NIGERIAN JOURNAL OF GENETICS

VOLUME 32, 2018

Published By The Genetics Society of Nigeria

EDITORIAL BOARD OF THE NIGERIAN JOURNAL OF GENETICS

Editor-In-Chief:
Prof. T. R. Fayeye
Department of Animal Production,
University of Ilorin.
+2348060395678
fayetiro@yahoo.com

Associate Editor:
Dr. Kennedy Omokhafe
National Rubber Research Institute,
Benin.

Business Manager:
Dr. O.F. Owolade
I.A.R. & T.,
Obafemi Awolowo University,
P.M.B. 5029,
Moor Plantation, Ibadan
ofowolade@softhome.net

EDITORIAL ADVISORY COUNCIL

Professor Kayode Adetugbo
(Medical Genetics)
Department of Chemical Pathology,
Hematology and Immunology
Obaafemi Awolowo University
Ile-Ife, Nigeria

Professor Omotoye Olorode
(Plant Genetics)
Department of Botany
Obafemi Awolowo University
Ile-Ife, Nigeria

Professor I. U. Obi
(Plant Breeding)
Department of Crop Science
University of Nigeria
Nsukka, Nigeria

Professor M.E. Aken 'Ova
(Plant Breeding)
Department of Agronomy
University of Ibadan
Ibadan, Nigeria

Professor N. I. Dim
(Animal Breeding)
Department of Animal Science
Ahmadu Bello University,
Samaru, Zaria, Nigeria

Professor (Mrs.) O.A. Adebambo
(Animal Breeding)
Department of Animal Breeding and
Genetics
University of Agriculture,
P.M.B. 2240, Abeokuta, Nigeria

Professor J. A. Adegoke
(Molecular Genetics)
Department of Zoology
Obafemi Awolowo University
Ile-Ife, Nigeria

HETEROSIS AND RECIPROCAL EFFECTS IN GROWTH TRAITS OF F_1 GENERATION CROSSES BETWEEN THE FULANI ECOTYPE CHICKENS AND HUBBARD BROILERS STRAIN

*Sola-Ojo, F. E., Ayorinde, K. L and Toye, A. A.
Department of Animal Production, University of Ilorin.
*Email: mofesola1@yahoo.com

Abstract: This study was designed to contribute to the genetic upgrading of the Fulani Ecotype (FE) a Nigerian local chicken through crossing with an exotic meat strain (Hubbard Broiler chickens). The heterotic and reciprocal effects of the crossing were observed in growth traits of the progenies of the Hubbard Broiler male and Fulani Ecotype female (HBxFE), and the Fulani Ecotype male and Hubbard Broiler Female (FExHB). The results show variations in heterosis from week 1 to 8. Heterosis for Bodyweight in crossbred produced with Hubbard broiler male was higher than in crossbreds from the female line from week 2 to 8. Weak and negative heterosis was obtained for morphometric traits measured from week 1 to 8. The Reciprocal Effects (RE) of Body Weight and morphometric measurements were low throughout the experimental period. Percentage heterosis obtained for weight gain and feed intake were positive and high for HBxFE (86.35 and 12.41, respectively), but low heterotic value was obtained for feed efficiency and viability (8.92 and 16.00). FE x HB had positive heterosis for feed intake and viability (89.25 and 7.60), and negative heterosis for weight gain and feed efficiency (-12.95 and -3.79). This study showed that the Hubbard broiler male crossed with Fulani Ecotype female (i.e. HB x FE) is the superior cross for upgrading growth traits, weight gain and viability, while the FE x HB cross is superior for improving feed efficiency over the Fulani Ecotype.

