Nig. J. Pure & Appl. Sci. Vol. 19 (2004): 1602 – 1609 0794-0378
Printed in Nigeria ©2004 Faculty of Science Univ. of Ilorin, Nigeria.

BIOCHEMICAL ASSESSMENT OF THE NUTRITIONAL QUALITY OF CORN BASED TRADITIONAL SNACKS "AADUN" AND "MASA" FORTIFIED WITH SOYABEANS

O. B. Oloyede and * F. T. Kolawole
Department of Biochemistry, University of Ilorin, Ilorin, Nigeria.

ABSTRACT: The nutritional quality of corn based traditional snacks "Aadun" and "Masa" fortified with soyabeans was assessed. Three different combinations of each snack were made viz 100% corn; 75% corn: 25% soyabeans and 50% corn: 50% soyabeans. The protein content and ether extract of 50% corn: 50% soyabeans "aadun" and "masa" were significantly higher ($P>0.05$) than that of the 100% corn and 75% corn: 25% soyabeans combinations. A total of thirty (30) weanling rats grouped into six (6) of five (5) rats each were used in a 14-day feeding trial to determine the quality of protein in the two snacks. Groups 1 to 3 were placed on 100% corn, 75% corn: 25% soyabeans and 50% corn: 50% soyabeans "aadun" respectively while groups 4 to 6 were placed on the same combinations of corn and soyabeans for "masa" preparation. Although food intake and consequently protein intake were significantly lower ($P<0.05$) in rats placed on 50% corn: 50% soyabeans "aadun" than the other two groups, the biological value (BV), true digestibility (TD) and protein efficiency ratio (PER) were generally significantly ($p>0.05$) higher in the fortified "aadun" snack. In the "masa" group however, protein intake increased significantly ($P>0.05$) with increase in fortification which consequently led to increase in weight gain when compared with 100% corn "masa" group. Also the BV, TD and PER increased significantly ($P>0.05$) in the fortified "masa" snack. Overall, the fortification of the two corn based traditional snacks with soyabeans increased the nutritional quality of the snacks and the best result manifested in the 50% corn: 50% soyabeans "aadun" and "masa".

INTRODUCTION

The term "Snack" or "Snack food" can be basically defined as an easy to handle, miniature-portioned, hot or cold products in solid or liquid form which need little or no preparation and are intended to satisfy the occasional "pangs" of hunger (Staffer, 1983). In general, snack foods are considered as "junk foods" or empty calories". Therefore, the role of the snack foods is to offer a light, convenient and enjoyable food option when, for reasons of hunger or sociability, a food selection is required at a time between that allotted for the principal meals. Thus, snack foods are not designated to be alternatives for the three main meals a day (Morgan, 1983). They are convenient to eat, involving no preparation time or effort by the consumer. Snacks are eaten not only to satisfy hunger or to supply the nutrients to our body, but also for social reasons.

On many occasions, the inclusion of snack foods in our diet is not justified in terms of nutritional demands (Delroy, 1985). Another aspect of concern is the energy contents of snack foods. It is generally believed that snack foods are both rich in energy and fat since they are cooked in or blended with oil. The technology for the production of fat-reduced potato chips for example does not exist, but the level of fat can be controlled by careful regulation of the cooking parameters considering the fact that oil is essential in cereal snacks to give an acceptable mouth-feel. However, the only way to control the energy consumption via snack foods is to reduce the size of serving.

In order to counter the belief of consumers and nutritionists that snack foods are "empty calories", a number of manufacturers of snack foods have started the development of products supplemented with vitamins, minerals or proteins (Gould, 1985). Protein supplementation is of paramount interest since most snacks are poor sources of protein and in most cases the protein which is present is often of poor nutritional quality. Protein supplementation is possible either by increasing the protein efficiency ratio of the protein already present, or increasing the total amounts of protein present by adding some purified nitrogenous material such as casein, soya protein or egg white (Tettweiller, 1991). Untreated corn is a staple food worldwide and there is a need to develop more nutritious, corn based snack foods. Certain combination of cereals and legumes are very desirable from a nutritional point of view. Legumes are better sources of lysine and total protein than cereals and the latter are superior sources of sulphur amino acids (Tettweiller, 1991).

