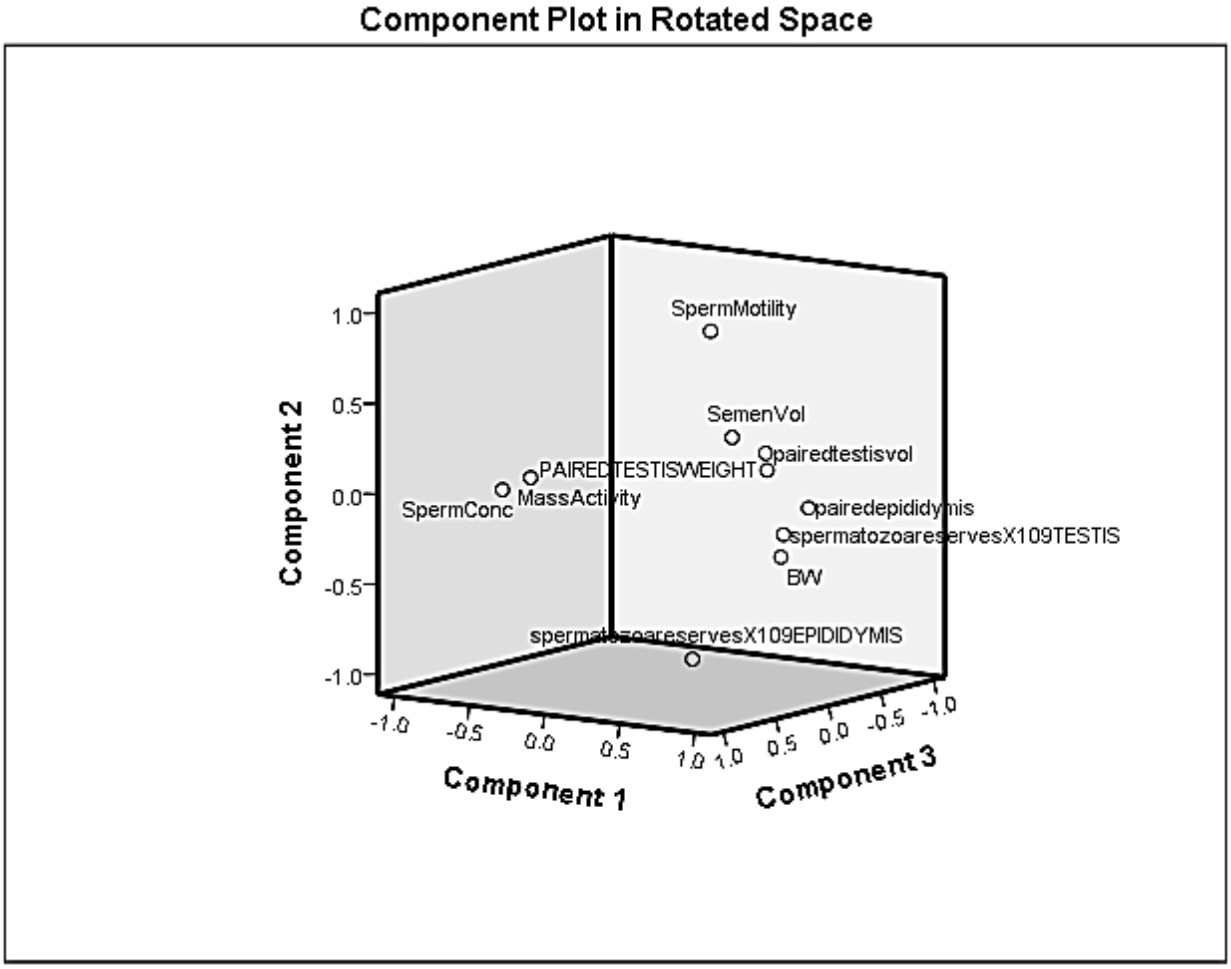


Figure 6.14 Component plot in rotated space of the spermiogramic parameters of birds fed 15% MOSM

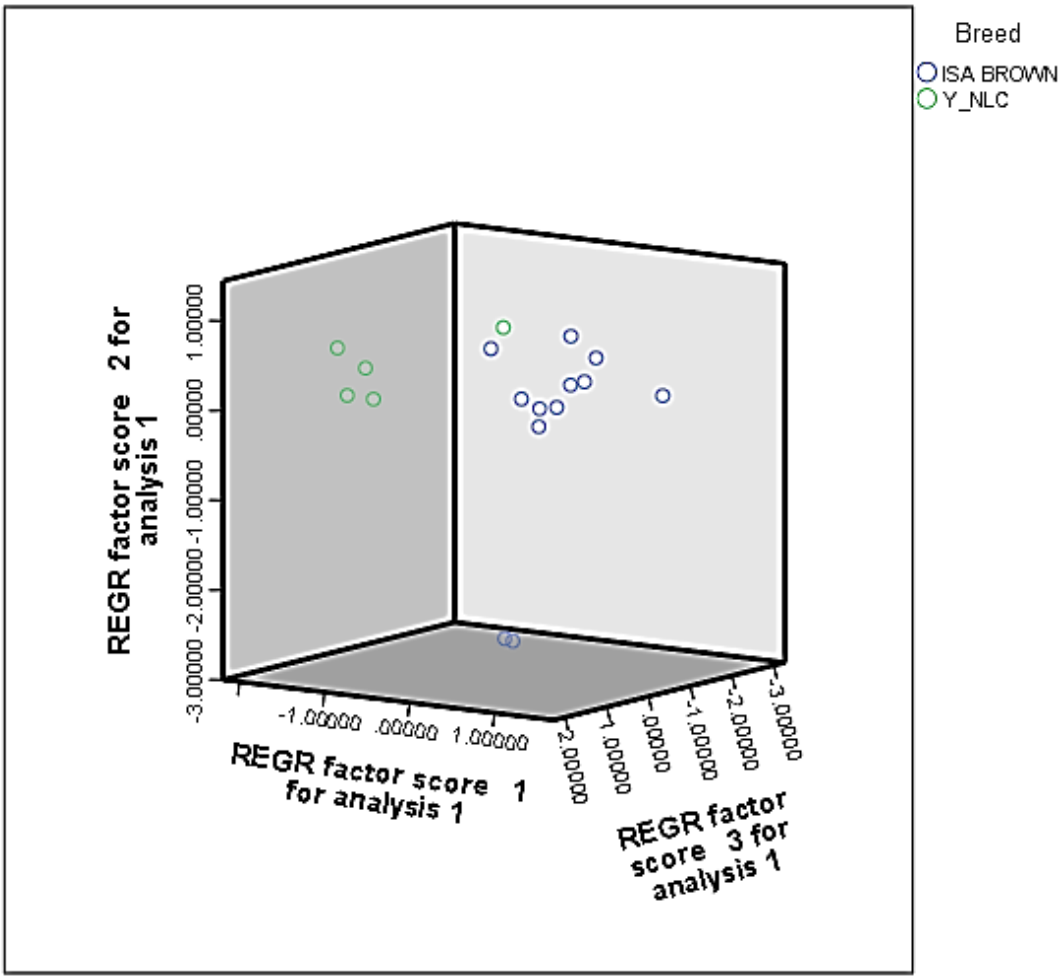


Figure 6.15: Graph showing effect of 15% MOSM on spermiogramic parameters of YENLC and Isa Brown cocks

Figure 6.15 showed that genotype significantly influenced the spermiogramic parameters and 15% MOSM did not have effect on the parameters as the effect was different in different genotypes of chickens.

6.23. Phenotypic Correlations of Egg Parameters of YENLC and Isa Brown Hens

The result of phenotypic correlation determined between the internal and external quality traits of the eggs as recorded in Table 6.28 indicated that all the internal and external egg qualities except the egg weight were highly positively correlated. This implies that an increase in one will significantly ($p<0.05$, $p<0.01$) lead to an increase in the other egg parameters. However, egg weight was highly positively correlated ($P<0.01$) with the albumen weight. This implies that as an increase in the weight of albumen will significantly lead to an increase in the egg weight.

The result of phenotypic correlation determined between the internal and external quality traits of the eggs in YENLC as recorded in Table 6.29 showed that all the internal and external egg qualities were highly positively correlated with each other. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters.

The result of phenotypic correlation determined between the internal and external quality traits of the eggs of Isa Brown Layers as recorded in Table 6.30 indicated that all the internal and external egg qualities except the egg weight were positively correlated. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters. However, egg weight was highly positively correlated ($P<0.01$) with the albumen weight. However, there were low and non-significant positive relationship between egg weight and shell weight ($r=0.088$), shell weight and yolk height ($r=0.001$), shell weight and yolk weight ($r=0.061$) and shell weight and egg width ($r=0.082$).

The result of phenotypic correlation determined between the internal and external quality traits of the eggs of birds fed 0% MOSM as recorded in Table 6.31 indicated that all the internal and external egg qualities except the yolk height were positively correlated. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters. However, all the parameters were highly correlated ($P<0.01$) with one another.

The result of phenotypic correlation determined between the internal and external quality traits of the eggs of birds fed 5% MOSM as recorded in Table 6.32 indicated that all the internal and external egg qualities

except the yolk height were positively correlated. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters. However, all the parameters were highly correlated ($p<0.01$) with one another with the exception of yolk height with some low and non-significant correlations.

The result of phenotypic correlation determined between the internal and external quality traits of the eggs of birds fed 10% MOSM as recorded in Table 6.33 indicated that all the internal and external egg qualities except the yolk height were positively correlated. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters. However, all the parameters were highly correlated ($p<0.01$) with one another. The results also elucidated that a significant increase ($p<0.01$) in one egg parameter would be accompanied with a significant decrease ($p<0.01$) in yolk height for all the birds fed 10% MOSM.

The result of phenotypic correlation determined between the internal and external quality traits of the eggs of birds fed 15% MOSM as recorded in Table 6.34 indicated that all the internal and external egg qualities except the yolk height were positively correlated. This implies that an increase in one will significantly ($p<0.01$) lead to an increase in the other egg parameters. However, all the parameters were highly correlated ($p<0.01$) with one another. The results also elucidated that a significant increase ($p<0.01$) in one egg parameter would be accompanied with a significant decrease ($p<0.01$) in yolk height for all the birds fed 15% MOSM.

Table 6.28. Correlations of egg parameters of birds irrespective of diets and genotypes

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLK WT	SHLWT	ALBH EIGHT	YOLKH EIGHT
EGG WEIGHT	1							
EGG LENGTH	.165*	1						
EGWDT	.122	.999**	1					
ALBWT	.892**	.525**	.485**	1				
YOLKWT	.561**	.894**	.873**	.839**	1			
SHLWT	.275**	.980**	.977**	.582**	.907**	1		
ALBHEIGHT	.252**	.991**	.988**	.579**	.916**	.995**	1	
YOLKHEIGHT	.511**	.775**	.750**	.810**	.916**	.737**	.767**	1

***. Correlation is significant at the 0.05 level (2-tailed).**

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 6.29. Correlations of egg parameters of YENLC irrespective of diets

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.899**	1						
EGWDT	.937**	.926**	1					
ALBWT	.950**	.926**	.949**	1				
YOLKWT	.910**	.903**	.920**	.911**	1			
SHLWT	.877**	.919**	.948**	.930**	.903**	1		
ALBHEIGHT	.927**	.919**	.959**	.951**	.912**	.924**	1	
YOLKHEIGHT	.931**	.822**	.897**	.919**	.833**	.827**	.934**	1

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 6.30. Correlations of egg parameters of Isa Brown irrespective of diets

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.857**	1						
EGWDT	.798**	.922**	1					
ALBWT	.668**	.903**	.886**	1				
YOLKWT	.708**	.808**	.855**	.806**	1			
SHLWT	.088	.120	.082	.108	.061	1		
ALBHEIGHT	.430**	.516**	.619**	.399**	.579**	.145	1	
YOLKHEIGHT	.586**	.625**	.674**	.675**	.714**	.001	.222	1

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 6.31. Correlations of egg parameters of birds fed 0% MOSM

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.993**	1						
EGWDT	.987**	.995**	1					
ALBWT	.969**	.984**	.980**	1				
YOLKWT	.881**	.895**	.903**	.903**	1			
SHLWT	.974**	.970**	.965**	.953**	.872**	1		
ALBHEIGHT	.967**	.981**	.981**	.965**	.937**	.953**	1	
YOLKHEIGHT	-.700**	-.723**	-.735**	-.722**	-.549**	-.674**	-.690**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6.32. Correlations of egg parameters of birds fed 5% MOSM

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.978**	1						
EGWDT	.987**	.975**	1					
ALBWT	.910**	.945**	.917**	1				
YOLKWT	.841**	.864**	.825**	.931**	1			
SHLWT	.927**	.877**	.930**	.759**	.622**	1		
ALBHEIGHT	.961**	.933**	.973**	.827**	.713**	.958**	1	
YOLKHEIGHT	.021	.125	.005	.344	.506*	-.271	-.192	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6.33. Correlations of egg parameters of birds fed 10% MOSM

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.941**	1						
EGWDT	.960**	.970**	1					
ALBWT	.880**	.916**	.945**	1				
YOLKWT	.702**	.690**	.716**	.560**	1			
SHLWT	.942**	.949**	.973**	.950**	.687**	1		
ALBHEIGHT	.934**	.965**	.967**	.909**	.739**	.965**	1	
YOLKHEIGHT	-.852**	-.865**	-.901**	-.870**	-.661**	-.903**	-.923**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6.34. Correlations of egg parameters of birds fed 15% MOSM

	EGG WEIGHT	EGG LENGTH	EGWDT	ALBWT	YOLKWT	SHLWT	ALBHEIGHT	YOLKHEIGHT
EGG WEIGHT	1							
EGG LENGTH	.904**	1						
EGWDT	.980**	.875**	1					
ALBWT	.794**	.833**	.718**	1				
YOLKWT	.950**	.898**	.935**	.789**	1			
SHLWT	.981**	.920**	.967**	.764**	.956**	1		
ALBHEIGHT	.924**	.820**	.955**	.592**	.903**	.924**	1	
YOLKHEIGHT	-.921**	-.847**	-.888**	-.697**	-.861**	-.887**	-.867**	1

****. Correlation is significant at the 0.01 level (2-tailed).**

6.22. Forward Stepwise Regression to predict egg weight of YENLC and Isa Brown from external and internal quality parameters

From Tables 6.35, 6.36 and 6.37 it was observed that all the egg parameters could predict the egg weight for all the genotypes.

Table 6.35: Simple regression equations to predict egg weight of YENLC and Isa Brown from external and internal quality parameters

Dependent Variable (y)	Independent Variables (x)	Regression equation	R^2	SE
Egg Weight	EWd EL	5.506 + 2.042EL + 11.521EWd	0.944*	2.310
Egg Weight	AH AW	5.326 + 0.807AW + 4.188AH	0.914*	2.856
Egg Weight	YH YW	13.144 + 4.301YW + (-1.362)YL	0.821*	4.116
Egg Weight	EWd, EL, AH, AW, YH, YW,SH	5.290 + 4.067EL + 9.445EWd + (-0.539)AW + 0.172YW + 1.061SW + (-0.157)AH + 0.358YH	0.953*	2.161

Key: EL (Egg Length), EWd(Egg Width), AH(Albumen Height), AW(Albumen Weight), YH (Yolk Height), YW(Yolk Weight), SW(Shell Weight), R^2=Variance explained, SE (Associated Standard Error)

Table 6.36: Simple regression equations to predict egg weight of the Isa Brown from external and internal quality parameters

Dependent	Independent	Regression equation	R^2	SE
Egg Weight	EWd	20.638 + 6.579EL + 0.688EWd	0.735*	2.235
	EL			
	AH	22.902 + 0.711AW + 1.378AH	0.478*	3.136
	AW			
	YH	24.275 + 1.732YW + 0.341YH	0.515*	3.022
	YW			
	ALL	19.3 + 9.816EL + 5.102Ewdt + (-1.047)AW	0.839*	1.850
	SW	+0.426YW + 0.155SW + (-1.347)AH + 0.214YH		

Key: EL (Egg Length), EWd(Egg Width), AH(Albumen Height), AW(Albumen Weight), YH (Yolk Height), YW(Yolk Weight), SW(Shell Weight), R^2=Variance explained, SE (Associated Standard Error).