Keywords: Chicken, Exotic, Growth traits, Heterosis. Local, Performance

INTRODUCTION

The performance of village fowl in Africa is primarily affected by the poor management systems within which they are produced, as well as their relatively poor history of systematic genetic improvement relative to exotic chickens. Nevertheless, much variation has developed and is maintained as a result of random breeding within and sometimes between diverse populations (El Husadfi, 1990; Sonaiya *et al.*, 1992; Nimbkar *et al.*, 2008). According to the authors, such birds can be improved genetically through selective breeding or by crossing with exotic stock. The wide variation in performance of the local chicken indicates their potential for improvement through genetic selection, cross breeding or both.

Crossbreeding which is a tool for improvement and upgrading genetic potential of animals is the mating of two or more different breeds. It is mainly used for commercial production especially in countries where highly developed pure breeds are available and it is known to maintain heterosis which cannot be fixed by inbreeding techniques. The gradual replacement of local genes through crossbreeding and artificial selection has been the basis of initial genetic development in many countries (Omeje and Nwosu, 1984). In developing world, most genetic changes are taking place through change of breeds via cross breeding programme aimed at 'grading up' of indigenous breeds towards exotic from the developed world (Nimbkar *et al.*, 2008).

Introduction of high producing species of farm stock to the tropic and subtropical conditions is usually accompanied by performance degenerate due to lack of adaptability and resistance to tropical diseases (Ayorinde, 1990; Ibe, 1990). Also, grading up of nondescript livestock in developing countries has failed beyond a certain level of pure-bred inheritance due to the same reasons. Under such circumstances, crossbreeding of local breeds with improved exotic breeds can bring enough capacity for the animal to withstand the direct and indirect effects of unfavourable conditions. The native breeds of many species of livestock have very low genetic potential for production but they possess

qualities like adaptation to hot climatic conditions, resistance to many diseases prevalent in the tropical regions and general thriftiness under inferior feeding and management conditions (Akinnokun and Dettmers, 1976).

Nwosu and Asuquo (1984) opined that the local chicken can be developed into a broiler or meat type chicken. Crossing of the local chicken with Arbor Acre broilers have shown that crossbreeding of the local chicken with a broiler strain can significantly improve the meat performance of local chicken. Nwagu *et al.* (2001) showed that using the Arbor Acre cock and the local chicken hen was the preferred cross if a broiler strain is to be developed from the Nigerian local chicken.

The developmental breeding programs which introduce exotic males into villages as well as systematic breeding procedures used to establish synthetic breeds that are adapted to a specific environmental condition – as in India (Rao, 1983, Khan and Roy, 2003), have a sound basis. This is especially the case if higher productivity is to be combined with special genetically founded characteristics of local population such as body size, feathering type or pigmentation of skin and meat. Another genetic contribution of local strains can be seen in the provision of tropically relevant gene complexes for alternative breeding strategies. Since the fowl belongs to a well investigated species with over 250 known loci (Somes, 1990) fitting genes can also be directly identified in indigenous birds. Such major genes from local stocks can be easily integrated into appropriate breeding schemes, particularly those focused on the rural sector in developing countries.

Therefore, the Fulani Ecotype chicken which is an indigenous chicken characterized by low body weight and length of body parts (Sola-Ojo and Ayorinde, 2009) can be improved genetically through crossing with exotic stocks since the exotic breed are characterized by high productivity. It is therefore expedient to evaluate performance heterosis and reciprocal effects in progenies obtained from crossing of the Hubbard Broiler parent stock strain and the Fulani Ecotype chicken so as to have information on the performance of the resulting F_1 compared to the pure parent and to determine whether there is a benefit (growth performance) to using crosses in commercial production relative to inferior parent.

MATERIALS AND METHODS

Origin and Management of Parental Genotypes: One hundred and twenty five matured Hubbard broiler parent stock and ninety seven adult Fulani Ecotype chickens (produced from a flock at the Teaching and Research farm, University of Ilorin) were allowed to mate randomly at a ratio 8 females to 1 male in pure bred Hubbard group and 10 females to 1 male in other groups. Group A (HBxHB) consist of 10 Hubbard broiler males and 80 Hubbard broiler females; group B (HBxFE) 3 Fulani Ecotype chicken males and 30 Hubbard Broiler males, group C (FExHB) 5 Hubbard Broiler males and 50 Fulani Ecotype chicken females, and group D (FExFE) 4 Fulani Ecotype chicken males and 40 Fulani Ecotype chicken females.