*Present Address: Department of Catering and Hotel Management, Kwara Polytechnic, Ilorin, Kwara State.

Substantial efforts have been made to reduce the "snacking habit" of various populations, but snack foods consumption continues to increase. Snack foods are generally preferred by children and teenagers. In these stages of life, the amount and nutritional quality of protein are important because of their essential function in physical and mental development. Consequently, there is a need to increase the production of more nutritious snacks, including those made from corn.

'Aadun' and 'Masa' are examples of corn-based snacks widely consumed in Nigeria. "Aadun" is prepared by dry-milling whole dry maize while "masa" is prepared by wet milling of whole maize. "Aadun" is mostly consumed among the Yorubas who live mainly in the South-western part of Nigeria while the consumption of "masa" extends to the Northern part of Nigeria. In the present study, attempt is made to report on the nutritional quality of these two corn-based traditional snack foods namely "Aadun" and "Masa" which are fortified with soyabeans.

MATERIALS AND METHODS

Chemicals and Reagents

The chemicals and reagents used in this study were of analytical grades.

Source of Materials

The maize and soyabean grains employed in this study as well as other ingredients namely pepper, salt, sugar, palm oil, baking powder and groundnut oil were purchased at Ipata Market, Ilorin, Nigeria. The maize and soyabean grains were first handpicked to remove the grits and dirts before being used for the production of the corn based snacks.

Production of "Aadun"

The cleaned corn (1kg) was subjected to roasting before it was dry milled using a grinder. This was followed by the addition of 50g each of dry pepper and salt as well as 200ml of hot palm oil. The resulting paste was mixed thoroughly until a good blend was obtained and then wrapped in leaves (Figure 1). The resulting "aadun" is regarded to be 100% corn "aadun". The corn was then fortified with soyabean powder to make 75% corn: 25% soyabean "aadun" (750g corn and 250g soyabean) and 50% corn: 50% soyabean "aadun" (500g corn and 500g soyabean). The soyabean grains employed in the fortification of "aadun" was also subjected to roasting until a light brown colour was obtained. It was allowed to cool in open air before it was dry milled using a grinder to obtain soyabean flour which was used in the various combinations.

Corn grains
↓
Cleaning (handpicking of grits, dirts and stones)
↓
Roasting
↓
Dry-milling of corn
↓
Corn flour
↓
Fortification with soyabean flour (for fortified diets)
↓
Addition of other ingredients (dry pepper, salt and hot palm oil)
↓
Mixing to obtain a uniform blend.
↓
"Aadun" (wrapped in leaves or nylon.)

Figure 1: Flowchart for the production of "aadun"

Production of "Masa"

The cleaned corn (1kg) was washed thoroughly and then soaked for 24hours with the water being changed every 6 hours. At the expiration of 24 hours, the corn was wet milled into a paste using a grinder followed by the addition of 50g each of salt and sugar as well as 10g of baking powder. The resulting paste was mixed thoroughly to obtain a good blend and then fried with groundnut oil until a golden brown colour was obtained (Figure 2). The resulting "masa" is said to be 100% corn "masa". The corn was then fortified with soyabean paste to make 75% corn: 25% soyabean "masa" (750g corn and 250g soyabeans) and 50% corn:50% soyabean "masa" (500g corn and 500g soyabeans). In like manner, the soyabean seeds used for fortification of "masa" was soaked in water for 24 hours after which they were washed and wet milled to make a paste before being utilized in the various combinations for the fortification of the formulated "masa". The proximate analyses of the formulated snacks were then carried out using standard methods (AOAC, 1990). The carbohydrate content was obtained by difference (Jacobs, 1956).