Table 6.37: Simple regression equations to predict egg weight of the YENLC cocks from external and internal quality parameters

Dependent	Independent	Regression equation	R^2	SE
Egg Weight	Egg width	4.178 +1.568EL + 12.816EWd	0.883*	1.866
	Egg length			
	AH	1.977 + 1.160AW + 2.978AH	0.905*	1.686
	AW			
	YH	0.493 + 1.356YH + 1.252YW	0.923*	1.518
	YW			
	EWd, EL, AH, AW, YH, YW, SW	0.440 + 0.957EL + 7.229Ewdt + 0.589AW + 0.765YW + (2.619)SW + (4.181)AH + 1.016YH	0.947*	1.334

Key: EL (Egg Length), EWd(Egg Width), AH(Albumen Height), AW(Albumen Weight), YH (Yolk Height), YW(Yolk Weight), SW(Shell Weight), R^2=Variance explained, SE (Associated Standard Error)

6.21. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of all experimental birds irrespective of diets and genotype

Principal components analysis of ten original variables in 96 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.38). The two principal components collectively explained 96.597% of overall variation. PC1 accounted for more than half (77.230%) of the total variance while PC2 accounted for 19.367% of the variance.

Table 6.38: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient factors underlying variation in egg characteristics of birds irrespective of diets and genotypes

Principal Components	Eigen Values	% of Variance	Cumulative %
1	6.178	77.230	77.230
2	1.549	19.367	96.597

6.22. Rotated component matrix and communalities of egg parameters of experimental birds irrespective of diets and genotype

From Table 6.39, communalities were found to be high across the parameters as all were greater than 80%. PC1 had high loadings (correlations between the components and the variables) on egg width (0.993) and egg length (0.987). PC2 had the highest loading on egg weight (0.978).

Table 6.39: Rotated component matrix and communalities of the egg parameters of all experimental birds irrespective of diets and genotype

	Component		
	1	**2**	**Communalities**
EGG WEIGHT	0.008	0.978	0.957
EGG LENGTH	0.987	0.157	0.999
EGWDT	0.993	0.112	0.999
ALBWT	0.385	0.917	0.989
YOLKWT	0.815	0.573	0.993
SHLWT	0.954	0.237	0.966
ALBHEIGHT	0.967	0.228	0.987
YOLKHEIGHT	0.697	0.593	0.837

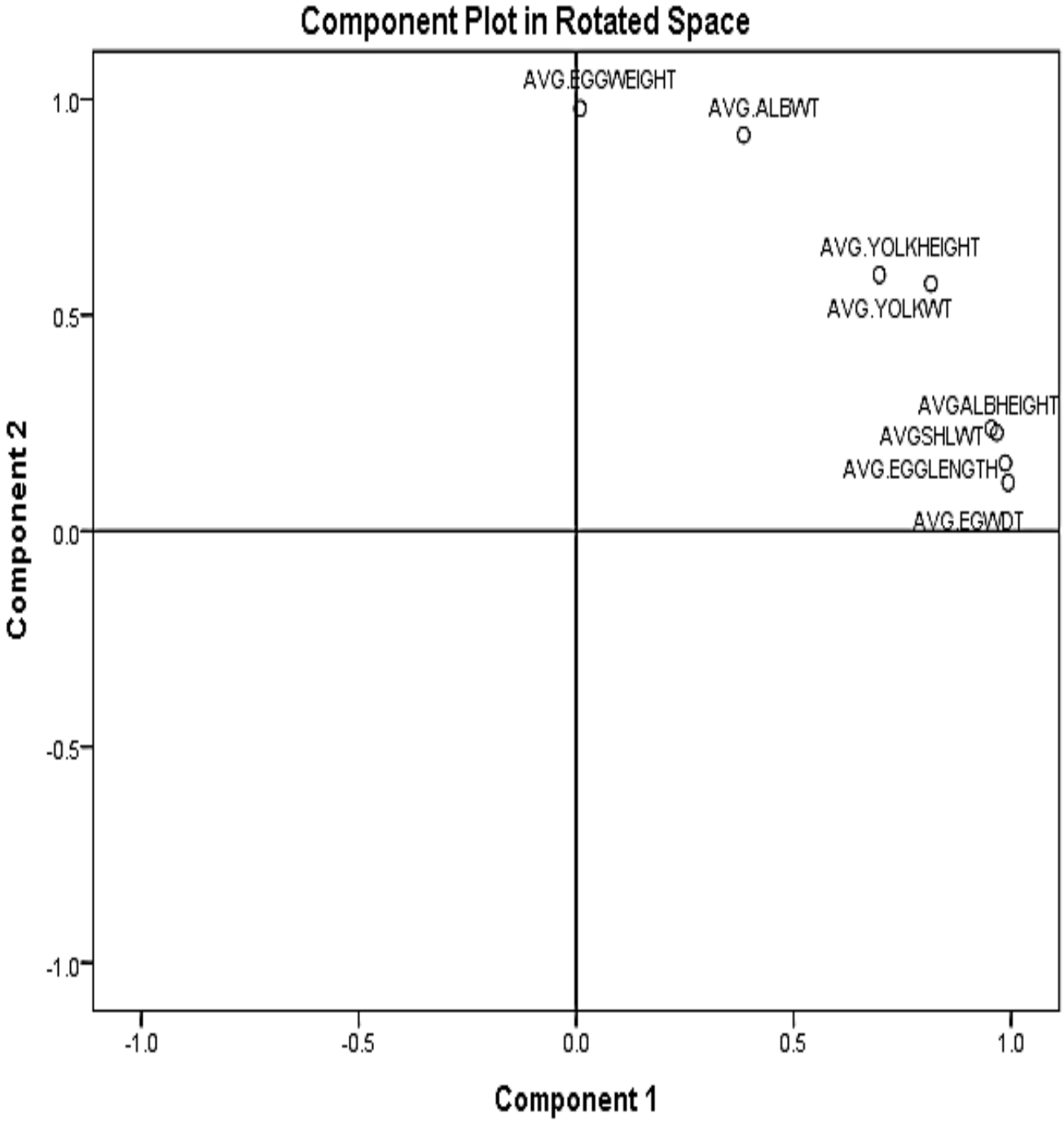


Figure 6.16: Component plot in rotatedspaceof the egg parameters of all experimental birds irrespective of diets and genotype

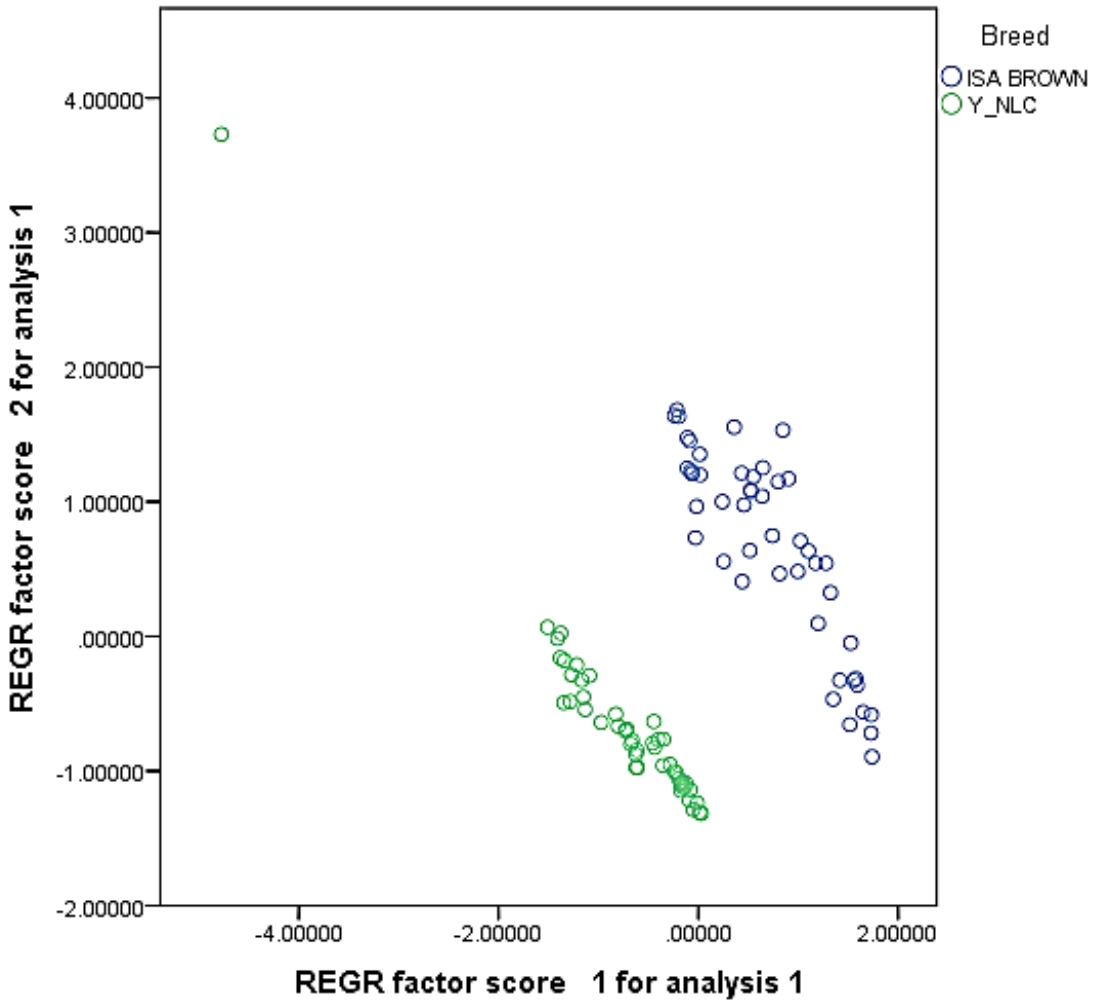


Figure 6.17. Graph showing effects of genotypes on egg characteristics

Figure 6.17 clearly showed that the egg characteristics in terms of number, internal and external qualities are greatly influenced by genotypes.

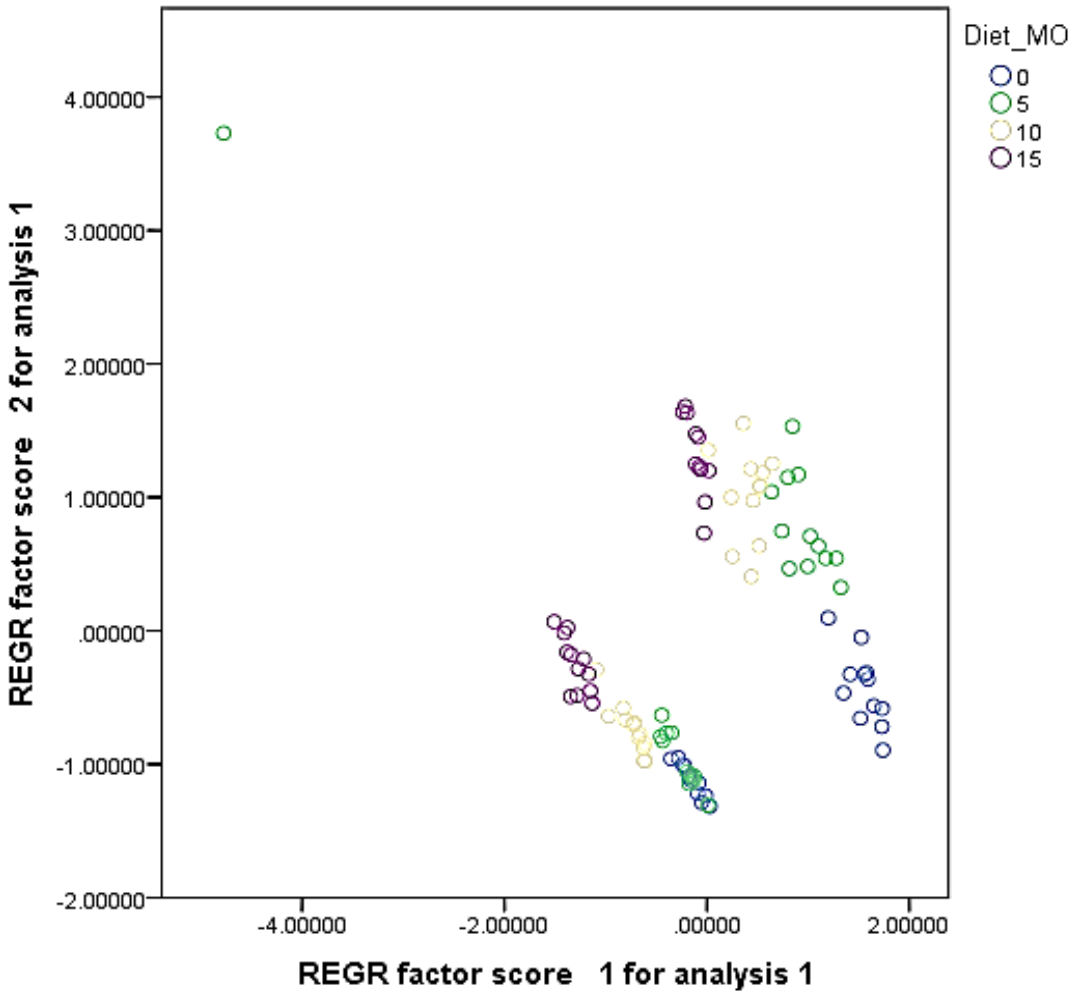


Figure 6.18: Graph showing effects of MOSM on egg characteristics of YENLC and Isa Brown hens

Figure 6.18 showed clearly that diet influenced egg characteristics but the effect were also differed greatly per genotype.

6.23. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of YENLC irrespective of diets

Principal components analysis of ten original variables in 96 chickens revealed that one principal component contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.40.). The principal component explained 92.206% of overall variation.

Table 6.40: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of YENLC irrespective of diets

Principal Component	Eigen Value	% of Variance	Cumulative %
1	7.376	92.206	92.206

6.24. Rotated component matrix and communalities of egg parameters of YENLC irrespective of diets

From Table 6.41, communalities were found to be high across the parameters as all were greater than 80%.

Since there was only one principal component it could not be rotated.

Table 6.41: Rotated component matrix and communalities of egg parameters of YENLC irrespective of diets

Communalities		
	Initial	**Extraction**
EGG WEIGHT	1.000	0.929
EGG LENGTH	1.000	0.890
EGWDT	1.000	0.958
ALBWT	1.000	0.961
YOLKWT	1.000	0.901
SHLWT	1.000	0.910
ALBHEIGHT	1.000	0.959
YOLKHEIGHT	1.000	0.870

6.25. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of Isa Brown hens irrespective of diets

Principal components analysis of ten original variables in 96 chickens revealed that two principal components contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.42). The two principal components explained 77.712% of overall variation.PC1 accounted for 64.708% which represented more than half of the total variation while PC2 accounted for the remaining 13.004%,

Table 6.42: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of Isa Brown hens irrespective of diets

Principal Component	Eigen Value	% of Variance	Cumulative %
1	5.177	64.708	64.708
2	1.040	13.004	77.712

6.26. Rotated component matrix and communalities of egg parameters of Isa Brown pullets irrespective of diets

From Table 6.43, communalities were found to be high across the parameters as all were greater than 60% with the exception of albumen height (47.90%). PC1 had high loadings (correlations between the components and the variables) on egg weight (0.845), egg length (0.941), egg width (0.956), albumen weight (0.904), yolk weight (0.913) and yolk height (0.785). PC2 had the highest loading on shell weight (0.931).