Incubation and Hatching: Six hundred eggs were collected over a seven day period from the flocks and eggs were identified by group and stored in an aerated and ventilated room, after which they were taken to a commercial hatchery (Nefraday farm, Lasoju, Kwara State) for incubation and hatching. A total of 120 chicks from A, 80 chicks from group B, 60 chicks from group C and 65 chicks from group D were randomly selected for data collection per group.

Management of Experimental birds and Data collection: The chicks in each group (i.e. each genotype) were wing banded, weighed and randomly assigned to 4 pens such that each pen contained chicks of one genotype only. They were fed the same commercial broiler diet from day old to eight weeks of age. Vaccination and medication were administered (MVM, 1986). Measurement of body parts and body weight were done as described by Sola-Ojo and Ayorinde (2009).

Statistical Analysis: Heterosis (Specific) among the crossbred (HBxFE, FExHB) were estimated as the differences between the average parental genotype means (pure breed) and means of crossbred offspring as outlined by Falconer, (1989). It was calculated using the parental genotype F_1

...contemporaneously with the hybrid performance ...under the same environmental conditions.

$$\%\ DH = [(P_F) - (P_A+P_B)/2] \times 100] / (P_A+P_B)/2$$

Where

%DH is the directional heterosis (in percentage)

P_F is the mean performances of F_1

P_A is the mean performance of parental genotype A,

P_B is the mean performance of parental genotype B.

Reciprocal Effects were calculated as the differences between reciprocal F_1 performances. % RE= $[P_{F1}$ (HBxFE)–P_{F1} (FExHB) while % RE= $[P_{F1}$ (HBxFE) – P_{F1} (FExHB)] x 100/ $[P_{F1}$ (HBxFE) + P_{F1} (FExHB)]

Where:

RE = the reciprocal effect.

P_{F1}(HBxFE) = the mean performance of the F_1 from Hubbard male and FE hen

P_{F1}(FExHB) = the mean performance of the F_1 from FE male and Hubbard hen.

RESULTS AND DISCUSSION

Heterosis and Reciprocal Effects of Body weight, Body parts and Growth Performance in Crosses involving Hubbard Broiler and Fulani Ecotype Chicken

The percentage heterosis (Table 1) for body weight in HBxFE was higher than that of FExHB from week 2 to 8 while FExHB had higher heterotic value for body weight at week 1 only. Heterotic value in HBxFE was 80.89 percent higher compared to that of FExHB at week 5 and 0.8% higher at week 6. The percentage heterosis for body weight was highest in both genotypes at week 7 (Table 1), thus reflecting performance in the range between the mid parental value and superior parent at that age. The heterosis values showed that with respect to body weight performance, HBxFE crosses are superior to the reciprocal which was in turn superior to the inferior parent and the mid parent value at all weeks (Table 1). Indeed, with respect to body weight, the performances of both F_1 crosses were comparable to the mid-parent value and heterosis was moderate for HBxFE from weeks 1 to 8 and FExHB from weeks 6 to 7.

In 6 weeks out of the 8 weeks examined, both F1 crosses performed less well in body length (BL) than the mid-parent value as evident from their negative heterosis. In HBxFE, BL heterosis was negative at weeks 1, 2, 6, 7 and 8, while that of FEXHB was negative at weeks 1, 2, 3, 6, 7 and 8 (Table 1). For body girth, the percentage heterosis for HBxFE and FExHB were negative at weeks 1 and 2, and also negative at week 8 in HBxFE, (Table 1), other values obtained were positively low.