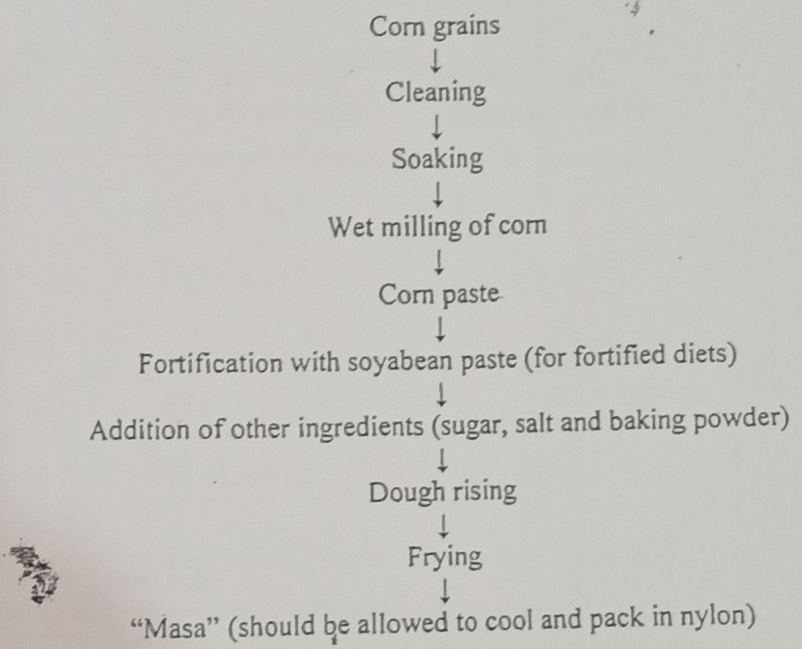


Figure 2: Flowchart for the production of "masa"

Feeding Experiment

A total of thirty albino rats (*Rattus novergicus*) with an average weight of 30.05 ± 1.26 were used in the study. The animals were grouped into six of five rats each as follows:

Group 1: Rats placed on 100% corn "aadun" daily
Group 2: Rats placed on 75% corn: 25% soyabean "aadun" daily
Group 3: Rats placed on 50% corn: 50% soyabean "aadun" daily
Group 4: Rats placed on 100% corn "masa" daily
Group 5: Rats placed on 75% corn: 25% soyabean "masa" daily
Group 6: Rats placed on 50% corn: 50% soyabean "masa" daily

All the rats were housed in metabolic cages and fed daily with known weights of their diets and volumes of water for a period of 14 days which was preceded by 5 days of acclimatization. The initial and final body weights of the experimental animals were taken. Urine and faeces were collected daily for 14 days during which the experiment lasted for the purpose of evaluating the protein quality of the formulated snacks (AOAC, 1990).

RESULTS AND DISCUSSION

The proximate analysis of "aadun" made from 100% corn and its combination with soyabeans (75% corn: 25% soyabean and 50% corn: 50% soyabean) is shown in Table 1. There is no significant difference ($p<0.05$) in moisture contents of the three corn based "aadun". However, there is a significant difference ($p<0.05$) in the ash contents of these three snacks. The combination of 50% corn and 50% soyabean "masa" demonstrated a two – fold increase in ash content compared with that of 100% corn "masa". This is supported by the work of Herog *et al* (1994) which revealed that the ash content of soyabeans is higher than that of corn. It may be inferred therefore that "aadun" prepared from 50% corn: 50% soyabeans may contain more mineral elements than that of 100% corn.

Table 1: Proximate composition of "aadun" prepared from different proportions of corn and soyabean.

