Full Paper

NUTRITIONAL EVALUATION OF COMPLEMENTARY FOODS PRODUCED FROM MALTED WHITE MAIZE AND SOY CONCENTRATE BLENDS

A.V. Ikujenlola
Department of Food Science and Technology
Obafemi Awolowo University, Ile- Ife
avjenlola@oauife.edu.ng

S.O. Oguntuase
Department of Food Science and Technology
Federal University of Technology, Akure

ABSTRACT

Complementary foods are foods given to infant in addition to breastmilk as from the 4-6th month of age. White maize grains were malted to produce malted maize flour.Soybean seeds were processed into soyconcentrate. The resulting flours were formulated at the ratio of 70:30 (maize product : soybean product) for complementary foods' production.The resulting complementary foods were assessed for proximate composition and protein quality assessment using animals feeding experiment . The results showed that protein content of the processed maize increased with soyconcentrate supplementation. The protein contents (18.10 - 25.30%) of the supplemented diets were significantly higher ($p<0.05$) than that of the commercial diet (control) (15.00%).There was no significant difference ($p >0.05$) between the proximate parameters of processed maize supplemented with similar additives. The malted maize based diet gave better growth and high Protein Efficiency Ratio (PER) and food efficiency ratio than the unmalted maize diets. The PER ranged between 1.46 and 2.38 for all the formulated diets. The biological value,true digestibility and net protein utilization were of higher values with respect to the supplemented diets and compared favourably with the commercial diet and casein. The malted maize and soyconcentrate blend is superior ($p<0.05$) to the commercial diet (control) diet.The blend of malted maize and soyconcentrate could be produced by mothers and caregivers; fed to infants in order to reduce the prevalence of protein energy malnutrition in the developing countries.

Keywords: *Complementary foods, maize, soyconcentrate, malted, biological assessment, protein efficiency ratio,*

1. INTRODUCTION

Exclusive breastfeeding for the first 6 months and continued breastfeeding with appropriate complementary feeding for up to 2 years and beyond is recommended by the World Health Organization (WHO,1998). Complementary feeding period is the time when malnutrition starts in many infants contributing significantly to the high prevalence of malnutrition in children under 5 years of age worldwide (Anigo *et al*., 2010). Many factors contribute to the vulnerability of children to malnutrition during the complementary feeding period. In most developing countries, the prevalence of malnutrition during the complementary feeding is attributable not only to inadequate amounts of food but also to the poor nutritional quality of the available food supply (Hotz *et al*., 2007; Brown, 1991).

Infants generally show symptoms of protein energy malnutrition (PEM) during their early stage of life when family foods are introduced to complement the breast milk. Most of the foods that are offered to the infants are not hygienically produced which may result to intoxication, while some have the problem of high dietary bulk which makes feeding difficult and cumbersome for some mothers and causing choking in babies (Desikachar,1980; Ikujenlola and Fashakin, 2005). The nutritional quality of the food in terms of the protein and other nutrients is of major concern because some of the home made diets are made from cereals as the sole protein source. Cereals are regarded as incomplete protein due to the fact that cereals generally lack lysine and tryptophan. These problems are responsible for high infantile mortality in many developing countries Nigeria inclusive where maize is a major staple (Obayanju and Ikujenlola, 2002; Adelekan, 2003).

Maize (*Zea mays*) is a cereal crop which is grown in every part of Nigeria and it has a very high yield. Because of its abundance, it is usually utilized in the production of various food items for both adults and infants. The common product used as complementary food among the low income earners is called "ogi" which is produced by soaking, wet milling, wet sieving and settling (Inyang and Idoko, 2006). This product has been reported to contain very poor protein quality and cannot support growth of rats as well as children (Ikujenlola, 2004; Ghasemzadeh and Ghavidel 2011; Ikujenlola, 2010). Soy beans (*Glycine max*) a leguminous crop is known to be of good quality protein, its protein quality compares well with that of animal origin. It has been utilized in the production of soy milk, soy flour, soy isolate, soy concentrate e.t.c.(Iwe, 2003). Because of the protein quality of soy bean it could be used to supplement the inadequate protein present in maize in order to produce diet of high nutritional quality; that could maintain a healthy living and support growth among the infants. The objectives of this study were to produce nutritious complementary food from malted white maize and soy bean, and to assess its nutritional quality using animal feeding experiment.