Table 6.43: Rotated component matrix and communalities of the egg parameters of Isa brown hens irrespective of diets

	Component		
	1	**2**	**Communalities**
EGG WEIGHT	0.845	0.102	0.725
EGG LENGTH	0.941	0.151	0.907
EGWDT	0.956	0.139	0.934
ALBWT	0.904	0.083	0.825
YOLKWT	0.913	0.089	0.841
SHLWT	0-.017	0.931	0.867
ALBHEIGHT	0.549	0.421	0.479
YOLKHEIGHT	0.785	-0.151	0.639

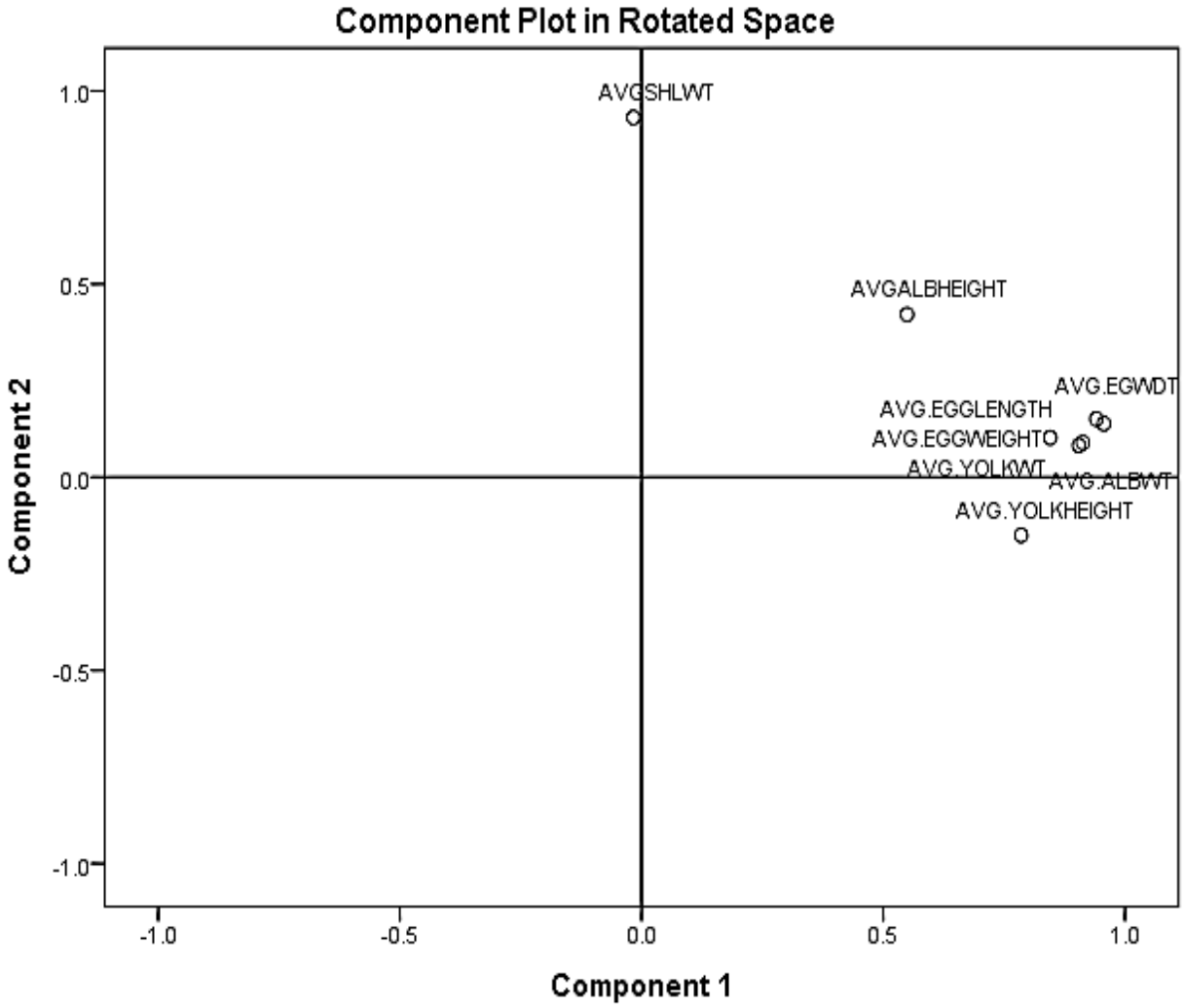


Figure 6.19: Component plot in rotated space of the egg parameters of Isa brown hens irrespective of diets

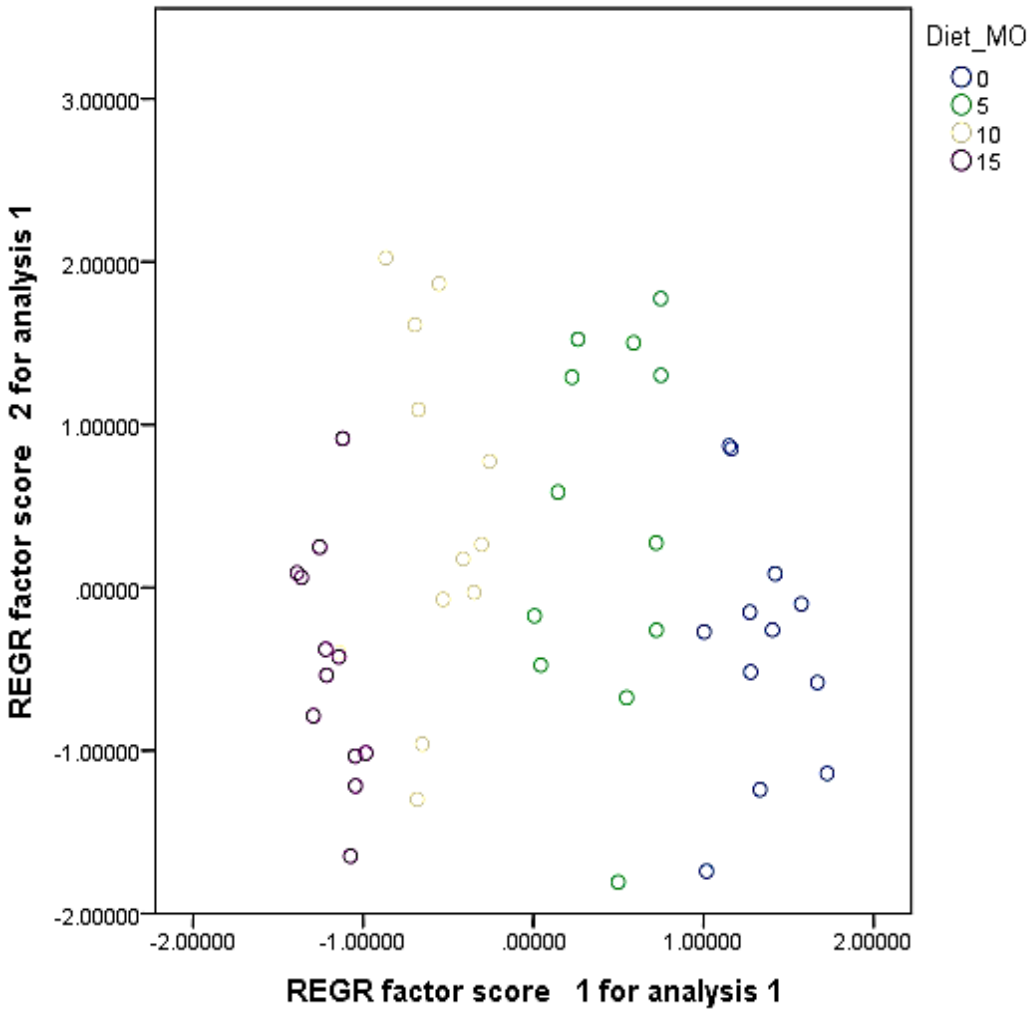


Figure 6.20: Graph showing the effect of MOSM on egg characteristics of Isa Brown Hens

Figure 6.20 clearly showed that the egg characteristics in terms of number, internal and external qualities are greatly influenced by various levels of inclusion of MOSM.

6.27. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of birds fed 0% MOSM

Principal components analysis of ten original variables in 24 chickens revealed that one principal component contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.44). The principal component explained 90.581% of overall variation.

Table 6.44: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of birds fed 0% MOSM

Principal Component	Eigen Value	% of Variance	Cumulative %
1	7.246	90.581	90.581

6.28. Rotated component matrix and communalities of egg parameters of birds fed 0% MOSM

From Table 6.45, communalities were found to be high across the parameters as all were greater than 80% with the exception of yolk height (56.40%). It could not be rotated because it only had one component.

Table 6.45. Communalities of the egg parameters of birds fed 0% MOSM

Communalities		
	Initial	**Extraction**
EGG WEIGHT	1.000	0.972
EGG LENGTH	1.000	0.989
EGWDT	1.000	0.990
ALBWT	1.000	0.972
YOLKWT	1.000	0.842
SHLWT	1.000	0.944
ALBHEIGHT	1.000	0.973
YOLKHEIGHT	1.000	0.564

6.31. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of birds fed 5% MOSM

Principal components analysis of ten original variables in 24 chickens revealed that two principal component contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.46). The two principal component explained 97.830% of overall variation. PC1 accounted for more than half of the variation (79.360%) while PC2 aaccounted for 18.470% of the total variation.

Table 6.46: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of birds fed 5% MOSM

Principal Component	Eigen Values	% of Variance	Cumulative %
1	6.349	79.360	79.360
2	1.478	18.470	97.830

6.32. Rotated component matrix and communalities of egg parameters of birds fed 5% MOSM

From Table 6.47, communalities were found to be high across the parameters as all were greater than 90%. PC1 had high loadings across board (correlations between the components and the variables) on all the parameters and were all positive except yolk height (-0.065). PC2 had the highest loadings on yolk height (0.992)

Table 6.47: Rotated component matrix and communalities of egg parameters of birds fed 5% MOSM

	Component		
	1	**2**	**Communalities**
EGG WEIGHT	0.990	0.086	0.988
EGG LENGTH	0.971	0.187	0.977
EGWDT	0.993	0.068	0.992
ALBWT	0.895	0.409	0.968
YOLKWT	0.795	0.576	0.963
SHLWT	0.955	-0.225	0.963
ALBHEIGHT	0.986	-0.128	0.988
YOLKHEIGHT	-0.065	0.992	0.988

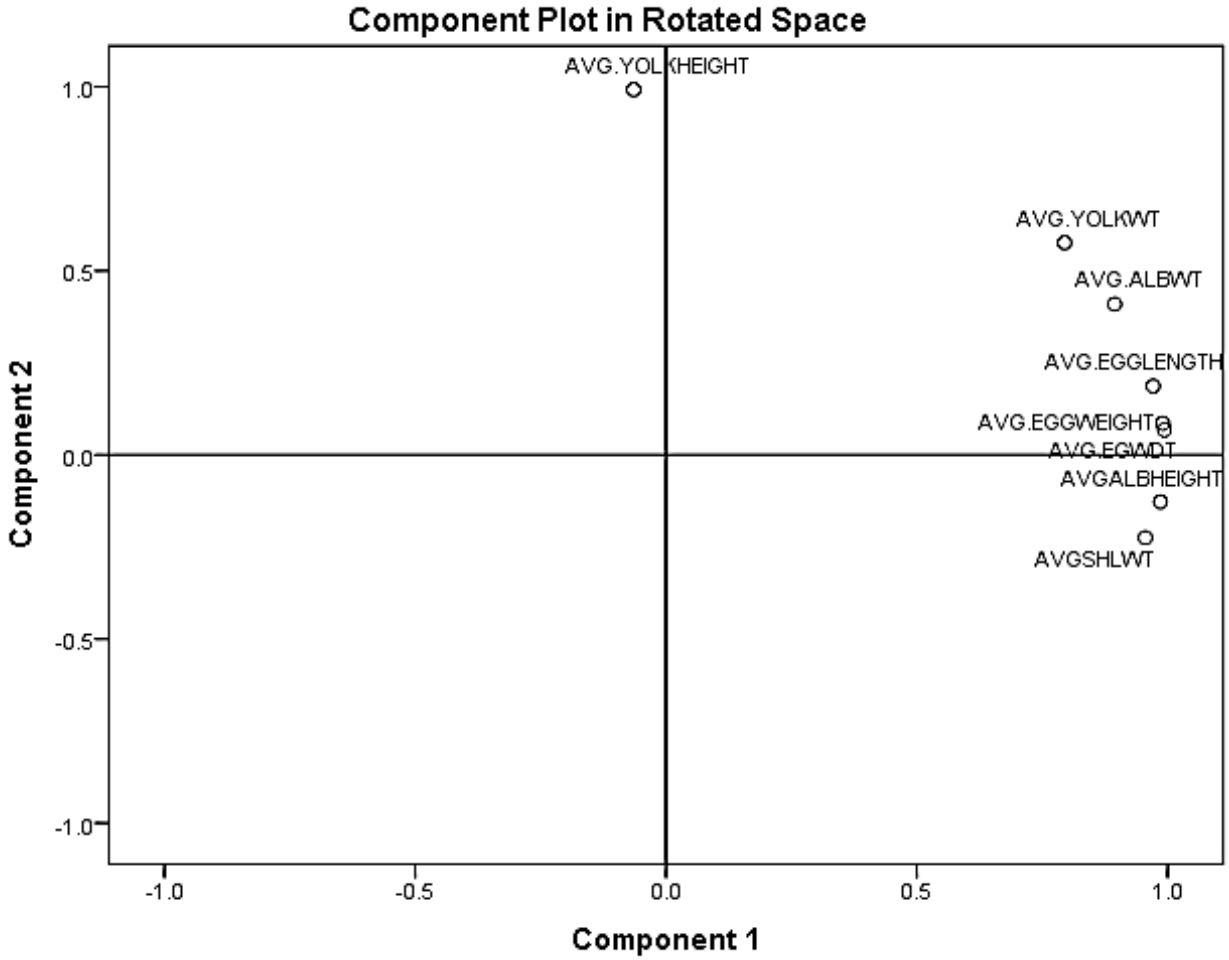


Figure 6.21: Component plot in rotated space of egg parameters of birds fed 5% MOSM

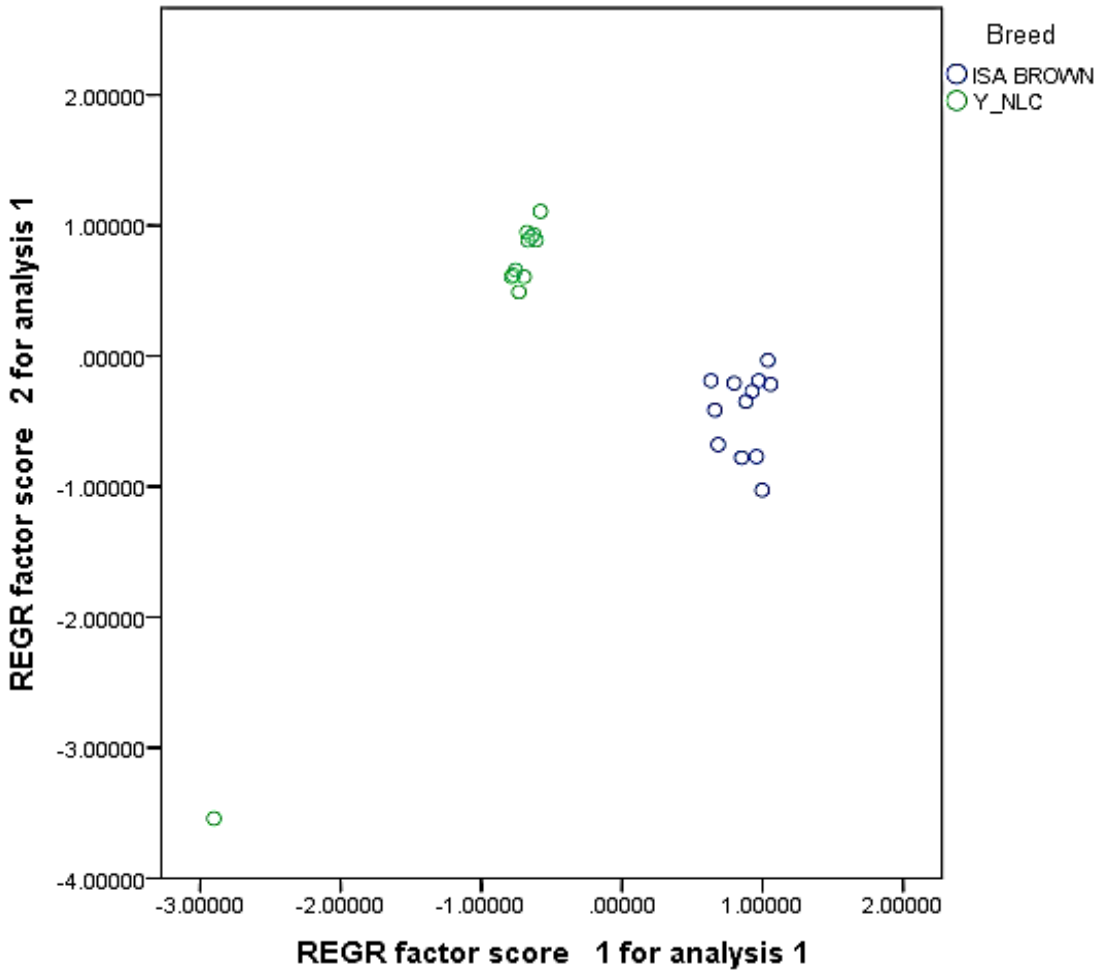


Figure 6.22 Graph showing effect of 5% MOSM on egg characteristics of chickens

Figure 6.22 clearly showed that the egg characteristics in terms of number, internal and external qualities are greatly influenced by 5% inclusion of MOSM as the effect were different per genotype.