Heterosis for shank length (SL) ranged from -3.88 to 15.67 for the HBxFE and -22.97 to 15.45 for the FExHB from weeks 1 to week 8. Both F1 genotypes had the highest SL at week 3 and identical heterosis at week 5 (Table 2). The shank diameter (SD) heterotic values ranged from 2.91 to 29.32 in HBxFE and -6.67 to 15.22 in FExHB from week 1 to week 8. Both F1 genotypes had identical SD heterosis at weeks 5 and 8. Positive heterotic values were obtained for the drumstick length (DL) in HBxFE from week 1 to 8, while FExHB had negative heterosis at week 1 (-8.03) with the highest positive value of 21.26 at week 3 (Table 2). DL heterosis was identical in both F1 genotypes at week 3.

The heterotic values obtained for wing length of HBxFE ranged from -13.78 to 17.86 from week 1 to week 8, while the percentage heterosis for the FExHB ranged from -12.93 to 12.84 (Table 3). The heterosis value obtained for Thigh length (TL) were positive for both HBxFE and FExHB throughout the 8 weeks period, and it ranged from 3.99 to 21.18 in HBxFE, and 3.38 to 19.70. The keel length (KL) heterotic values were positive for HBxFE, ranging from 0.94 to 18.72 whereas, in FExHB negative heterotic values were obtained at week 1, 2 and 5, and positive values ranging from 2.80 to 16.12 at weeks 3,4, 6, 7 and 8 (Table 3).

The percentage heterosis obtained for weight gain and feed intake were positive and high (86.35 and 82.41) for HBxFE while those of feed efficiency and viability were low (Table 4). High and positive percentage heterosis (89.25) was obtained for feed intake of FExHB while low or negative heterosis (7.6, -12.95 and -3.79) values were obtained for viability, weight gain and feed efficiency, respectively in the same cross.

Across the nine traits examined at weeks 1 to 8, reciprocal effect (RE) values ranged from 0 to

13.12 percent. The *RS* value was zero for BG at week 6, SL at week 5, SD at week 1, 5, 6 and 8, DL at week 2 and 3, KL at week 3, and TL at week 6 (Table 5). Reciprocal effect of 44.19 percent was obtained for weight gain, 5.81 percent for feed efficiency while feed intake and visibility had values of 65.94 and 0.09 percent respectively as shown in Table 5. The reciprocal effects showed that HBxFE F1 genotype exhibited numerically superior performance over the reverse cross (FExHB) across all traits (Table 5).

These results indicate that the hybrids between Fulani Ecotype chicken and the Hubbard Broiler strain achieved an improved 8th week body weight over the inferior parent (Fulani Ecotype chicken) irrespective of the direction of crossing and indeed both F1 crosses performed better than the figure reported for another local breed (Nwagu, 1988). This should be relevant in the development of a meat line strain from the Nigeria local chicken.

Negative heterosis obtained for weight gain in FExHB is consistent with published literature showing that not all F1 crosses perform as well as the mid-parent (Verma and Chaudhary, 1980). This author observed body weight heterosis ranging from positive to negative values in 2, 3 and 4 way broiler crosses. The authors inferred that this is a usual pattern for body weight in broiler chickens and does not correspond to dominance or epistatic model. Positive heterosis obtained for HBxFE indicates that this genotype displayed better performance than the average of the parental types. The data showed that the HBxFE crosses were superior to the reverse (FExHB) for meat production. Positive heterosis in HBxFE cannot be explained by dominance or recessive action of autosomal genes, since they were F_1 hybrids, but may have been through sex chromosome-specific, mitochondrial origin specific or epi-genetic effects (Toye, 2013). Generally, the reciprocal effects of body weight and weight gain were poorer than the heterotic effects and this corresponds with the findings of Friars *et al.* (1992) that reciprocal effects are of low importance in crosses relative to meat strains. However, the low level of heterosis obtained for viability (7.6 and 16) is within the range of -9 to 24 % reported for heterosis for viability in poultry by Fairfull *et al.* (1987).