2. MATERIALS AND METHODS

The white maize grains and soy bean seeds used were purchased from the International Institute of Tropical Agriculture, Ibadan, Nigeria.

2.1. Methodology

2.1.1. *Production of Malted Maize and Unmalted Maize Flours*

The maize grains were cleaned by sorting and floatation processes to remove dirts and extraneous materials. The grains were washed thoroughly and soaked for 8 hours to moisten the grains to increase the moisture content to about 40% . The moistened grains were spread in the germinating chamber at about 1.5cm loading depth and allowed to sprout for a period of 72 hours with watering every 12 hours. The germinated grains were washed and dried in a cabinet dryer at 60 ^{0}C for 20 hours. The dried sprouts were de-vegetated to remove the rootlets and plumules. The de- vegetated grains were milled, sieved (60 mesh), packaged and stored in a refrigerator until needed (Ikujenlola,2004; Marero *et al.*,1988). The unmalted maize flour was produced from cleaned grains by milling and sieving(60 mesh), packaging and stored in a refrigerator until needed (Ikujenlola, 2010). Figure 1 shows the unit operations involved in the production of malted maize and unmalted maize flours.

2.1.2. Production of Soybea full fat and Soy concentrate flours

Soy bean full fat flour was produced from soy bean seeds that were cleaned of all extraneous materials by winnowing and hand sorting. The seeds were soaked in warm water for 2 hours, thereafter the seeds were dehulled, cooked for 2 hours (to destroy the anti-nutrition factors), drained, washed in fresh water and dried (in cabinet dryer for 12 hours at 60 ^{0}C) milled and sieved.

The soy concentrate was produced from a portion from the soy full fat flour which had been defatted using solvent (hexane), and thereafter by dissolving the defatted soy flour in 60% alcohol solution to remove water soluble carbohydrates and other oligosaccharides responsible for flatulence. The meal from the extraction was dried and packaged for further utilization. Figure 2 shows the flow diagram for Soy full fat flour and soy concentrate production (Iwe, 2003).

2.1.3. Determination of Chemical composition of the blends

The chemical composition of the blends was determined by the standard methods of A.O.A.C. (1990). The parameters determined were protein (Kjeldahl method; N x 6.25), fat (Soxhlet extraction), ash, crude fibre, moisture content, carbohydrate (by difference) and energy {Atwater factor (9 x fat) + (4 x protein) + (4 x carbohydrate)} Kcal.

2.1.4. Biological evaluation of the complementary diets

For this study, forty albino (wistar var.) rats between three and four weeks of age were used. They were weighed, randomly distributed in metabolic cages and were adapted to the basal diet over a period of five days. After this period of acclimatisation the animals were re-weighed and re-grouped. The average weight per group was approximately the same (zero block design). The animals were fed with the experimental diets for a period of 28 days. Water was supplied *ad libitum*. During this period, dietary intake and growth were recorded. The urine and faecal discharge were collected appropriately. After the completion of the experiment the animals were anaesthetized and sacrificed. Tissue specimens were obtained and weighed. The data collected during feeding trial were used in computing the protein quality parameters (protein efficiency ratio, feed efficiency ratio, biological value, true digestibility, net protein utilization) (Dahiya and Kapoor, 1993; Ikujenlola and Fashakin,2005; Ikujenlola, 2010).

2.1.5. Formulation of various blends

The complementary diets were produced by blending the maize products (maize flour and malted maize flour) and soy products (soy full fat and soy concentrate) separately at a ratio of 100:0 and 70:30 respectively according to FAO/WHO(1985).

2.1.6. Basal diet formulation

The basal diet was patterned after the basal diet composition reported by Fashakin and Unokiwedi (1993).