6.33. Multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of birds fed 10% MOSM

Principal components analysis of ten original variables in 24 chickens revealed that one principal component contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.48). The principal component explained 88.737% of overall variation.

Table 6.48: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient features underlying variation in egg characteristics of birds fed 10% MOSM

Principal Component	Eigen value	% of Variance	Cumulative %
1	7.099	88.737	88.737

6.34. Rotated component matrix and communalities of egg parameters of birds fed 10% MOSM

From Table 6.49, communalities were found to be high across the parameters as all were greater than 80% with the exception of yolk weight (56.80%). PC1 had low loadings (correlations between the components and the variables) on all the parameters and were all positive.

Table 6.49: Communalities of the egg parameters of birds fed 10% MOSM

	Communalities	
	Initial	**Extraction**
EGG WEIGHT	1.000	0.923
EGG LENGTH	1.000	0.946
EGWDT	1.000	0.981
ALBWT	1.000	0.883
YOLKWT	1.000	0.568
SHLWT	1.000	0.965
ALBHEIGHT	1.000	0.971
YOLKHEIGHT	1.000	0.862

6.35. Multivariate dimension reduction principal component analysis to identify salient dimensions underlying variation in egg characteristics of birds fed 15% MOSM

Principal components analysis of ten original variables in 24 chickens revealed that one principal component contributed significantly (Eigen value≥1) to variation in the examined data (Table 6.50). The principal component explained 88.862% of overall variation.

Table 6.50: Eigen values, percentage of total variance and cumulative percentage for multivariate dimension reduction principal component analysis to identify salient factors underlying variation in egg characteristics of birds fed 15% MOSM

Principal Component	Eigen Value	% of Variance	Cumulative %
1	7.109	88.862	88.862

6.36. Rotated component matrix and communalities of egg parameters of birds fed 15% MOSM

From Table 6.51, communalities were found to be high across the parameters as all were greater than 80% with the exception of albumen weight (66.50%).

Table 6.51: Communalities of the egg parameters of birds fed 15% MOSM

	Communalities	
	Initial	**Extraction**
EGG WEIGHT	1.000	0.981
EGG LENGTH	1.000	0.886
EGWDT	1.000	0.948
ALBWT	1.000	0.665
YOLKWT	1.000	0.938
SHLWT	1.000	0.968
ALBHEIGHT	1.000	0.867
YOLKHEIGHT	1.000	0.857

6.37. DISCUSSION

Economically important egg morphometric parameters such as weight, size, albumen and yolk contents are quantitative traits that show continuous variability (Chatterjee et al., 2007; Islam & Dutta, 2010). It is also an established fact that the weight of an egg is a direct proportion of shell, albumen and yolk that it contains and this varies significantly between breeds or strains of the bird species (Jones *et al*., 2010; Momoh *et al*., 2010). The present results lend support to the findings of Nahar *et al.* (2007) for broiler, Islam & Nahar (2008) for White Leghorn, RIR and indigenous, and Miazi (2008) for Fayoumi and Sonali chickens. Internal egg parameters such as AW and YW are very important from nutritional and health viewpoints (Sparks, 2006). In this regard, ISA Brown eggs showing the highest albumen contents (35.50±2.17g) and indigenous eggs showing the lowest yolk content (7.96±2.03g) could be considered preferable. Significant correlations between EW and various external and internal egg parameters of the present study agree with Pohle & Cheng (2009) and Momoh *et al*. (2010).

This study however elucidated that egg weight is highly dependent and greatly associated with the internal and external egg quality parameters.

CHAPTER 7

SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1. Summary

The study evaluated the chemical composition of MOSM as the nutrigenetic effect of MOSM on growth performance and nutrient reflection of local and exotic chickens.It was observed that MOSM contained 89.25% dry matter, 21.67% crude protein,36.50% crude fat, 17.88% crude fibre, 3.67% total ash and energy of 14.39MJ/kg. However, anti nutrient composition of MOSM include 0.11% phenol, 0.09% tannin, 1.16% alkaloid 0.90% saponin, 22.67 Mg/kg cyanide and 0.07% glucosinolate.

Considering the effect of genotypic responses of the chickens across board for body weight and the body parameters, it was observed that the Marshall broilers had significant higher ($p<0.05$) body weight and the morphormetric indices measured when compared to the LNLC.

However, considering the effects of MOSM inclusion at 0%, 5%, 10% and 15% on all the birds irrespective of the genotype, it was observed that at the starter phase, body weight decreased significantly ($p<0.05$) across the group whole at the finisher stage, body weight increased significantly ($p<0.05$) from 0%, to 5% and a significant sharp decrease ($p<0.05$) to 10% and 15%. This was also true for thigh length hut for shank length there was a significant reduction ($p<0.05$) from 0% to 15% right from week 1 to week 8. This was also the case with keel length and body girth, there was an increase ($p<0.05$) from 0% to 5% while the value reduced significantly ($p<0.05$) from10% inclusion to 15% inclusion for seven weeks, however, at the eighth week, there was a significant reduction ($p<0.05$) from 0% to 15% inclusion level.

The value of body length significantly increased ($p<0.05$) from week 2 to week 8 from 0% to 5% and a significant reduction ($p<0.05$) from 10% to 15%. Body length decreased significantly ($p<0.02$) from week 2 to week 8 across the group.

However, there were significant interactions ($p<0.05$) between genotype and diet for all the traits measured.

Considering the effect of feeding graded levels of MOSM on the body parameters of LNLC, for body weight, there was an increase from 0% to 5% inclusion and reduction ($p<0.05$) from 10% to 15% MOSM at

weeks 4, 7 and 8 however, at weeks 1,2,3,5 and 6, there was a significant reduction ($p<0.05$) in weight from 0% MOSM to 15% MOSM. Whole for broilers, birds at 5% group had the significant highest ($p<0.05$) weight while the15% growed had the significant least weight ($p<0.05$) at weeks 1, 3, 6 while body weight decreased significantly ($p<0.05$) at weeks 2,4,5,7 and 8.

For shank length, there were significant ($p<0.05$) reductions from 0% to 15% in Y -NLC at weeks 1,2,3,7 and 8 whole the same was true for Marshall broilers at weeks 1, 6, 7 and 8.

For thigh length, among the YENLC and Marshall broilers, the highest values were recorded alternatively from birds in the 0% and 5% MOSM group.

For keel length in both genotype at the end of weeks4, there was a significant ($p<0.05$) increase from 0% MOSM to 5% MOSM and subsequent reduction from 10% MOSM to 15% MOSM. While at the end of the week 8, the keel length of both genotype of chickens were decreasing significantly ($p<0.05$) with increasing level of MOSM inclusion.

For body girth, the values reduced significantly ($p<0.05$) with increasing level of MOSM at weeks 1,2,3,6,7 and 8 for Y NLC while for Marshall broilers birds from 0% to 15% MOSM had the highest body growth and at least body growth for birds fed higher level inclusion of MOSM throughout the weeks under consideration.

In both genotypes, for wing length, birds fed lower level of MOSM (from 0% to 5%) had significantly ($p<0.05$) longer wings compared to birds fed higher levels of MOSM (10% and 15%).

However, observing body length of YENLC, birds fed graded levels of MOSM till 10% had significantly ($p<0.05$) higher body length, then birds fed 15% MOSM group had the highest body length but this was not true for Marshall broilers as the body length decreased significantly ($p<0.05$) with increasing levels of the inclusion of MOSM for all the weeks.

Phenotypic correlation between the body weight and body parts of both genotypes showed significantly ($p<0.01$) high positive relationship. This implies that there were close association between body parts and body weights.

Comparing the two genotypes separately, there were a high positive correlation ($p<0.01$) in Y NLC between the high level and wing level, shark length and body length whole in Marshall broilers, there sting significant association ($p<0.01$) between, body growth and body weight , high length, shark length and body length. This implies that the both genotypes and increase in high increase in body length.

Considering the effect of the diet (MOSM) on the phenotypic correlation of the birds, there was significantly ($p<0.01$) high correlation between the body parts and body weight for birds in the control group (0% MOSM), 5% MOSM group, medium but significant ($p<0.01$)association between body weight and body length in the 15% group.

In predicting body weight at week 7 from both genotypes, body growth showing length at week 1, body weight and body girth at week3, body weight and thigh length at weeks 5 and body girth at week 3, body weight at week 5 and body girth and body length at week 7 would be useful for predicting body weight at week 7. For YENLC, thigh length and body weight at weeks 3, thigh length and body weight at week 5 and thigh length at week 7.

The highest accuracy for prediction in both genotypes: $BW_7=89.741 + 1.770BW_5 +17.305T_5$ ($R^2=93.20\%$). While for Marshall Broilers; $74.394 + 1.655BW_5$ ($R^2=81.30\%$) while the fraction of variance explained (R^2) for YENLC was very low (all below 30%).

The principal component analysis in all the experimental birds showed that 6 principal components contributed significantly. PCI loaded heavily on body weights at weeks 2, 3,4,5,6 and 7. PC_2 loaded heavily on weeks 4 and 5. PC_3 had the highest loadings on shark length and keel length at week1.

The PCA of YENLC showed that 12 principal components contributed significantly and for only 37.11% of the variation. PC_1 loaded heavily on thigh length at weeks 3,4,5,6,7 and 8 PC_2 loaded heavily on body lengths at weeks 3,4,5 and 6 on body weights at weeks 2,3,4,5,6 and 8.

The PCA of Marshall broilers also showed 12 principal components contributing 82.523% of the variation. PC_1 loaded heavily on body weights at weeks 3,4,5,6, 7 and 8.

PC_2 loaded heavily on thigh lengths at weeks 3, 4,5and 6 and shark length at week7 and keel lengths at weeks 7 and 8.

The PCA of birds fed 0% MOSM showed 7 principal components and accounted for 89.692% of the variation. PC_1 had the highest loadings on body weight at weeks 1, 2,3,4,5, and body length at week 2. PC_2 loaded heavily on thigh length at weeks 3, 4, wing length at weeks 4, 5 and 6 are shank length at week 4. PC_3 loaded heavily on wing length at weeks 1 and 2.

The PCA of birds fed5% MOSM had 7 principal components and accounted for 90.251% of the variation. PC_1 had the highest loadings of body lengths at weeks 1 and 2, and body weights at weeks 3 and 5. PC_2 loaded heavily on thigh length at weeks 3, 4, 5, and 6 and wing lengths at weeks 4 and 5. PC_3 had how to medium values. The 3-D diagram showed that the responses of the genotype to diet were different but some few parameters overlapped. This implies that the diet did not affect all the parameters.

For birds in the 10% MOSM group, PCA showed 8 principal components that accounted for 88.136% of the variations. PC_1 loaded heavily on body weight at weeks 1 and 2, body girth at week 1 and keel length at weeks 5, 6, 7 and 8. PC_2 loaded heavily on thigh lengths at weeks 4, 5, 6 and 8 and shark length at week 2. The 3-D diagram showed that the responses of both genotypes to the diet were different.

For birds in the 15% MOSM group, PCA showed 7 principal components that accounted for 90.060% of the total variation. PC1 loaded much on wing lengths at weeks 4, 5 and 7, shank length at weeks 7 and 8.PC2 loaded heavily on body weights at weeks 2, 4,5,6,7 and 8. While pc_3 had higher loadings on body length at

weeks 1 and 2 and keel length at week 7. The 3-D diagram was similar to what was obtained for birds fed 10% MOSM.

When the genotype effect of all the birds were considered irrespective of diets. FCR and weight gain increased weekly and Mashall broilers had significantly higher ($p<0.05$) weight gains and significantly lower ($p<0.05$) FCR when compared with YENLC. When the effects of the diets on the birds were considered, birds fed 15% MOSM had significant ($p<0.05$) least weight and poorest feed conversion ratio and the same was observed when the genotypes were separated.

The carcass of Marshall Broilers was significantly ($p<0.05$) better than YENLC. However, the carcass parameters was better up till 10% MOSM inclusion but significantly ($p<0.05$) reduced at 15% MOSM. This was also the report when the genotypes of the birds were separated.

PCV, RBC, WBC, HB, MCHC, Monocyte, Lymphoctee, basophils, eosinophils and heterophils of YENLC were significantly ($p<0.05$) higher than that of Marshall broilers. The value of PCV, RBC, WBC, Hb, Monocytee, lymphocyte, basophils, eosinophils and heterophils increased significantly ($p<0.05$) with increasing levels of MOSM while MCH decreased significantly ($p<0.05$) with increasing levels of MOSM.

However, for YENLC and Marshall broilers when considered separately, PCV, RBC, WBC, Hb, lymphocyte and heterophils increased with increasing levels of MOSM.

However, there was significant interaction ($p<0.05$) between MOSM and genotype.

Also, the concentrations of Na^{+},k^{+},Ca^{2+},HCO_3^{2-}, PO_4^{2-} and Cl^{-} were significantly ($p<0.05$) higher in YENLC than Marshall broilers . However, for all the serum electrolytes, the values increased with increasing levels of MOSM.

Moreso, in YENLC, Na^{+},k^{+},Ca^{2+},HCO_3^{2-}, PO_4^{2-} and Cl^{-} increased wih the increasing level of MOSM and the same was true for Marshall broilers .

The total protein, globulin, urea, creatinine, ALT, AST and ALP of YENLC were significant ly higher ($p<0.05$) than those of Marshall broilers while Marshall broilers had higher globulin and cholesterol. In considering all the birds irrespective of genotype, total protein, urea, creatinine, ALT increased significantly ($p<0.05$) with increasing level of MOSM. However, the value of albumin, globulin, AST and ALP were significantly higher in birds fed 15% MOSM but cholesterol was high birds in the control group (0% MOSM). When all the genotype were considered separately, all the values were significantly higher ($p<0.05$) , in birds fed 15% MOSM compared to other group except in cholesterol when birds is in control diet (0% MOSM) had the significant highest ($p<0.05$) values.