The result obtained agrees with the findings of Omeje and Nwosu (1984) where high heterosis of early body weight was observed for F1 offsprings of cross of local chicken with an exotic GL strain of chickens. The results of better body weight performance when Hubbard cocks were mated to the Fulani hens correspond with the findings of Nwagu *et al.* (2001), where exotic (Arbor Acres) cock vs. Local chicken hen was the preferred cross in the development of an indigenous broiler strain. The result of the heterosis of the F_1 in this study indicates that there is a cross direction-specific dominance effect of high growth determinant genes, specifically in the HBxFE group from week 2 to 8 while it was experienced in FExHB only at week 1. The dominance effects obtained in this study reflects that the phenotypic values of body weight in progenies at those ages were higher than those of mid parental genotype values and is likely to be from epistatic effect of sex chromosomes or mitochondrial on autosomes as reported by Toye (2013).

The lack of concordance of heterosis between the reciprocal crosses indicates that cross breeding with Hubbard will lead to an improvement in the body weight of the indigenous chicken irrespective of direction of crossing, and this will be an additional benefit to choosing the superior cross direction i.e male line in HB crossed to female line in FE. Low heterotic values obtained for the feed efficiency suggest co-dominance of the genetic determinants contributed by the local chickens on one hand, and the HB on the other hand, also the absence of major sex chromosome, mitonchondrial and epi-genetic effect as stated by Toye (2013).

The superior performance of hybrid over both parents yielding positive heterosis for body weight points to haplo-complementation of allele contributed by each parent at some loci. The reverse cross from age 2-8 weeks while yielding superior weight gain heterosis, yielded mildly inferior feed efficiency heterosis than the reverse crosses (FExHB). This study also indicated that the lack of concordance in bodyweight heterosis between reciprocal crosses of parents is likely due to sex chromosome, mitochondrial genetic inheritance or epi-genetic factors and not autosomonal gene dominance. The HB male crossing with the FE female (HBxFE) should be encouraged because it

...ovens that body weight was more under paternal ...influence resulting in improved body weight over ...ve FE indigenous chicken at all age points and ...yields superior BW compared to the reciprocal ...ross.

In conclusion, this study shows that reciprocal crosses revealed the extent; the direction of a cross will improve trait performance over that of the inferior parent, and the direction that will provide the better gain in performance over the inferior parent. In the present study, the body weight heterosis data favour HBxFE over FExHB, while feed efficiency heterosis data favour FExHB over HBxFE. The result of crossbreeding between Hubbard Broiler strain and the Fulani Ecotype chicken showed that the Hubbard Broiler male line and the Fulani Ecotype chicken female line are the preferred lines of F_1 crossing for an improved meat production.

Table 1. Percentage Heterosis of BW, BL and BG in Hubbard Broiler and Fulani Ecotype chicken crossbreds

Age	BW		BL		BG	
(weeks)	HBxFE	FExHB	HBxFE	FExHB	HBxFE	FExHB
1	4.18	4.88	-4.99	-13.99	-9.09	-12.29
2	9.50	8.82	-6.27	-14.50	-0.18	-1.74
3	40.20	38.60	4.68	-8.41	20.05	14.51
4	44.34	25.09	1.91	2.97	14.03	12.04
5	45.84	25.34	2.67	1.29	16.64	13.91
6	43.98	43.63	-4.25	-5.28	14.20	14.20
7	50.91	47.13	-5.07	-9.21	17.91	10.92
8	43.53	38.27	-3.24	-2.99	-9.01	29.96

HBxFE = Hubbard Broiler Male and Fulani Ecotype chicken Female
FExHB= Fulani Ecotype chicken Male and Hubbard Broiler Female
BW= Body weight; BL= Body length; BG= Body girth.