2.1.7. Statistical analysis

Experimental results were subjected to analysis of variance. The level of significance was determined according to the method of Alika (1997).

Table 1: Basal diet formulation

Component	g/kg
Corn Starch	800
Vegetable Oil	100
Sugar	60
Mineral Salt	10
Vitamin mix	10
Salt	15
Cod Liver Oil	5
Energy (Kcal)	438.50

Source: Fashakin and Unokiwedi (1993)

3. RESULTS AND DISCUSSION

3.1. Proximate composition of the diet

Table 2 shows the proximate composition of the diets formulated from maize products (unmalted and malted) and soy bean products (full fat and concentrate). There was no significant difference ($p > 0.05$) in the proximate parameters of the processed maize to which similar additives have been added. The protein content ranged between 10.70 (Unmalted maize) and 25.30% (Malted maize + Soy concentrate). The addition of soy products increased the level and quality of protein of the fortified maize diets. Soy concentrate contains over 60% crude protein with improved amino acid profile (Iwe, 2003). The complementary effect of the protein (amino acids) in the soy bean and maize will no doubt be of valuable advantage to the end user of the formulated diets that is the infants. Since the sulphur bearing amino acids – methionine is abundant in maize but insufficient in legumes (soy bean) generally while the soy bean will make up for the inadequate quantity of lysine and tryptophan in maize (Ghasemzadeh and Ghavidel, 2011)

In infant nutrition, the quantity and quality of protein are of high importance, food that are high in protein are expected to be of reasonable quality in terms of essential amino acid. The protein content of the samples containing soy concentrate were significantly higher ($p < 0.05$) than that of the commercial diet.

Table 2: Proximate composition of formulated diets (%)

Sample	Moisture Content	Protein	Fat	Crude fibre	Ash	Carbohydrate	Energy (Kcal)
Maize flour	8.95^{b}	10.70^{d}	5.62^{c}	2.69^{cd}	2.25^{bc}	69.79^{a}	372.54^{b}
Malted Maize flour	8.78^{b}	11.50^{d}	6.02^{c}	3.13^{c}	2.64^{b}	67.93^{a}	371.90^{b}
Maize flour + Soyfull fat	9.55^{a}	18.12^{b}	8.53^{a}	3.30^{c}	2.98^{b}	57.52^{b}	379.33^{b}
Malted maize flour + Soy full fat	7.65^{c}	18.10^{b}	8.24^{a}	2.98 ^{c}	2.30^{b}	60.73^{bc}	389.48^{a}
Maize flour + soy Concentrate	9.35^{a}	24.26^{a}	5.93^{c}	7.80^{ab}	2.01^{b}	56.65^{d}	377.01^{b}
Malted maize flour + Soy Concentrate	9.61^{a}	25.30^{a}	6.15^{c}	2.20^{d}	1.90^{b}	54.84^{d}	375.91^{b}
Control	8.59^{b}	15.00^{b}	9.00^{a}	4.00^{b}	5.00^{a}	58.41^{b}	374.64^{b}

Means of the same column followed by different letters are significant ($p < 0.05$)

The addition of soy full fat flour to the maize flour increased the fat content however, the addition of soy concentrate did not increase the level of the fat owing to the fact that soy bean flour was defatted during soy concentrate production. The fat content was below 10% for all the samples while the commercial diet was 9.00% fat, high fat level is associated with ranscidity and it promotes off flavour during prolong storage. The recommendation of PAG (1971) was that fat content of diet meant for infant should not be more than 10%. This is to prevent the occurrence of off flavour and change in taste.

There was no significant difference (p › 0.05) between the ash contents of the diets except in the control. The ash content indicates the level of mineral content of the product. The control had the highest crude fibre (5.00 %) compared to the other samples. The carbohydrate ranged between 54.84 and 69.79 %. The estimated energy derivable from the diet ranged between 371.90 and 389.48kcal. The energy value of the control was 374.64 kcal.