Considering all the genetypes irrespective of diets for laematological parameters, PCA revealed two principal components that contributeds 88.159% of the total variation. PCI loaded heavily on RBC, WBC and heterophils while PC_2 loaded heavily on MCH and MCHC. The 3D diagram showed that the haematological parameters were not influenced by genotype but highly affected by the various inclusion of MOSM.

The PCA of YENLC and Marshall broilers showed two principal components which accounted for 86.688% and 91.407% of the variation respectively PCI loaded heavily on RBC, and WBC for both while monocytes was also loaded for YENLC and heterophils for Marshall broilers. PC_2 on the other hand loaded heavily on MCH and MCHC for both genotypes. The 3D diagrams for both genotype showed that the various inclusion of MOSM influenced the haematological parameters.

In considering the effects of various inclusions of MOSM on the haematological parameters, PCA revealed three principal components that accounted for more than 80% of the total variation.

In 0%, PC_1 loaded heavily on PCV, lymphocyte (-0.817) and heterophile (0.909), PC_2 loadede heavily on RBC (0.822), MCV (-0.982) and heterophile (0.775) and PC_3 loaded much on eosinophils(0.942).

For 10% MOSM inclusion, PC1 loaded much on WBC(0.854), lymphocytes (0.880)and eosinophils (0.851), PC2 loaded much on Hb (0.897), MCH (0.929) and MCHC (0.902) while while PC3 loaded heavily on ALT(0.913), AST (0.874) and ALP(0.843).

Birds in the 15% MOSM group had fivr principal components that accounted for 91.332% of total variation. PC1 loaded much on albumin (0.960), globulin (-0.953) and albumin-Cl-(0.712) and creatine (0.766) while pc3 loaded much on PO42+ (0.789), total protein (-0.789), total protein (-0.641) and urea (0.947).

Study 3 was on the comparative responses of YENLC and Isa brown chickens to graded levels of MOSM for semen characteristics while Isa brown cocks had significantly higher values for spermiorgramic parameters. Considering the effects of all the birds, birds fed 5% MOSM had the highest semen volume (0.20ml), mass activity (1.53), sperm mobility (64.16%) while birds fed 10% MOSM had fed best semen concentration (5.99 X 109/ml). however birds for 0% MOSM and 15% MOSM had significantly ($p<0.05$) higher testis weights, epididymis weight, testis volume and spermatozoa reserves on the epididymis, but the spermatozoa reserved in the testis is reduced significantly ($p<0.05$) with increasing level of MOSM.

But considering both birds, both the YENLC and Isa brown cocks, those fed MOSM had significantly ($p<0.05$) better semen characteristics measures than the control group (0% MOSM) but for the spermiorgramis parameters the control (0% MOSM) had significantly higher values for YENLC and Isa brown except for paired epidymis weight and spermatozoa reserved in the epidymis where those that recurred MOSM had significantly better values than the control (0% MOSM) for Isa brown codes.

There was highly significant ($p<0.01$), high correlation between body weight and spermatozoa reserves in the testis. However, the correlation values varied from low to medium and high.

In YENLC, there was significantly high correlation between body weight and spermatozoa reserves in the testis and the same hold true for Isa brown cocks.

However, diets affected the sperm parameters of there were much high correlation associations when the effect of diets in the birds were observed.

The regression equation showed that body weights could predict the sperm characteristics with high levels of precision for YENLC and Isa brown cocks but the sperm parameters could not predict the body weight as the R2 value as below 50% for these was all birds.

Principal components showed that YENLC had 2 principal components that explained 61.741% of the variation while Isa brown cocks had 4 principal components that explained 67.475% of the variation. For both genotypes, PC1 loaded much in body weight and spermatozoa reserves in the testis.

Birds fed 0% and 10% MOSM had principal components with two principal components while those for 5% and 15% MOSM had three principal components that accounted for than 70% of the total variation. In all the dietary groups PC1 loaded heavily on paired testis weight, paired testis volume, spermatozoa reserves in the testis. However, birds with MOSM inclusion had high loadings to include paired eproymi, weight and spermatozoa reserve in the epidymis.

For eggs parameters, the egg indices off Isa brown here were significantly ($p<0.05$) higher than those of YENLC. There was a significant ($p<0.05$) interaction between genotype and diet. However, egg weight, egg length, egg width, albumin weight, yolk weight, shell weight, albumem height and yolk index of YENLC decreased significantly ($p<0.05$) with increasing levels of MOSM while the egg length, egg width, albumen weight, yolk weight of Isa brown hens decreased significantly ($p<0.05$) with increasing level of MOSM.

There were significant ($p<0.01$) high positive correlations among the egg parameters of YENLC. Also, there was how positive correlations ($p<0.01$) between shell weight and all other parameters measured and albumem height as yolk height for Isa brown hens.

For birds fed 0% MOSM, there was high significant ($p<0.05$) high correlations among the egg parameters but negative correlations between yolk height and all other parameters measured. Birds fed 5% MOSM had

significantly ($p<0.05$) high positive correlations except low correlation recorded for yolk height and other parameters except yolk height and yolk weight.

Birds fed 10% and 15% MOSM had significant high correlations ($p<0.05$) but negative correlations between yolk height and other egg parameters measured. The regression equation shows that all the eggs parameters could be used to predict the eggs weight with more than 80% accuracy.

However, eggs width and egg length could predict the weight off egg with 73.50% precision while all the other parameters could predict the egg weight of Isa brown with 83.90% accuracy. All the egg parameters could predict the weight of YENLC eggs with over 85% accuracy. 96.597% variation explained.

PCA showed 2 principal components width when all the genotype were considered, PC1 loaded heavily on all except egg width and albumen weight which were heavily loaded in PC2.

The 3-D diagram showed that genotype and diets significantly influenced the egg parameters.

YENLC had 1 principal component with 92.206% of the variation explained.

Isa brown had 2 principal components with 77.712% of the variation explained. PC1 had high loadings on all the parameters except shell weight which in turn loaded heavily on PC2. Birds fed 0%, 10%, and 15% MOSM had 1 principal component with 90.581%, 88.737% and 88.862% of the variation explained.

Birds fed 5% MOSM had 2 principal components that explained 97.830% of the total variation. PC1 loaded heavily on all the parameters except yolk height which had high on all the parameters except yolk height which had high loadings in PC2.

7.2. CONCLUSION

- It can be concluded that feeding both genotypes of chickens up to 5% MOSM will be effective in terms of weight gain, feed conversion ratio and better nutrient retention.

- The effects of MOSM varied based on genotype as it was observed that feeding YENLC up to 10% MOSM improved their weight gain but for best performance in Marshall Broiler chickens 5% inclusion of MOSM is safe.
- The nutrigenetic (Genotype x Diet interaction) effects observed with respect to body weight, feed digestibility and feed conversion to live body weight (FCR) point to need for care in recommending MOSM as a constituent of feed, ensuring that a genotype of interest will respond as desired at a particular level of moringa inclusion in the diet..
- Further studies will examine the transcriptomic basis of the observed effects of moringa and its interaction with genotype on the traits as reported in the present study.
- It is concluded from this study that MOSM can be included in the diets of broiler chickens up to 10% as all the haematological and biochemical parameters were within the normal physiological ranges at this point. Also feeding broiler chickens MOSM may be recommended as good feeding stuff since it reduces blood cholesterol.
- There was no significant difference in serum levels of AST and ALT indicating that the supplement has no toxic effects on the liver. It can be concluded that MOSM had a lot of potentials of being used in animal feed.
- The findings of this result have revealed that feeding chickens up to 15% lower the serum cholesterol and the BMI showed that MOSM inclusion up to 15% did not contribute to the obesity of broilers.
- Also, the feed is not toxic or feeding up to 15% still fall within the safety margin of broilers considering the relative organ weights of the heart, kidney and liver as well as the creatinine, ALT, ASP and ALP.
- MOSM had a crude protein that is greater than 20% and energy of 3,436.99Kcal/Kg which makes it a good protein and energy source. However, it contains some phytochemicals.
- Feeding MOSM to 10% was okay for YENLC while for Marshall broilers, feeding MOSM to 5% compared well with the control.

- Marshall broilers had better body weights and linear body measurements than the YENLC. There was significant interaction between MOSM and genotype.
- Feeding MOSM to 5% for chickens is desirable without any adverse effect on the growth parameters (body weight and morphometric parameters). However, the weights decreased from 5% with increasing levels of MOSM.
- For all the birds, there were high positive correlations between the parameters and the same was true for Marshall broilers. The correlation was from low to medium in YENLC but high positive correlation between thigh length and wing length, shank length and body length in YENLC. For Marshall broilers, there were high correlations between body girth and body weight, thigh length, shank length and body length and thigh length and body length.
- There were high positive correlations among the parameters in 0% and 5% MOSM inclusion, however at 5%, the association between body length and keel length and keel length and thigh length decreased from high to medium. At 15% MOSM, the association between body length and body weight and body girth and body weight reduced from high to medium.
- Also, later body weights could be predicted for all the genotypes using earlier body parameters with accuracy greater than 50% except for YENLC with less than 30% R2.
- Marshall broilers gained more weight with highly significant better FCR when compared with YENLC.
- For chickens, 5% MOSM showed the best results for FCR but the control (0% MOSM) had the best weight gain.
- For YENLC, birds fed 10% MOSM had the best FCR and weight gain while for Marshall broilers, the control had the best weight gain but no significant difference in FCR at the finisher stage.
- For BMI, Marshall broilers had significantly higher BMI than the YENLC and there was significant interaction between MOSM and genotype at weeks 5 to 7.
- BMI was similar from 0% to 10% MOSM when all the chickens were considered irrespective of genotypes.

- In Marshall broilers and YENLC, feeding MOSM up to 10% was similar to the control and 5% MOSM inclusion.
- The Marshall broilers had significantly higher relative weights of some body parts compared to YENLC. No significant difference in the relative weight of wings, drumstick and chest, however, birds fed 5% MOSM was the best for thighs and backs.
- In YENLC, there was no significant difference in all the parameters except 5% MOSM group that had the best relative weight for back. However, for Marshall broilers, birds fed 5% MOSM and control were similar for the relative weight of thigh and back.
- The haematological and biochemical parameters increased significantly with increasing levels of MOSM.
- YENLC had significantly higher values for semen characteristics but the reverse was the case for spermiogramic parameters where Isa Brown cocks had significantly higher ($p<0.05$) values.
- For all the chickens, birds fed 5% and 15% MOSM had significantly higher semen volume, 5% and 10% MOSM had higher mass activity and sperm motility while 10% had significantly better ($p<0.05$) sperm concentration.
- For YENLC, birds fed 15% MOSM had significantly higher semen volume, 5% and 10% had significantly higher mass activity and sperm motility while 10% and 15% had better sperm concentration.
- For Isa Brown cocks, birds fed 5% and 15% had significantly better ($p<0.05$) semen volume and sperm motility, 10% had significantly better ($p<0.05$) mass activity while birds fed MOSM had significantly better ($p<0.05$) sperm concentration.
- Correlations of all the birds were from low to medium to high and when separated by genotypes.
- Feeding 5% MOSM strengthened the association of Spermatozoa Reserves in the Epididymis with other parameters while it lowered the association between the spermatozoa reserves in the testis and all semen characteristics while the correlation of 10% MOSM reduced the association of sperm

concentration with others and strengthened the association of spermatozoa reserves in the epididymis but at 15% MOSM, semen volume reduced.

- However, body weight of the cocks could be predicted using all the spermiogramic parameters and spermatozoa reserves in the testis could be predicted from body weight with greater than 80% accuracy.
- The traits could only predict the body weight of Isa Brown cocks with less than 55% accuracy.
- Feeding MOSM up to 10% improved the egg parameters for both genotypes of chickens however, Isa Brown had significantly better ($p<0.05$) egg qualities than the YENLC.
- Correlation was positive and high for egg parameters in YENLC but varied from low to medium to high in Isa Brown hens.
- 0% MOSM had high positive correlations but negative values for yolk heights and other parameters.
- 5% MOSM lowered yolk height relationship with all the other parameters but medium relationship between yolk height and yolk weight. Also, negative correlations between yolk height and shell weight and albumen height.
- 10% MOSM had high correlations but negative correlations between yolk heights and other parameters.
- 15% MOSM correlation was high but negative between yolk height and other parameters. 15% MOSM inclusion also lowered relationship between albumen height and albumen weight from high to low.
- Egg weight could also be predicted from all the egg quality parameters.

7.3. RECOMMENDATIONS

It is recommended from this study that the detary inclusion of MOSM is affected by genotypes hence generalizations can not be made on chickens generally as their performance reponses were different grnotypically. MOSM can be included up to 5% and 10% in Marshall broilers and YENLC respectively for optimum performance response. There was no significant difference in serum levels of AST and

ALT indicating that the supplement has no toxic effects on the liver. It can be concluded that MOSM had a lot of potentials of being used in animal feed. The findings of this result have revealed that feeding chickens up to 15% lower the serum cholesterol and the BMI showed that MOSM inclusion up to 15% did not contribute to the obesity of broilers. Also, the feed is not toxic or feeding up to 15% still fall within the safety margin of broilers considering the relative organ weights of the heart, kidney and liver as well as the creatinine, ALT, ASP and ALP.

Also, the reproductive response of the chickens to dietary inclusion of MOSM are affected by genotypes. However, the inclusion of 10% MOSM is recommended for YENLC and 5% inclusion of MOSM for Isa Brown Chickens for optimum reproductive performance.

Also, further studies should be carried out to investigate the effect of the inclusion of MOSM as defined by levels of expression of the transcripts gene determinants of key biological processes in key tissues/organs

REFERENCES

Aba-Adulugba, F. and Joshua, R.A. (1990). Haematological studies in apparently normal five indigenous breeds of goats in Nigeria. Bull. Anim. Hlth. Prod., 38:59-64.

Abd El Ghany, F. A., Alm El Dein, A. K., Soliman, M. M., Rezza, A. M., and El-Sodany, S. M. (2011). Relationship between some body measurements and fertility in males of two local strains of chickens. Egyptian Poultry Science, 32(II), 331-349.

Abou-Elezz, F.M.K., Sermiento-Franco, I., Santos Ricalde, R. and Solorio Sanches, F. (2011). Nutritional effects of dietary inclusion of Leucaena leucocephala and Moringa oleifera leaf meal on Rhode Island Red hens performance. Cuban J. Agri. Sci., 45: 163-169.

Abu, O.A., Rabo, J.S., Onifade, A.A. and Danny, C.B. (1988). Blood composition and histological changes in the gastro-intestinal tract of rabbits fed untreated rice husk based diets. Proceedings of annual Conference of Nigerian Society for Animal Production, 23:144-147.

Adamu, S., Thomas, A., Iseh, N. M., Fatihumi, M. Y. and Esieno, K. A. N. (2006). Normal values of haematology of Nigeria adopted albino rats (Rattus norvegicus) in Zaria. Proc. of 31st Annual Conf. of Nig. Soc. for Anim. Prod. (NSAP)

Adebanjo, A. and Oluyemi, J.A. (1981). Studies on the meat production potential of the indigenous fowl of Nigeria: II. The effect of age on meat yield and quality. Bull Anim Health Prod Afr. 1981 Dec;29(4):389-92.

Adeniji, F.O. and Ayorinde, K.L. (1990). Prediction of body weight from body measurements of chickens. Nig. J. Anim. Prod., 17: 42-47

Adeogun, I. O. and Amole, F. O. (2004) Some quality parameters of exotic chicken eggs under different storage conditions. In Bulletin of Animal Health and Production in Africa, vol. 52, pp. 43–47.

Adeosun, B.E. (2004). Effects of genotype of dam on egg quality characteristics of chickens. A project submitted to the Department of Animal Breeding & Genetics, Federal University of Agriculture Abeokuta.Ogun State.