Nutrient (%)	100% Corn "aadun"	75% Corn: 25% Soyabean "aadun"	50% Corn: 50% Soyabean "aadun"
Apparent Moisture	7.85 ± 0.11^{a}	9.24 ± 0.34^{a}	6.91 ± 0.13^{a}
Ash	1.20 ± 0.09^{a}	1.92 ± 0.13^{b}	2.42 ± 0.14^{c}
Protein	5.313 ± 0.23^{a}	7.66 ± 0.28^{b}	10.63 ± 0.31^{c}
Fat	46.42 ± 1.04^{a}	62.67 ± 0.40^{b}	69.06 ± 1.12^{c}
Carbohydrate (by difference)	39.22 ± 1.03^{a}	18.51 ± 0.62^{b}	5.98 ± 0.03^{c}

Each value is a mean of three determinations ± SEM.
a, b, c ... Row values with the same superscript are not significantly different ($p< 0.05$)

Of all the combinations, the 50% corn: 50% soyabean "aadun" demonstrated the highest crude protein content. Indeed, this is about one and a half fold the protein level in "aadun" from 75% corn and 25% soyabean. This may be attributed to the high soyabean content which is a known protein diet. Soyabean occupies a premier position as a world crop because of its high protein and edible oil content as well as its high nutritional value (FOS/FAO, 1965). The fortification of "aadun" with soyabean at the level of 50% as it is in the present study may go a long way in improving the nutritional quality of "aadun" as snacks. 50% corn: 50% soyabean "aadun" contained as much as 69% oil. This may be due to the two different types of oil used in its preparation. The same reason can be adduced to the high percentage of fat in the diet containing 75% corn: 25% soyabean when compared with 100% corn "aadun".

The proximate analysis of "masa" (100% corn) and its combination with soyabean 75% corn: 25% soyabean and 50% corn: 50% soyabean are as presented in Table 2. The percentage apparent moisture content in the three formulated snacks is not significantly different ($p<0.05$) from one another. However, this is not true for the ash content with the 50% corn: 50% soyabean combination, having the highest ash content. This is supported by the work of Herog *et al* (1994) on the proximate composition of corn and soyabeans. In the same trend, the protein content is significantly higher ($p>0.05$) in the snack containing the combination of 50% corn: 50% soyabean than that of 100% corn snack. Indeed the protein level was found to be about three and a half fold that of the protein from 100% corn "masa". The high protein content as observed in these corn based snacks may also lead to an increase in the content of essential amino acids since an earlier report indicates that soyabean is rich in essential amino acids (Morgan, 1983). The essential amino acids present in a protein, is in part a reflection of its nutritive characteristics (Morgan, 1983). The evidence from the present study indicates that fortification of "masa" with soyabeans improved the nutritional quality of "masa" (Gomez *et al*, 1987).

The consumption of the snack as revealed in this study may assist to take care of diseases relating to protein deficiency like protein energy malnutrition (PEM) which characterizes the children.

Table 2: Proximate composition of "masa" prepared from different proportions of corn and soyabean

Nutrient (%)	100% Corn "Masa"	75% Corn: 25% Soyabean "Masa"	50% Corn: 50% Soyabean "Masa"
Apparent Moisture	1.47 ± 0.21^{a}	1.62 ± 0.12^{a}	1.20 ± 0.28^{a}
Ash	0.82 ± 0.07^{a}	1.45 ± 0.10^{b}	2.04 ± 0.09^{c}
Protein	5.69 ± 0.18^{a}	10.70 ± 0.21^{b}	20.94 ± 0.08^{c}
Fat	11.22 ± 0.52^{a}	33.16 ± 0.38^{b}	41.28 ± 0.77^{c}
Carbohydrate (by difference)	80.80 ± 1.10^{a}	53.07 ± 1.19^{b}	34.54 ± 0.77^{c}

Each value is a mean of three determinations ± SEM.
a, b, c, ... Row values with the same superscript are not significantly different ($p < 0.05$).