Table 2. Percentage Heterosis of SL, SD and DL in Hubbard Broiler and Fulani Ecotype chicken crossbreds

Age	SL		SD		DL	
(weeks)	HBxFE	FExHB	HBxFE	FExHB	HBxFE	FExHB
1	-3.88	-6.63	4.44	-6.67	14.70	-8.03
2	-10.59	-22.97	2.91	0.97	15.14	15.14
3	15.67	15.45	29.32	-0.75	21.26	21.26
4	13.81	12.36	12.82	5.13	15.56	14.52
5	13.89	13.89	15.22	15.22	18.49	14.08
6	1.30	-0.16	6.53	6.53	16.66	16.44
7	12.90	11.68	7.62	5.71	20.22	17.18
8	13.88	6.87	13.91	13.91	15.09	14.99

HBxFE = Hubbard Broiler Male and Fulani Ecotype Chicken Female
FExHB= Fulani Ecotype chicken Male and Hubbard Broiler Female
SL =Shank length: SD= Shank diameter; DL = Drumstick length.

crossbreds

Age (weeks)	WL		TL		KL	
	HBxFE	FExHB	HBxFE	FExHB	HBxFE	FExHB
1	-13.78	-12.93	10.41	8.60	8.70	-3.84
2	-12.78	-7.24	5.56	5.28	0.94	-1.65
3	-5.58	12.84	21.18	19.70	16.12	16.12
4	17.86	5.48	3.99	3.38	2.98	2.80
5	11.00	7.69	14.73	14.54	1.99	-0.95
6	3.88	3.72	14.29	14.29	16.90	15.65
7	6.38	-2.08	16.44	12.30	18.72	14.61
8	11.47	5.11	11.83	11.57	13.82	13.70

HBxFE = Hubbard Broiler Male and Fulani Ecotype chicken Female
FExHB= Fulani Ecotype chicken Male and Hubbard Broiler Female
WL= Wing length; TL = Thigh length; KL = Keel length.

Table 4: Heterosis and Reciprocal Effect of Growth and Performance Traits in the Hubbard Broiler and Fulani Ecotype crossbreds

Parameters	Heterosis		RE
	HBxFE	FExHB	
Weight gained	86.35	-12.95	44.19
Feed Intake	82.41	89.25	65.94
Feed Efficiency	8.92	-3.79	5.81
Viability	16.00	7.60	0.09

HBXFE = Hubbard Broiler Male and Fulani Ecotype chicken Female
FEXHB =Fulani Ecotype Male and Hubbard Broiler Female
RE = Reciprocal Effect.

Table 5: Reciprocal Effect of Crossing Hubbard Broiler and the Fulani Ecotype chicken

Age weeks	Traits								
	BW	BL	BG	SL	SD	DL	WL	KL	TL
1	0.68	0.27	3.58	7.98	0.00	22.0	0.18	12.23	1.65
2	0.62	2.31	1.57	14.88	1.90	0.00	1.77	2.60	0.27
3	1.15	1.64	4.73	0.19	26.32	0.00	4.11	0.00	1.23
4	14.28	0.61	1.77	1.29	7.06	0.91	2.23	0.18	0.59
5	15.12	1.44	2.31	0.00	0.00	3.79	3.03	2.93	0.17
6	0.24	1.09	0.00	1.45	0.00	0.19	0.15	1.08	0.00
7	2.54	4.46	6.11	12.57	1.79	2.56	8.28	3.53	3.63
8	3.73	0.26	13.0	0.00	0.00	0.08	5.87	0.11	0.24

BW = Body weight, BL=Body length, BG= Body girth, WL= Wing length, DL= Drumstick length, KL=Keel length, TL =Thigh length SL= Shank length SD= Shank diameter.

REFERENCES

Akinnokun, O. and Dettmers, A. (1976). Genotype and Environment Interactions in an exotic commercial egg strain and the local chicken of Nigeria. *Ife Journal of Agric.*, 1: 57-62.