Ahemen, T, Abu, A.H. and Orakaanya, T.T. (2013). Sperm quality, testicular morphometry of rabbits fed dietary levels of water spinach (Ipomoea aquatica) leaf meal. Agric. Biol. J. N. Am., 2013, 4(3): 352-357 http://www.scihub.org/ABJNA

Ahemen, T., Abu, A. H. and Akuba, J. O. (2016) Effect of Gmelina arborea Leaf Meal on Sperm Production and Sperm Reserves in Rabbit Bucks. International Journal of Livestock Research, 6 (4), 98-104.

Ahmed, M. K., Bargue, A. R., Nawaz, H. and Siddiqui, R. H. (1994). Effect of varying energy and protein levels of the haematology of Japanese quail. Pakistan Vet. Journal. 14(4): 200-202.

Aja, P.M., Ibiam, U.A, Uraku, A.J., Orji, O.U., Offor, C.E. and Nwali, B.U. (2013). Comparative, Proximate and Mineral Composition of Moringa Oleifera Leaf and Seed. Global Advanced Research Journal of Agricultural Science. Vol 2 (5). Pp137-141.

Ajagbonna O. P., Onifade, K. I. and Suleman, U. (1999). Haemotological and biochemical changes in rats given extracts of Calotropis procera sokoto. J. Vet. Sci., 1:36-42.

Ajayi, F O, Ejiofor, O. and Ironkwe, M. O. (2008). Estimation of bodyweight from body measurements in two commercial meat type chicken. Global Journal of Agricultural Science, 7(1): 57-59.

Ajayi, A.F., Raji, Y. and Togun, V. (2009) Caudal epididymal sperm characteristics and testicular morphometrics of rabbits fed graded levels of a blood-wild sunflower leaf meal (BWSLM) mixture diet. J. Compl. Integr.. Med. V. (6) 1-26

Akinmutimi, A. H. (2004). Evaluation of sword bean (*Canavalia gladiata*) as an alternative feed resource for broiler chickens. Ph.D. Thesis, Department of Non-ruminant Animal Production, Michael Okpara University of Agriculture, Umudike, Nigeria.

Akinola, A.O. andAbiola, S.S. (1991). Blood chemistry and carcass yield of cockerels fed melon husk diets. Trop. J. Anim. Sci., 2:39-44.

Aletor, V.A. (1989). Effect of varying levels of fishmeal substitution with soybean meal on certain serum metabolites. Niger. J. Technol. Res., 1: 111-114.

Aletor, V.A. and Egberongbe, O. (1992). Feeding differently processed soybean. Part 2: An assessment of haematological responses in the chicken diet. Nahrung, 36(4): 364-369.

Amann, R.P. (1970). Sperm Production Rates. *The Testis*. A.D. Johnson, W.R. Gomes and N.L. VanDermark. Eds. Vol. 1. New York. Academic Press. 433 – 482.

AOAC (1990). Association of Official Analytical Chemists, Official methods of Analysis. 15th edition, Washington, D. C.

Armstrong B, Stevens N, and Doll R (1974) Retrospective study of the association between use of rauwolfia derivatives and breast cancer in English women. Lancet 2: 672–675

Aro, S. O. and Akinmoegun, M. B. (2012). Haematology and red blood cell osmotic stability of pigs fed graded levels of fermented cassava peel based diets. Proc. 17th Annual Conf. of Anim. Sci. Assoc. of Nigeria (ASAN), 152-153.

Aro, S. O., Ogunwale, F. F. and Falade, O. A. (2013). Blood viscosity of finisher cockerel fed dietary inclusions of fermented cassava tuber wastes. Proc. of the 18th Annual Conf. of Anim. Sci. Assoc. of Nig., 74-77.

Awosanya, B., Joseph, J.K., Apata, D.F. and Ayoola, M.A. (1999). Performance, blood chemistry and carcass quality attributes of rabbits. Int. Trop J. Anim. Sci., 2:89-96.

Ayssiwede, S.B., Dieng, A., Bello, H., Chrysostome, C.A.A.M., Hane, M.B., Mankor, A., Dahouda, M., Houinato, M.R., Hornick, J.L. and Missohou, A. (2011). Effects of Moringa oleifera leaves meal incorporation in diets on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. Pak. J. Nutri., 10: 1132-1145.

Bah, G. S., Chaudhari, S. U. R. and Al-Amin, J. D. (2001). Semen characteristics of local breeder cocks in the sahel region of Nigeria. Revue Elev. Med. Vet. Pays trop., 54(2), 153-158.

Baker, F.S. and Silverton, R.E. (1982). Introduction to Medical Laboratory Technology, 5th edn. Butterworth S.C., London, pp 481-494.

Barnes, A.R and Amega, W.K. (1984). Utilization of cocoa pod husk meal by growing-finishing pigs. Proc. 9th International cocoa Research Conference, Lome, Togo, pp 449-454.

Bath, G.S. and Chaurdhari, S.U.R. (2002).Sperm Reserve and its Relationship to Parameters of the Testis, Epididymis and Vas Deferns of Local Cocks in the Sahel Region of Nigeria. International Journal of Agricultural and Biology.1560-8530/2002/04-4-562-564.

Bhatnagar, D., Cary, J.W. and Chang, P.K. (1996) Consolidated information on aflatoxin pathway genetics. In: Proceeding of Aflatoxin Elimination Workshop (Ed. by Robens, J.F. and Cleveland, T.E.). Fresno, C.A., pp. 72–75

Bhatt, R.S. and Sharma S.R. (2001). Nutrient utilization and growth performance of broiler rabbit fed oat plant meal and tall fescue hay. Asian-Australasian Journal of Animal Science, 14: 1228-1232.

Becker K. and Makkar, H.P.S. (1999). Effects of dietary tannic acid and quebracho tannin on growth performance and metabolic rates of common carp. Aquaculture, 175:327-335.

Bell, G.H., Enslie-Smith, D. and Patterson, C. R. (1992). Textbook of Physiological biochemistry. Churchill Livingstone, Edinburgh, pp229-230.

Bennett, R.N., Mellon, F.A., Foidl, N., Pratt, J.H., DuPont, M.S., Perkins, L. and Kroon, P.A. (2003). Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees *Moringa oleifera* L. (Horseradish tree) and *Moringa stenopetala* L. Journal of Agriculture and Food Chemistry, 51: 3546-3553.

Bentrick, S.(1974). Haematology, Textbook of Veterinary Pathology. Williams and Co., Baltimore, pp 217-224.

Berger, M.R., Habs, M., Jahn, S.A. and Schmahl, S. (1984). Toxicological assessment of seeds from *Moringa oleifera* and *Moringa stenopetala,* two highly efficient primary coagulants for domestic water treatment of tropical raw waters. East African Medical Journal, 61: 712-716.

Bhatt, R.S. and Sharma S.R. (2001). Nutrient utilization and growth performance of broiler rabbit fed oat plant meal and tall fescue hay. Asian-Australasian Journal of Animal Science, 14: 1228-1232.

Blood, D.C. and Radostits, O.M. (1989). Veterinary Medicine, 7th Edition, Balliere Tindall, London, pp. 589-630.

Bone, F. J. (1979).Anatomy and Physiology of Farm Animals.Printice–Hall, Inc., New Jersey, U.S.A.

Boone, M.A. and Hughes, B.L. (1969). Starvation and its effect on semen quality. Poult. Sci., 48: 1723-1729.

Booth, F.E.M. and Wickens, G.E. (1988). Non-timber uses of selected arid zone trees and shrubs in Africa. FAO conservation guide, Rome, pp 92-101.

Bichi, H.M. (2013). A Review of the Applications of *Moringa oleifera* Seeds Extract in Water Treatment. Civil and Environmental Research, Vol.3, No.8.

Bilcik, B., Estevez, I. and Russek-Cohen, E. (2005). Reproductive success of broiler breeders in natural mating systems: The effect of male-male competition, sperm quality and, morphological characteristics. Poultry Science, 84, 1453-1462.

Bosh, C.H. (2004). USDA National Nutrient Database for standard reference. In: Grubben, G.J.H. and Denton, O.A. (eds). PROTOA Foundation, Wageningen Netherlands/CTA, Wageningen, Netherlands,pp 392- 393.

Burke, J. (1994). Clinical care and medicine of pet rabbit. In: Proc. of the Michigan Veterinary Conf., 49-77.

Campbell, J. R. and Lasley, J. F. (1975). The science of animal that serve man. 2nd ed. McGraw Hill Book Company, New York, USA: 200-222.

C.S.I.R. (1962). The wealth of India. A dictionary of Indian raw materials and industrial products. Raw materials, volume 6: L-M, New Delhi, CSIR, India.

Chatterjee, R.N., Rai, R.B., Kundu, A., Senai, S. and Sundar, J. (2007). Egg quality traits in indigenous breeds of chickens of Andaman. Indian Vet. J. 84: 206-208.

Cheeke, P.R. (1976). Nutritional and Physiological Properties of Saponins. Nutr. Rep. Int.,13:315-324.

Cooper, G.R. and McDaniel, V. (1970). Standard methods in serum enzyme activity. *Clinical Chem*. 6: 159.

Dahot MU. 1988. Vitamin contents of flowers and seeds of *Moringa oleifera*. *Pak. J. Biochem.* **21** (1+2): 21-24.

Daxenbichler, M.E., Spencer, G.F., Calson, D.G., Rose, G.B., Brinker, A.M and Powell, R.G. (1991). Glucosinolate composition of seeds from 297 species of wild plants. Phytochemistry, 30: 2623-2638.

Dei, H. K., Rose, S. P. and Mackenzie, A. M. (2007). Shea nut (*Vitellaria paradoxa*) meal as a feed ingredient for poultry. Poult. Sci., 63 (4): 611-624

Dellman, H. and Brown, E. (1976). Textbook on Veterinary Histology. LEA and Febilger, Philadelphia, pp 88-96.

Duke,A.J.(1998). Moringaceae. Handbook of energy crops. Available: Http://www/hort.purdue/edu./newcrop/duke_energy/moringa. htm.Accessed on 04/05/2008

Duke, H.H.(1975). Duke's physiology of Domestic Animals, 8th edn. Comstock Publishing Associates, a division of Cornell University Press,New York, U.S.A. pp 33.

Duke, J.A. (1983). Ipomoea batatas. Handbook of Energy Crops Unpublished.http://www.hort.purdue.edu/newcrop/default.htm.Accessed on 04/05/2008

Ebenebe C I, Anigbogu C C, Anizoba M A and Ufele A N. (2013).Effect of various levels of Moringa leaf meal on the egg quality of Isa Brown breed of layers. Advances in Life Science and Technology, ISSN 2224–7181 (Paper) ISSN 2225–062X (Online).

Egbunike, G.N., Holtz, W., Endell, W. and Smidt, D. (1975). Reproductive capacity of German Improved Landrace boars. I. Gonadal and extragonadal sperm reserves. *Zuchthygiene*. 10: 184-187.

Eggum, B. O., (1970). Blood urea measurement as a technique for assessing protein quality. Br. J. Nutrition, 24: 983-988.

Eheba, E. T. E., Omoikhojie, S. O., Bangbose, A. M., Druna, M. B., Isidhahomen, C. E. (2008). Haematology and serum biochemistry of weaner rabbits fed cooked bambara groundnut meal as replacement for soybeans meal. Proc. of 33rd Annual Conf. of Nig. Soc. for Anim. Prod., 192-196

Ekeocha, A.H. (2002). Effect of "Inhibin" from bovine testicular and follicular fluids on attainment of puberty in male rabbits. M.Sc. Dissertation of the Dept. of Anim. Sci. University of Ibadan, Nigeria

Esonu, B.O., Emenelom, O.O., Udedibie, A.B.I., Herbert, U., Ekpor, C.F., Okoli, I.C. and Iheukwumere, F.C. (2001). Performance and blood chemistry of weaner pigs fed raw Mucuna (Velvet bean) meal. Trop. Anim. Prod. Invest, 4:49-54.

Esonu, B.O., Udedibie, A.B.I., Emenalom, O.O., Madumere, C.C. and Uchegbu, O.A. 2008. Evaluation of oil palm (Elaeis guinensis) leaf meal as fed ingredient in broiler diets. Nigerian J. Anim. Prod. 35(1): 32-39.

Estrella, M.C.P., Mantaring, J.B.V. and David, G.Z. (2000). A double blind, randomized controlled trial on the use of malunggay (*Moringa oleifera*) for augmentation of the volume of breast milk among non-nursing mothers of preterm infant. The Philippine Journal of Pediatric, 49: 3-6.

Etches, R.J., Buckland, R.B. and Hawes, R.O. (1979). The effect of the genes for rose comb and polydactyle sperm transport in the hen's oviduct. *Poultry Science*. 53: 422.

Etim, N. N., Enyenihi, G. E., Akpabio, U and Offiong, E. E (2014) Effects of nutrition on the heamatology of rabbits: A review. European Scientific Journal, 10(3):413-424

Ewuola, E.O, Ogunlade, J.T, Gbore, F.A, Salako, A.O, Idahor, K.O. and Egbunike, G.N. (2003). Performance Evaluation and organ Histology of Rabbits fed Fusarium Verticillioides culture material. Trop. Anim. Prod. Invest. 6: 111-119.

Ewuola, E.O and Egbunike G.N (2009). Gonadal and extra-gonadal sperm reserves and sperm production of pubertal rabbits fed dietary fumonisin B_1. *Animal Reproduction Science*, doi:10.1016/j.anireprosci.2009.12.001.

Ewuola E.O., Sanni K.M., Oyedemi O.M., Alaba O. and Lawal T.J. (2011). Serum biochemical response of gestating and lactating does administered graded level of moringa leaf extract. Proceedings of 16th Annual Conference of Animal Science Association of Nigeria, p.158-162

Ewuola E.O., Jimoh O.A., Atuma O.V., and Soipe O.D. (2012). Heamatology and serum biochemical response of growing rabbits fed graded levels of Moringa oleifera leaf meal. World Rabbit Science Association Proceedings 10th World Rabbit Congress – September 3 - 6, 2012– Sharm El- Sheikh Egypt, 679 - 683

Ezekwe, A.G. (1998). Gonadal and extragonadal sperm reserve and testicular histometry of post pubertal Muturu bulls. Nig. J. Anim. Prod., 25: 106-110.

Ezekwe, A.G., Udozor, I.J. and Osita, C.O. (2003). Effect of quantitative feed restriction on the semen quality of Nigerian Local Cocks. Nig. J. Anim. Prod., 30: 127-132.

Fahey, J.W., Zakmann, A.T. and Talalay, P. (2001). The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. [Corrigendum: phytochemistry,(59): 200- 237].

Farooq, M., Mian, M.A. Ali, M., Durranim F.R., Asquar, A. & Muqarrab, A.K. (2001). Egg traits of Fayoumi bird under subtropical conditions. Sarad J. Agri. 17: 141-145.

Fayeye, T. R. and Owoeye, M. F. (2016). Correlation between body weight and morphometric traits in Isa Brown and Fulani ecotype chickens in Southern Guinea Savannah of Nigeria. Gashua Journal of Irrigation and Desertification Studies, Vol. 2. No. 2

Foidl, N., Makkar, H.P.S. and Becker, K. (2001). The potential of *Moringa Oleifera* for agricultural and industrial uses. In: Fugile, L.J. (ed). The miracle tree: the multiple attributes of Moringa.CTA. Publication. Wageningen, The Netherlands, pp 45-76.

Frandson, R.D. (1986). Anatomy and Physiology of FarmAnimals, 4th Edition. Lea and Febilger. Pennsylvania, USA.,pp 240-242.

Fuglie, L. (1999). Producing food without pesticides: local solution to crop pest control in West Africa. CTA., Wageningen, The Netherlands.

Fuglie, L.J. (2001). Natural Nutrition for the Tropics. In: Fubalie, L.J. (ed). The Miracle Tree: The Multiple Attributes of *Moringa.* CTA Publication,Wageningen, The Netherlands, pp 103-115.