The fat content of 41.28% was recorded in the snack containing the combination of 50% corn and 50% soyabean. The level of the oil recorded emanated from the oil in the corn, soyabean and the groundnut used for frying. Additionally, fat contents from 100% corn "masa" and combination of 75% corn: 25% soyabean "masa" were found to be significantly different ($p<0.05$) from each other. The values however being lower than that of the oil from the 50% corn: 50% soyabean "masa". The present study therefore indicates a significant improvement in quality of the oil of "masa" as a result of the combination of 50% corn and 50% soyabean oil. Corn oil and soyabean oil are known to be very rich in essential fatty acids (Staffer, 1983). Therefore the fortification of corn with soyabean would not only improve the quantity of the oil but also the quality. Essential fatty acids play very significant role in mental development (Dobbling and Sand, 1971) and hence the snack would be very beneficial health wise to the children of school age. It may therefore be necessary to cross check the levels of the essential fatty acids in these snacks in future studies.

Table 3 shows the protein quality indices of "aadun" prepared from different proportions of corn and soyabean. "Aadun" from both 75% corn: 25% soyabean and 50% corn: 50% soyabean exhibited no significant difference ($p<0.05$) in their biological values but were significantly higher than that of 100% corn "aadun". It is viewed that the fortification of maize with soyabean for the purpose of producing "aadun" provided more nitrogen for utilization and body growth than the maize alone. This is, however, despite the significant decrease in food intake by the rats placed on the 50% corn: 50% soyabean "aadun" compared to the other rats. It is very likely that the rats may not be well disposed to the snack possibly because of the oil. This needs to be investigated in future studies.

The protein intake by rats placed on 75% corn: 25% soyabean "aadun" and 50% corn: 50% soyabean "aadun" were not significantly different ($p<0.05$) but were significantly lower than the value obtained for 100% corn "aadun". The loss in weight experienced by rats placed on 50% corn: 50% soyabean "aadun" is a reflection of the significant decrease ($p<0.05$) in the food intake by rats in this group. This in turn reduced the protein intake. However, a significant increase in true digestibility value (93.48%) was obtained for the 50% corn: 50% soyabean "aadun" when compared with the other two formulated diets and as expected, the PER for rats in this group was also significantly higher ($p<0.05$). This is an indication that the little food consumed was well digested (Bodwell *et al*, 1980) and the protein content

therein was efficiently utilized. However, the PER values for 100% corn and 75% corn: 25% soyabean "aadun" were significantly lower ($p<0.05$) than the value obtained for 50% corn: 50% soyabean. Indeed the PER value for the latter was found to be about five fold that of 100% corn "aadun". It is observed that even though, rats in the other groups consumed more food, the digestibility was low and this probably accounts for the low PER. However, the appreciation in weight may be partly due to the lower faecal and urinary nitrogen. This implies that more nitrogen is being retained for body utilization rather than being lost in the urine and faeces as is the case with rats placed on 50% corn: 50% soyabean "aadun". It was also observed that the weight gained per gram by the rats placed on 100% corn "aadun" and 75% corn: 25% soyabean "aadun" was more than the rats placed on 50% corn: 50% soyabean "aadun". This may be due to the increas in weight of the rats placed on the former snack which in turn is due to the quantity of food consumed. Nevertheless, the PER value of the three corn based snacks were higher than 0.95% previously reported by Ayatse *et al* (1983) for roasted corn.

Table 3: Protein quality indices of "aadun" prepared from different proportions of corn and soyabean

Parameters	100% Corn "aadun"	75% Corn: 25% Soyabean "aadun"	50% Corn: 50% Soyabean "aadun"
Number of rats	5	5	5
Weight gain/loss	+ 7.50 ± 0.98	+ 5.80 ± 0.92	-8.80 ± 0.58
Food intake (g)	18.61 ± 0.95 [a]	14.15 ± 2.17 [a]	7.11 ± 1.10 [b]
Protein intake (g)	7.52 ± 0.59 [a]	2.48 ± 0.99 [b]	1.79 ± 0.66 [b]
Faecal nitrogen (g)	0.24 ± 0.05 [a]	0.48 ± 0.02 [b]	0.49 ± 0.01 [b]
Urinary nitrogen (g)	0.16 ± 0.02 [a]	0.52 ± 0.05 [b]	0.89 ± 0.04 [c]
Biological value (%)	74.00 ± 2.62 [a]	81.61 ± 2.08 [b]	87.33 ± 4.78 [b]
True digestibility (%)	78.38 ± 2.62 [a]	80.65 ± 1.81 [a]	93.48 ± 2.38 [b]
Protein Eff. Ratio (%)	1.00 ± 0.15 [a]	2.34 ± 0.21 [b]	4.92 ± 0.92 [c]