Ayorinde, K.L. (1990). Problems and prospects of guinea fowl production in the rural of Nigeria. *In Rural Poultry in Africa Sonaiya E.B, Ed :106-115.*

El Houadfi, M. (1990). *Rapport sur la production Avicole et probleme liels aux Elevages Traditionnels au Maroc.* Proc. CTA International Seminar on small holder Rural Poultry Production. Thessaloniki, Greece, Oct. 9- 13. 2: 161- 172.

Fairfull, R.W., Gowe, R.S. and Nagal, J. (1987). Dominance and epistasis in heterosis of White Leghorn strain crosses. *Canadian Journal of Animal Sci.*, 67: 663-680.

(1992). Time trends in estimates of genetic parameters in a population of Chicken subjected to multiple objective selections. *Poultry Science*, 41: 1773- 1784.

S.N (1990). Increasing rural poultry production by improving the genetic endowment of rural poultry. *In workshop in Rural Poultry Development in Africa. OAU, Ile-Ife, Nigeria, pp 78-81.*

Khan, M.R and Roy , P.C. (2003). Credit policy, disbursement and its impact on poultry industry in Bangladesh, Proc. 3rd International Poultry Show and Seminar Dhaka, Bangladesh. Worlds Poultry Science Association, Bangladesh Branch: 43 -51.

M.M, (1986). The Merck Veterinary Manual. 6 Edn. York. Merck and Co., INC. Rahway, N.J., USA: 1-19.

Kinkkar, C., Gibson, J., Okeyo, M., Boettene, P. and Soelknor, J. (2008). Sustainable use and genetic Improvement. *Animal Genetic Resources Information*, 42: 49 – 69.

Iwagu, B.I. (1988). Heterosis of Biometrical characteristics in crosses between Arbor Acre Broilers and local chickens of Nigeria. *MSc. Thesis, University of Nigeria, Nsukka, Nigeria.*

Iwagu, B.I., Nwosu, C.C., Abubakar, B.Y., Oni O.O. and Adeyinka, I.A. (2001). Productive Performance of F_1 Crosses between Arbor Acre Broilers and Local Chickens. *Nigeria Journal of Animal Production*, 17 (1 & 2): 66-77.

body weight in the chicken. *In proceedings of the 9th Annual Conf. of NSAP, Nsukka, Nigeria: 41-49.*

Omeje, S.S.I. and Nwosu, C.C. (1984). Heterosis and superiority in body weight and feed efficiency evaluation of exotic parent stock by local chicken F_1 Crossbreds. *Nig. Journal of Genetics*, 5: 11- 26.

Rao, G.V. (1983). Improved dessi birds for poultry farming in tribal areas. *Indian Farming*, 33: 36-38.

Sola-Ojo, F.E. and Ayorinde, K.L. (2009). The Fulani Ecotype Chicken: Growth and Feed Utilization Potentials. *World Journal of Applied Science and Technology*, 1: 37-44.

Somes, R. G. (1990). Mutations and major variants of plumage and skin in chickens. (Crawford R.D., Ed.). *Poultry Breeding and Genetics*: 169-208.

Sonaiya, E. B, Laogun, E.A., Matanmi, O., Daniyan, O. C., Akande, B.E., Oguntade, E. A., Omisebi, R. O. and Olori, V. E. (1992). Health and husbandry aspects of Village extensive poultry production in south western Nigeria. *In Proc. of an International Workshop on village Poultry in Africa (Pandey, W.S and Demey F., Eds). Rabat, Morroco: 34- 41.*

Toye, A.A. (2013). Systematic Elucidation of the role Nuclear genes in mitochondrial health and disease. Published by Omega Initiative, Causal Genetics LTD. UK.

Verma, S.K. and Chaudhary, R.P. (1980). Note on the influence of two-three-and four-way crosses on growth for broiler production. *Indian Journal of Animal Science*, 50: 213-214.