Fuglie, L.J. (2005). The Moringa tree: a local solution to malnutrition? Church World Service, Senegal.

Gage M.J.G. and Freckleton, R.P. (2003). Relative testis size and sperm morphometry across mammals: No evidence for an association between sperm competition and sperm length. Proc. Biol. Sci., 22: 625-632.

Garg, S.K.,Makkar, H.P.S., Nagpal., K.B, Sharma, S.K., Wadhwa, D. R. and Singh, B. (1982). Toxicological investigation into oak leaf poisoning in cattle. Vet. and Human Toxicology, 34: 161-164.

GassenSchmidt, U., Jany, K.D., Tauscher, B. and Niebergall, H. (1995). Isolation and characterization of a flocculating protein from *Moringa oleifera* Lam. Biochimica Biophysica Acta, 1243: 477-481.

Gebriel, G. M., Kalamah, M., El-Fiky, A., and Ali, A. F. A. (2009). Some factors affecting Semen quality trait in Norfa cocks. Egyptian Poultry Science, 29(11), 677-693.

Ghasi, S., Nwobodo, E. and Ofili, J.O. (1999). Hypocholesterolemic effects of crude extract of leaf of *moringa oleifera* Lam in high-fat diet fed Wister rats. Journal of Ethnopharmacology, 69: 21-25.

Grubben, G.J.H. and Denton, O.A. (2004). Plant Resources of Tropical Africa 2. Vegetables. PROTA Foundation, Wageningen, Netherlands/ Backhuys Publishers, Leiden, Netherlands/ CTA, Wageningen, Netherlands.

Guèye, E.F. and Branckaert, R.D.S. (2002). FAO's programme for support to family poultry production. Proccedings of a workshop on poultry as a tool in poverty eradication and promotion of gender equality. Animal Production and Health Division, FAO, Rome, Italy.

Gunn, H. H., Ude, I. and Omeje, I. S. (2016). Effects of Crude Oil Pollution and Carcass-traits of the Nigerian Normal feathered Local Chicken in the Niger Delta, Nigeria. Proc. 41st Conf. Nigerian Society for Animal Prod. 20th– 24th March 2016. p699 – 702.

Gupta, K., Barat, G.K., Wagle, D.S. and Chawla, H.K.L. (1989). Nutrient contents and anti-nutritional factors in conventional and non-conventional leafy vegetables. Food chemistry, 31: 105-116.

Hafez E S E 1987 Techniques for improving reproductive efficiency. In: reproductive in farm Animals. 5th Edition. Philadelphia, PA, USA. Lea and Febifer. Pp 455-497.

Hale, O.M. and McCormick, W.C. (1981). Value of peanut skins testa as a feed ingredient for growing-finishing swine. J.Anim. Sci., 53: 1006-1010.

Harkness, J. E. and Wagner, J. E. (1989). The Biology and medicine of rabbits chemistry. 17th ed. Lang Medical, Los Altos, California, 9442:60-81; 188-216.

Harper, H.A. (1973). Review of Physiological Chemistry, 14th edition. Lange medical publications, California.

Harper, H.A. (1979). Epithelial, Connective, and Nerve Tissues. *Review of Physiological Chemistry*. H.A. Harper, V.W. Rodwell and P.A. Mayes. Eds. California. Lange Medical Publication.

Hartwell JL. 1995. Plants used against Cancer. A Survey. Lloydia. 30-34 http://www.europaworld.org/issue44/cropandlivestock 27701.htm http://www.un.org.pk/drought/rereport15.htm

Helen, A.G. (1989). Introductory Nutrition. Times mirror, Mosby College publishing Co

Hocking, P.M. and Bernard, R. (1997). Effect of dietary crude protein content and food intake on production of semen in two lines of broiler breeder males. Brit. Poult. Sci., 38: 199-202.

Hoder, M. and Rej, R. (1983). Alanine transaminase. *Methods of enzymatic analysis*. H.U. Bergmeyer, J. Bergmeyer and M. Grassl, Eds. Weinheim. Verlag-Chemie. 3: 416-433.

Hrncar, C. Hanusová, A. and Hanus, J.B. (2014). "Effect of Genotype on Egg Quality Characteristics of Japanese Quail (Coturnix Japonica)" Slovak Journal of Animal Science, Vol. (47), No.1, 6-11.

Ibe, S. N. (1989). Measurement of size and conformation in commercial broilers. Journal of Animal Breeding and Genetics, 106: 461-469.

Iheukwumere, F.C. and Okoli, I.C.(2002). Preliminary studies on raw Napoleana Imperialis as feed ingredient. 1: Performance and blood chemistry of weaner rabbits. Trop. Anim. Prod.,5: 100-110.

Isaac, L. J., Abah, G., Akpan, B. and Ekaette, I. U. (2013). Haematological properties of different breeds and sexes of rabbits. Proc. of the 18th Annual Conf. of Anim. Sci. Assoc. of Nig., 24-27.

Islam, M.S. and Dutta, R.K. (2010). Egg quality traits of indigenous, exotic and crossbred chickens (Gallus domesticus L.) in Rajshahi, Bangladesh. J. Life Earth Sci. 5: 63-67.

Iyayi, E.A. and Tewe, O.O. (1998). Serum total protein, urea and creatinine levels as indices of quality of cassava diets for pigs. Trop. Vet., 16:59-67.

Jain, N.C. (1986). Schalms veterinary haematology. 4th Edition. Philadephia, USA. Lea and Febiger.

Jain, N.C. (1993). Essentials of Veterinary Hematology. The Amazon Book Review

Jimoh A. A., Olorede B. R., Abubakar A., Fabiyi J. P., Ibitoye E. B., Suleiman N. and Garba S. J (2012). Lipids profile and Haematological Indices of Broiler Chickens fed Garlic (Allium sativum) - Supplemented Diets Vet Adv 2012, 2(10): 474-480

Jolkumen-Tiito, R. (1985). Phenolic constituents in the leaves of northern willows: Methods for the analysis of certain phenolics. J. Agric. Food Chem. 33:213-217.

Jones, D.R., Musgrove, M.T., Anderson, K.E. and Thesmar, H.S. (2010). Physical quality and composition of retail shell eggs. Poult. Sci. 89: 582-587.

Joseph J. K., Balogun O. O. and Famuyima M. A., (1992). Carcass evaluation and organoleptic assessment of quality attributes of some selected Nigerian birds. Bulletin of Animal Health and Production in Africa, 40: 97-102.

Kakengi, A.M.V., Kaijage, J.T., Sarwart, S.V., Mutayoba, S.K. Shem, M.N. and Fujihara, T. (2007). Effect of Moringa leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. Livest. Res. Rural Develop. 19: article number 120.

Kasolo, J.N., Bimenya, G.S., Ojok, L. and Ogwal-Okeng, J.W. (2012). Sub-acute toxicity evaluation of Moringa oleifera leaves aqueous and ethanol extracts in Swiss Albino rats. Int.J. Med.Plants.Res. Pp74-81

Kawo, A.H., Abdullahi, B.A., Gaiya, Z.A., Halilu, A., Dabai, M. and Dakare, M.A. (2009). Preliminary phytochemical screening, proximate and elemental composition of Moringa oleifera LAM seed powder. Bayero J. Pure Appl. Sci., 2: 96-100.

Kristin, D. (2000). The moringa tree. Echo technical note. Florida, U.S.A.

Kronfield, O.W. and Mediway, N.C. (1975). Blood Chemistry In: Prier, J. E., and Wilkinson, J.S. (Eds.). Textbook of Veterinary Clinical Pathology. Williams and Williams Co., Baltimore, USA. pp: 81-96.

Kumar, R. and Singh, B. (1984). Antinutritional adverse role in ruminant nutrition. J. Agric. Food Chem, 32:447-453.

Kumar, S. (2017). Medicinal importance of Moringa oleifera: drumstick plant. Indian J.Sci.Res. 16 (1): 129-132.

Lake P E, Rule, O. and Naddington, D (1985) some effects of the composition of inseminated semen and site of its deposition and fertility in Gallus domesticus. Animal Reproduction Science 9: 273-284.

Lindsay, D.B. (1977). The effect of feeding patterns and sampling on blood parameters. Occasional Publication Lister (Ed.). No. 1. Br. Soc. Anim. Prod., pp: 99-120.

Madubike, F.N. and Ekenyem, B.U. (2006). Haematology and Serum Biochemistry Characteristics of Broiler Chicks fed varying Dietary Levels of Ipomoea Asarifolia leaf meal. Int. J.Poult. Sci., 5:9-12.

Makhafola, M. B., Umesiobi, D. O., Mphaphathi, M. L., Masenya, M. B. and Nedambale, T. L. (2012). Characterization of sperm cell motility rate of Southern African indigenous cockerel semen following Analysis by sperm class analyzer. Journal Animal Science Advances, 2(4), 416-424.

Makkar, H.P.S and Becker,K. (1988). *Moringa oleifera* seed meal and proteins on rumen fermentation *in vitro*. Annual report. Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart. Germany.

Makkar, H. P. S., M. Blummel and K. Becker. 1993. Formation of complexes between polyvinylpyrroidones or polyethylene glycols and tannins and their implication in gas production and true digestibility *in vitro* techniques. Br. J. Nutr. 73:897-913.

Makkar, H.P.S. and Becker, K. (1996). Nutritional value and anti-nutritional components of whole and ethanol extracted *Moringe oleifera* leaves. Animal feed science and technology, 63: 211-228.

Makkar, H. P. S. and K. Becker. 1996. A bioassay for polyphenols (tannins). Polyphenols communications 96, Bordenaux (France). July 15-18, 1996.

Makkar, H. P. S. and K. Becker. 1997. Nutrients an antiquality factors in different morphological parts of the Moringa oleifera tree. J. Agric. Sci. 128:311-322.

Makkar, H. P. S. 2000. Quantification of tannins in tree foliage. A laboratory manual for the FAO/IAEA coordinated research project on 'Use of Nuclear and Related Techniques to Develop Simple Tannin Assay for Predicting and Improving the safety and Efficiency of Feeding Ruminants on Tanniniferous Tree Foliage'. Joint FAO/IAEA Vienna, Austria, 2000

Makker,H.P.S and Becker,K. (1997). Nutrients and anti quality factors in different morphological parts of the *Moringa oleifera*tree. Journal of Agric. Sci. (Cambridge), 128:311-322.

McComb, R.B., Bowers, G.N. and Rosen, S. (1983). *Alkaline phoshatase*. New York: Plenum Press.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (1999). *Animal Nutrition.* (5th Edition). Harlow, England: Addision Wesley Longman.

Mekonnen, Y. and Dräger, B. (2003). Glucosinolates in *Moringa stenopetala.* Planta medica, 69: 380-382.

Melo, V., Vargas, N. Quirino, T. and Calvo, C.M.C. (2013). *Moringa Oleifera* L. – An underutilized tree with macronutrien3ts for human health. Emirates Journal of Food and Agriculture, Vol. 25(10), 785-789

Mendes, M. (2011). Multivariate multiple regression analysis based on principal component scores to study relationship between some pre- and post- slaughter traits of broilers. Journal of Agricultural Science (Tarim Bilimleri Dergisi.) 17:77-83.

Miazi, O.F. (2008). Liveability of Fayoumi and Sonali chicks. M. Phil. thesis, Dept. of Zoology, Chittagong University. 49+42 pp.

Mitruka, B.M. and Rawnsley, H.M. (1977). *Clinical biochemical and haematological reference values in normal experimental animals*. NewYork: Masson Publishing.

Mmereole, F.U.C. and Udeh, I. (2009). Genotype by Diet Interaction on Body Weight of the Local Chicken and its Crosses with Barred Plymouth Rock. International Journal of Poultry Science, 8: 504-507.

Momoh, O.M, Ani, A.O. and Ugwuowo L.C. (2010). Part-period egg production and egg quality characteristics of two ecotypes of Nigerian local chicken and their F1 crosses. Int. J. Poult. Sci. 9(8): 744-748.

Monsi, A., (1992). Appraisal of Interrelationships among live measurements at different ages in meat type chickens. Nig. J. Anim. Prod., 19: 15-24.

Moreira, F., Orlandi, C, Risco, C.A., Mattos, R., Lopes, F. and Thatcher, W.W. (2001). Effects of pre-synchronization and bovine somatotropine on pregnancy rates to a time artificial insemination protocole in lactating dairy cows. J. Dairy Sci., 84: 1646-1659.

Moyo, B, Masika, P.J, Hugo, A. and Muchenje, V. (2011). Nutritional characterization of Moringa (*Moringa oleifera* Lam) leaves. Afr. J. Biotechnol. 10(60):12925-12933

Murray, R.K, Grammar, D.K., Mayes, P.A. and Rodwell, V.W (1988). Harpers Biochemistry, 21st edition, A Lange Medical Book. California. Pp 241-252.

Muriu, J.I., Njoka-Njiri, E.N., Tuitoek, J.N. and Nanua, J.N. (2002). Evaluation of sorghum (*Sorghum bicolor*) as replacement of maize in the diet of growing rabbit (*Oryctolagus cuniculus*). Asian-Australisian Journal of animal science, 15: 565-569.

Mutayoba, S.K., Dierenfeld, E., Mercedes, V.A., Frances, Y. and Knight, C.D. (2011). Determination of chemical composition and anti-nutritive components for Tanzanian locally available poultry feed ingredients. International Journal of Poultry Science, vol. 10, no. 5, Pp. 350-357.

Nahar, K., Ahmed, S., Monir, M.M. and Rahman, M.S. (2007). Comparative evaluation of egg quality characteristics of broiler parent stock and synthetic broiler. Bang. J. Anim. Sci. 36 (1 & 2): 82-87.

Nityanand, P. (1997). Textbook of Feed Processing Technology. Vikas Publishing House PVT Ltd., New Delhi, India.

Njidda, A. A., Igwebuike, J. U. and Isidahomen, C. E. (2006). Haematological parameters and carcass characteristics of weaning rabbits fed grade levels of molasses. Global Journal of Agric. Sci., 5(7):167-172.

Nwosu, C.C. (1979). Characterization of the local chicken in Nigeria and its potential for egg and meat production. Proceedings of the 1st National Seminar on Poultry Productio, Dec. 11-13, Ahmadu Bello University, Zaria, pp: 187-210.

Odetola, O. M. ; Adetola, O. O. ; Ijadunola, T. I. ; Adedeji, O. Y. ; Adu, O. A., (2012). Utilization of moringa (*Moringa oleifera*) leaves meal as a replacement for soya bean meal in rabbit's diets. Schol. J. Agric. Sci., 2 (12): 309-313

Odeyinka, S. M., Oyedele, O. J., Adeleke, T.O. and Odedire, J. A. (2008). Reproductive performance of rabbits fed *moringa oleifera* as a replacement for *Centrosema pubescens*. In: 9th World Rabbit Congress – June 10 – 13, 2008, Verona, Italy.

Odunsi, A.A. (2003). Assessment of Lablab (*Lablab purpureus*) leaf meal as a feed ingredient and yolk colouring agent in the diet of layers. International Journal of Poultry Science, 2(1): 71-74.

Oduro, I., Ellis, W.O. and Owusu, D. (2008). Nutritional potential of two leafy vegetables: *Moringa Oleifera* and *Impomea batatas* leaves. Scientific research and essay, 3(2): 57-60.

Oduye, O.O. and Adadevoh, B.K. (1976). Biochemical values of apparently normal Nigerian sheep. Nig. Vet.J., 5(1): 43-50.

Ogah, D. M., Alaga, A. A and Momoh, M. O. (2009). Principal component factor analysis of the morph structural traits of Muscovy duck. International Journal of Poultry Science 8 (11): 1100-1103.