Each value is a mean of three determinations ± SEM.
a, b, c, ... Row values with the same superscript are not significantly different ($p<0.05$)

The faecal nitrogen values of rats placed on 75% corn: 25% soyabean "aadun" and 50% corn: 50% soyabean "aadun" were not significantly different ($p<0.05$) but were significantly higher than the value obtained for the rats placed on 100% corn "aadun" during the 14 days feeding periods. Faecal nitrogen comes from undigested or incompletely digested food. Also, large amounts of faecal nitrogen may come from shed epithelial cells. Less than 10% of the dietary proteins usually appear in faeces. The low faecal nitrogen obtained in rats placed on 100% corn "aadun" probably gave rise to the increased weight gain experienced by rats in this group. The same reason can also be adduced to urinary nitrogen values which were observed to be significantly higher in rats placed on 75% corn: 25% soyabean "aadun" (0.52 ± 0.05) and 50% corn: 50% soyabean "aadun" (0.89 ± 0.04) when compared with the value obtained for rats placed on 100% corn "aadun" (0.16 ± 0.02). The principal source of urinary nitrogen is from absorbed protein which has not been rapidly incorporated into the body. This may be

partly responsible for the marked weight loss experienced in rats placed on 50% corn: 50% soyabean "aadun" at the end of the 14 days feeding period.

Some protein quality indices of "masa", a corn-based formulated diet, are presented in Table 4. Although the daily feed intake by the three groups of rats is not significantly different ($p<0.05$), the weight gain observed at the end of the experimental period was significantly different ($p<0.05$) with the rats placed on 50% corn: 50% soyabean "masa" experiencing the greatest weight gain. This may be attributed to the high protein content in their diet when compared to the other two formulated diets (i.e. 100% corn "masa" and 75% corn: 25% soyabean "masa"). Other reasons for the significant reduction ($p<0.05$) in weight in rats placed on 100% corn "masa" and 75% corn: 25% soyabean "masa" could be linked with the high nitrogen content in the faeces and urine as revealed by the high faecal and urinary nitrogen values. This implies that more nitrogen is being lost in faeces and urine rather than being utilized for essential body functions which will ultimately result in growth as is the case with rats placed on 50% corn: 50% soyabean "masa".

Table 4: Protein quality indices of "masa" prepared from different proportions of corn and soyabean

Parameters	100% Corn "masa"	75% Corn: 25% Soyabean "masa"	50% Corn: 50% Soyabean "masa"
Number of rats	5	5	5
Weight gain (g)	14.04 ± 1.85^{a}	19.62 ± 1.63^{b}	23.56 ± 1.51^{c}
Food intake (g)	17.68 ± 2.90^{a}	17.72 ± 2.05^{a}	19.35 ± 2.00^{a}
Protein intake (g)	3.32 ± 0.26^{a}	3.98 ± 0.06^{b}	4.20 ± 0.13^{c}
Faecal nitrogen (g)	0.39 ± 0.05^{a}	0.11 ± 0.02^{b}	0.05 ± 0.001^{c}
Urinary nitrogen (g)	0.78 ± 0.04^{a}	0.08 ± 0.01^{b}	0.03 ± 0.001^{c}
Biological value (%)	78.56 ± 1.53^{a}	88.77 ± 1.87^{b}	92.21 ± 1.98^{b}
True digestibility (%)	71.24 ± 2.66^{a}	82.16 ± 1.86^{b}	94.77 ± 1.89^{c}
Prot. Eff. Ratio (%)	4.23 ± 0.25^{a}	4.93 ± 0.26^{b}	5.53 ± 0.42^{c}

Each value is a mean of three determinations ± SEM
a, b, c ... Row values with the same superscript are not significantly different ($p<0.05$).

As is the case with "aadun", "masa" also provided more nitrogen for body utilization and growth than raw maize. This is reflected by the high biological value obtained from the three formulated diets which is higher than 57% for maize. However, the biological value obtained for 100% corn "masa" is significantly lower ($p<0.05$) when compared to the other two diets and this lent further credence to the significantly lower ($p<0.05$) weight gain observed in rats placed on this diet. Furthermore, the true digestibility and PER values (71.24% and 4.23% respectively) observed in 100% corn "masa" are significantly lower ($p<0.05$) in comparison to the other two formulated diets. This shows that rats placed on 50% corn: 50% soyabean "masa" are able to digest the food better accounting for the significantly higher ($p<0.05$) PER. The high PER obtained in this group indicates effective use of the proteins obtained from soyabean which is properly digested and utilized.

CONCLUSION

The results of this study have provided information on the nutrient composition of corn based traditional snacks and the effects of fortification with soyabeans on their quality. It can be concluded:

1. That "aadun" and "masa" prepared from 100% corn are relatively low in protein.

2. That fortification of these snacks with soyabeans improved the quantity being 10.63% and 20.94% in "aadun" and "masa" respectively as well as the quality of proteins as reflected by biological value (BV) and protein efficiency ratio (PER).

3. That fortified snacks can also be good and quality sources of protein and fats contrary to their status as "junks" or empty calories. It may be of great importance in the diets of children since they are the main consumers of snacks.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the assistance of Messers T. O. Sunmonu and O. Adeyemi of Department of Biochemistry, University of Ilorin, Ilorin, Nigeria.

REFERENCES

A.O.A.C. (1990) Official Methods of Analysis. 15th edn. Association of Official Analytical Chemists, Washington, D.C., U.S.A.

Ayatse, J.O., Eka, O. U. and Ifon, E. T. (1983). Chemical evaluation of the effect of roasting on the nutritive value of maize (Zeamays Linn). Food Chem. 12: 135 – 147.

Bodwell, C. E., Sattterlee, E. D. and Hackler, E. R. (1980). Protein digestibility of the same protein preparation by human and rats assays and *in vitro* enzymic digestion methods. Amer. J. Clin. Nutr. 33: 677 – 686.

Delroy, B. (1985). The role of snack foods. Food Technology in Australia. 37 (4): 154 – 158.

Dobbling, J. and Sands, J. (1971). Vulnerability of developing brain IX, the effect of nutritional growth retardation on the timing of the brain spurt. Biol. Neonates 19: 363 – 378.

FOS/FAO (1965). Energy and Protein Requirements. Recommendation by joint FAO/WHO informed gathering of experts. Food Nutr. 1: 2 – 5.

Gomez, M. H.; Rooney, L. W. and Waniska, R. D. (1987). Dry corn masa flours for tortilla and snack food production. Cereal Foods World 32 (5): 372.

Gould, W. A. (1985). Changes and trends in the snack food industry. Cereal Foods World 30 (3): 219 – 225.

Herog, F., Farah, Z. and Amado, R. (1994). Composition and consumption of gathered wild fruits in the V- Baoule, Cote D' Ivore. Ecol. Food. Nutr. 32: 181 – 196.

Jacobs, M. (1956). The chemical analysis of food and food products. 3rd edition. Pp. 504. Van Nostrand Co. Inc. New York.

Morgan, K. J. (1983). The role of snacking in American diet. Cereal Food World 28 (5): 305 – 312.

Staffer, C. E. (1983). Corn-based snacks. Cereal Foods World 28 (5): 286 – 298.

Tettweiller, P. (1991). Snack foods worldwide. Food Technology, 45 (2): 58 – 71.