Ogbe, A.O. and Affiku, J.P. (2012). Proximate study, mineral and anti-nutrient composition of Moringa oleifera leaves harvested from Lafia, Nigeria: potential benefits in poultry nutrition and health. Journal of Microbiology, Biotechnology and Food Sciences, 1: 296-308

Ogbuewu, I.P., Okoli, I.C. and Iloeje, M.U. (2009). Semen quality characteristics, reaction time, testis weight and seminiferous tubule diameter of buck rabbits fed neem (*Azadirachta indica*, A. juss) leaf meal based diets. Iranian J. Reprod. Med., 7: 23-28.

Ojedapo, L.E. Amao, S.E. Ameen, S.A. Adedeji, T.A., Ogundipe, R.I. and Ige, A.O. (2012). Prediction of Body Weight and other Linear Body Measurement of Two Commercial Layer Strain Chickens. Asian Journal of Animal Sciences, 6: 13-22.

Ojo, O.A. and Abdurahman, K.O. (2017). Effect of *Moringa Oleifera* Leaf Extract (Mole) on some Reproductive Parameters of Rabbits Reared in a Semi-Humid Environment. Global Journal of Science Frontier Research: D Agriculture and Veterinary Volume 17 Issue 4 Version 1.0

Okai, D.B., Easter, R.A. and Frank, G.R. (1984). The nutritive value of some non-conventional Ghanaian feed ingredients: Nutrient composition and effects on performance of weaning rats. Wld. Rev. Anim. Prod, 20:11-16.

Oke, U.K and Ihemeson, C. (2010). Effect of genotype on the morphometric differentiation of the reproductive organs and sperm reserves in the Nigerian local chicken. *Livestock Research for Rural Development. Volume 22, Article #53.* Retrieved March 24, 2018, from http://www.lrrd.org/lrrd22/3/oke22053.htm

Olawumi, S.O., Fajemilehin, S.O. and Fagbuaro, S.S. (2012). Genotype x Sex interaction effects on carcass traits of 3 strains of commercial broiler chickens. Journal of World's Poultry Research, 2(1):21-24.

Oleforuh-okoleh, V. U., Ibom, L. A., Eze J. and Ideozu, H. (2016). The effect of storage time and Methods on Some Internal Quality Traits of Nigerian local chicken eggs. Proc. 41st Conf. Nigerian Society for Animal Proceeding 20 – 24. March 2016. p185 -188.

Oleszek, W, - Nowacka, J, - Gee, J.M, - Wortley, G. And Johanson, L.T. (1994). Effects of some purified alfafa (Medicago sativa) saponins on transmural potential difference in mammalian small intestine. In Journal of the Science of Food and Agriculture, vol. 65, p. 35-39.

Ologhobo, A.D., Apata, D.F., Oyegide, A., Akinpelu, R. O. (1992). Toxicity of raw lima beans (*Phaseolus lunatus*) and Lima bean fractions for growing chicks. Brit. Poultry. Sci., 34:505-522.

Olsen, A. (1987). Low technology water purification by bentonite clay and *Moringa oleifera* seed flocculation as performed in Sudanese villages. Effect on *Schistosoma mansoni* cercariae. Water Research, 21(5): 517-820.

Olugbemi, T.S., Mutayoba, S.K. and Lekule, F.P. (2010). Moringa oleifera leaf meal as a hypocholesterolemic agent in laying hen diets. Livest. Res. Rural Dev., 22.

Oluyemi, J. A. and Robert, F. A. (1979). Poultry Production in Warmest Climate. Macmillan publishers limited London and Basingtoke, UK.

Omeje, S. S. I. and Nwosu C. C. 1983. Egg Production Patterns in Local Chickens and their Crosses in Short term. Nigerian Journal of Animal Production. 10 (2): 91-96.

Omeje,S.I. and Ude, I, (1998). Effect of Feed Restriction on Body Weight and Semen Characteristics of Native and Exotic (Broiler) Cocks. Journal of Applied Animal Research Vol. 14 Pp81-86

Onagbesan, O., Bruggeman, V., Desmit, L., Debonne, M., Witters, A., Tona, K., Everaert, N. and Decuypere, E. (2007). Gas exchange during storage and incubation of Avian eggs: Effects on embryogenesis, hatchability, chick quality and post-hatch growth. World's Poult. Sci. J. 63: 557-573

Onyeyilli, P.A., Egwu, G.O., Jiike, G.I., Pepple, D.O. and Ohaegbulem, J.O. (1992). Seasonal variation on haematological indices in the grey-breasted Guinea fowls. Nig. J. Anim. Prod., 18: 101-107.

Oyawoye, E.O. and Ogunkunle, M. (1998). Physiological and biochemical effects of raw jack beans on broilers. Proceedings of annual Conference of Nigerian Society of Animal Production, 23: 141-142.

Oyeyemi, M. O., Ajala, O.O, Akusu, M.O and Agbesola, O.O. (1998). Effects of starvation on semen characteristics of WAD bucks. Proc. 1st Ann. Conf. ASAN. Sept. 22-24, Lagos, Nigeria Pp 128-130.

Oyeyemi, M.O. and Okediran, B.S. (2007). Testicular parameters and sperm morphology of chinchilla rabbits fed with different planes of soy meal. Int.J.Morphol. 25 (1):139-144.

Pana, C.I., D. Stoica, E.P. Dregotoiu, E.P. Midosanu and Stanescu, M. (2000). Influence of quantitative and qualitative feed restriction on sperm quality and fecundity of broiler breeder males. Abstr. 14th Int. Cong. Anim. Reprod., 1: 89-89.

Parigi-Bini, R. andXiccato,G. (1998). Energy metabolism and requirements. In: De Blas,C. and Wiseman,J.(eds). The nutrition of the rabbit. CABI Publishing, U.K., pp103.

Perry, G, and Petterson, D. (2001). Determining reproductive fertility in herd bulls. University of Missouri Agriculture publication 2011:1-8.

Peters, T., Biomonte, C.T., and Doumas, B.T. (1982). Protein (total protein) in serum, urine and cerebrospinal fluid, albumin in serum: In selected methods of clinical chemistry, volume 9.

Peters, S. O. , Adenowo, J. A., Ozoje, M. O., Ikeobi C. O. N., Adebanbo, O. A. and Akano, K. (2005). Sire strain on growth performance of pure breed and cross breed progenies of Nigerian local chickens. Proc. 1st Nig. Intl. Poult. Summit. (NIPS) Feb. 20-25, 2005. Ota Farm, Ogun State.

Peters, S. O., Shoyebo, O. D., llori, B. M., Ozoje, M. O., Ikeobi, C. O. N., and Adebambo, O. A. (2008). Semen quality traits of seven strain of chickens raised in the humid tropics. International Journal of Poultry Science, 7(10), 949-953.

Pinto, L. F. B., Packer, I. U., De Melo, C. M. R., Ledur, M. C and Coutinho, L. L. (2006). Principal components analysis applied to performance and carcass traits in the chicken. Animal Research 55: 419-425.

Pohle, K. and Cheng, H.W. (2009). Comparative effects of furnished and battery cages on egg production and physiological parameters in White Leghorn hens. Poult. Sci. 88: 2042-2051.

Post Graduate Committee in Veterinary Science (PGCV) (1990). Rabbits and rodents laboratory Animal Science. Proc. No. 142. PGCVs, University of Sydney, Australia.

Price, M. L. (1985). The Moringa Tree. ECHO Technical Note (revised 2000 by Kristin Davis). U.S.A.www.current protocols.com/protocol/mc01g02.Accessed on 12/04/2009.

Priyadarshani, N and Varma, M. C. (2014). Effect of Moringa oleifera leaf powder on sperm count, histology of testis and epididymis of hyperglycaemic mice Mus musculus. Am. Int. J. Res. Form. Appl. Nat. Sci. 7:07-13.

Pundir, R.K., Singh, P.K., Singh, K.P., Dangi, P.S. (2011). Factor analysis of biometric traits of Kankrej cows to explain body conformation. Asian Australas J Anim Sci. 2011; 24:449–456.

Ranjhan, S.K. (1999).Animal Nutrition and Feeding Practices, 5thedition. Vikas Pub. House PVT Ltd., New Delhi, India,pp 159-167.

Ranjhan, S.K. (2001). Animal Nutrition in the tropics, 6th Ed. Vikas Publishing House. PVT Ltd., New Delhi,pp. 209, 466.

Raphael, K. J., Keambou, T. C., Raquel, S. J., Frederico, L., Mfopou, Y.S. (2015). Effects of substituting soybean with MoringaOleifera meal in diets on laying and eggs quality characteristics of KABIR chickens. Journal of Animal Physiology and Animal Nutrition, 1:1-6

Reilly, J. S. (1993). Euthanasia of animals used for scientific purposes. ANZCCART, Glen Osmond. South Australia, 7(4).

Reinhold, J.G. (1953). *Standard methods of clinical chemistry*. M. Reiner. Ed. Volume 188. New York: Academic Press.

Rej, R. and Hoder, M. (1983). Aspartate transaminase. *Methods of enzymatic analysis.* 3rd Edn. H.U. Bergmeyer, J. Bergmeyer and M. Grassl. Eds. Weinheim: Verlag-Chemie. 3: 416-433.

Roberts K.M., Daryl, K. G., Peter, A. M., Victor, W. R. (2000). Mayer's Biochemistry, 25th edition, McGraw Hill, New York, 25: 763-765.

Richards, M.P, Poch, S.M, Coon, C.N., Rosebrough, R.W., Ashwell, C.M. and McMurtry, J.P. (2003): Feed Restriction Significantly Alters Lipogenic Gene Expression in Broiler Breeder Chickens. *J. Nutr.* March 1, 2003 vol. 133 no. 3 707-715

Rosencranz, R. and Bogen, S.A. (2006). Clinical Laboratory Measurement of Serum, Plasma, and Blood Viscosity. American Journal of Clinical Pathology 125

Rowett, H. G. Q. (1962). Histological and embryology. 2nd ed. John Murry (Pub.) Ltd., London. Pp 72

Sarwatt, S.V., Kapange, S.S. and Kakengi, A.M. (2002). Substituting sunflower seed cake with *Moringa oleifera* leaves as supplemental goat feed in Tanzania. Agro-forestry systems, 56: 241-247.

Sarwatt, S.V., Milang'ha, M.S., Lekule, F.P. and Madalla, N. (2004). *Moringa oleifera* and cotton seed cake as supplements for smallholder dairy cows fed Napier grass. Livestock research for rural development. Vol. 16 Art. # 38. http//www.cipac.org.co//Irrd16/6/sarw16038.htm Accessed on 01/02/2006

Sarwatt, S. V., S. S. Kapange and A. M. V. Kakengi. 2002. The effects on intake, digestibility and growth of goats when sunflower seed cake is replaced with Moringa oleifera leaves in supplements fed with *Chloris gayana* hay. *Agroforestry*, Kluwer Academic Publisher (In press).

SAS Institute Inc. (1999). *SAS/STAT. User's Guide. Version 8 for Windows*. Cary NC, USA: SAS Institute Inc.

Schalm, O.W., Jane, N.C. and Carol, E.J. (1975). Veterinary Haematology. 3rd Edition. Lea and Febiger, Philadelphia.

Scott, T. A., and Silversides, F.G. (2000). The effect of storage and strain of hen on egg quality. Poult. Sci. 79:1725–1729.

Selle, P.H, Cadoganb, D.J, Li, X. and Bryden, W.L. (2010). Implications of sorghum in broiler chicken nutrition. Animal Feed Science and Technology; 156:57- 74.

Sparks, N.H.C. (2006). The hen's egg: Is its role in human nutrition changing? World's Poult. Sci. J. 62: 308-315.

Sutherland JP, Folkard GK, Mtawali MA, Grant WD. 1994. *Moringa oleifera* as a natural coagulant. In: Pickford, *et al.* eds. Affordable Water Supply & Sanitation: Proceedings of the 20th WEDC Conference, Colombo, Sri Lanka, 22-26 August 1994. Intermediate Technology Publications, ISBN 0906055423, pp.297-299.

Siddhuraju, P. and Becker, K. (2003). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro-climatic origins of drumstick tree (*Moringa oleifera Lam.*) leaves. Journal of agricultural and food chemistry, 51: 2144-2155.

Stewart, M. (1991). Animal Physiology. The Open University, U.S.A., pp: 132-133.

Subadra, S. and Monica, J. (1997). Retention and storage stability of beta carotene in dehydrated drumstick leaves (*Moringa oleifera*). International Journal of food science and nutrition, 48(6): 373-379.

Tabatabaei, S., Batavani, R. A., & Talebi, A. R. (2009). Comparison of semen quality in indigenous and Ross broiler breeder roosters. Journal of Animal Veterinary Advances, 8, 90-93.

Tabatabaei, S., Chaji, M. and Mohammadabadi, T. (2010). Correlation between age of rooster and semen quality in Iranian indegenous broiler breeder chickens. Journal of Animal and Veterinary Advances, 9(1), 195-198.

Tambuwal, F.M., Agaie, B.M. and Bangana, B. (2002). Haematological and biochemical values of apparently healthy Red Sokoto goats. Proc. 22nd Ann. Conf. Nig. Soc. Animal Production (NSAP), March 17-21, 2002. Federal University of Technology, Akure, Nigeria,pp. 50-53.

Testerman, T.L., Imbertson, L.M., Reiter, M.J., Miller, R.L., Wagner, T.L. and Tomai, M.A. (1995). Cytokine induction by the immunomodulators imiquimod**.** J Leuk Biol, 58 (1995), pp. 365-372

Togun, V. A., Farinu, G. O. and Olabanji, R. O. (2006). Feeding Graded Levels of Wild Sunflower (Tithonia diversifolia Hemsl. A. Gray) Meal in Replacement of Maize at Pre-pubertal Age, Negatively Impacts on Growth and Morphormetric Characteristics of the Genitalia of Anak 2000 Broiler Cocks at Their Pubertal Age. World Appl. Sci. J., 1(2) :115-21.

Togun, V. A., Oseni, B. S. A., Ogundipe, J. A., Arewa, T. R., Hammed, A. A., Ajonijebu, D. C., Oyeniran, A., Nwosisi, I. and Mustapha, F. (2007). Effects of chronic lead administration on the haematological parameters of rabbit – a preliminary study. Proc. of the 41st Conf. of the Agric. Soc. of Nig., 341.

Toro, G. and Ackermann, P.G.[1975]. Practical clinical chemistry. Little, Brown and Company. Boston.

Udeh, I., Ugwu, S. O. C., and Ogagifo, N. L. (2011). Predicting semen traits of local and exotic cocks using linear body measurements. Asian Journal of Animal Science, 5(4), 268-276.

Vasanthakumar, P., Sharma, K., Sastry, V.R.B. and Kumar, R. (1999). Effect of graded levels of neem (*Azadirachta inidica*) seed kernel cake on carcass characteristics of broiler rabbits. Asian-Australasian Journal of Animal Science, 12: 1246-1250.

Voss, K.A., Platnner, R.D., Bacon, C.W. and Norred, W.P (1990). Comparative studies of hepatotoxicity and fumonisin and B2 content of water and chloroform/methanol extracts of Fusarium moniliforme strain MRC 826 culture material. Mycopathologia, 112: 81-92.

Win, B. and Jongen, F. (1996). Glucosinolates in b*rassica*: occurrence and significance as cancer-modulating agents. Proceedings of the Nutrition Society, New Delhi, India, 55: 433-446.

Yang, R.Y., Tsou, S.C.S., Lee, T.C., Chang, L.C., Kuo, G. and Lai, P.Y. (2006). Moringa a novel plant rich in antioxidants bio-available iron and nutrients. American chemical society symposium series, 925: 224-239.

Yahaya, H. K., Ibrahim, H. and Abdulsalam, S. (2012). Correlation between body weight and body conformation of two broiler strains under the same dietary treatment. International Journal of Animal and Veterinary Advances, 4(3): 181-183

Yakubu A, Kuje D and Okpeku M (2009). Principal components as measures of size and shape in Nigerian indigenous chickens. Thai Journal of Agricultural Science, 42(3): 167- 176.