The moisture content ranged from 7.65 to 9.61%. The moisture content was less than 10% in the all the samples. The lower the moisture content of the product the better; to prolong the shelf-life especially in rural areas where storage facilities may not be available. Higher moisture content encourage caking of floury product (Onuorah and Akinjide, 2004; Owolabi *et al*., 2012).

3.2. Animal Feeding Experiment

The feed intake ranged between 165.5g (basal diet) and 208.5g (Commercial - Control diet). The highest feed was consumed by the groups fed on the malted maize based diet and control groups. The least feed (165.5g) was consumed by the group fed with basal diet. The feeding trials of the diets showed that the dispositions of the experimental animals to the diets varied. The disposition of rats fed with the malted maize-soy concentrate blend and Commercial - control diet groups were better compared to the rats fed with other formulated diets; they were more agile and increased in weight. The group of rats fed with basal diet were reducing in weight and did not exhibit similar agility seen in the other groups during the period of feeding trials. Ikujenlola and Fashakin (2005) reported similar observation about the inability of basal and unsupplemented maize diets to support growth. According to Wardlaw (2000) lack of protein in responsible for weight reduction which is otherwise referred to as stunted growth and if this persist death can be the last result.

Figure 3 shows the changes in the growth weight of experimental rats during the period of feeding trial. The data showed that malted maize based diet had better growth and higher overall weight increase than unmalted maize based diet. Although the addition of soy full fat to maize enhanced the growth of the rats better than those diets which contained no soy supplement; the addition of soy concentrate to malted maize further boosted the rate at which the diet enhanced the rats' growth. Malting according to Marero *et al.*(1988) and Sajilata *et al.*(2002) enhanced the level of protein and this invariably improves the growth and tissue development of animal and man. The observation in this result showed the complementary effect of both soy bean and maize especially as it affects the protein quality of the supplemented diets. This result also confirm the inability of maize flour as sole protein source to support adequate growth.

There was no significant difference (p ›0.05) between the muscle tissue (Table 3) of the experimental rats fed with the various formulated diets except the basal and maize flour samples. The weights of the kidney and liver followed a similar trend as observed in the muscle tissue. The weight of the various organs of the experimental rats revealed the influence of the various formulated diets on the size of the organs. These organs are required for various metabolic processes of the body. Table 3 shows the weights of the various organs from the experimental rats. The weights of the organs from the formulated diets compared favourably with those of the control diet, however the weights of similar organs reported by Ikujenlola (2010) were bigger.

The Protein Efficiency Ratio (PER) and Food Efficiency Ratio (FER) of the diets are presented in Table 4. The PER ranged between (1.46 - 2.38) for the formulated diets. The PER is one of the methods of measuring the quality of protein in foods. The PER of diets supplemented with processed soybean had PER above 2.00 which showed no significant difference (p ›0.05) from that of commercial-control diet. It has been reported earlier that maize protein is regarded as incomplete because it lacks lysine and tryptophan this is confirmed with the low PER in the diets to which no soy bean was added. Low PER accounts for the inability of the diets to support growth, at best the weight could be maintained for sometimes however, the growth diminished after a while. Howbeit, the inclusion of processed soy bean enhanced the growth of the experimental rats as observed in the study (Fig.3). Soy bean according to Iwe (2003) contain protein of high quality in terms of amino acids. The results of PER in this study compared well with the reports of Malleshi *et al.* (1989) who prepared weaning food from malted ragi and green gram (7:3) with PER 2.2. Also the PER of 2.13 – 2.58 was reported by Gupta and Sehgal (1992) for bajra, barley, green gram and amaranth blends, while Ikujenlola (2010) reported 2.1- 2.43 for processed quality protein maize - soy bean blends. The PAG (1971) recommended PER of 2.1 for diet meant for complementary feeding for infants. The PER of malted maize supplemented with soy bean products and the control were higher than the recommended value.

The FER (Table 4) ranged between 0.15 and 0.24 for all the formulated samples. The least value for feed efficiency came from the group of rats fed with unmalted maize diet while the highest value was found in the group of rats fed with malted maize supplemented with soy concentrate diet. The well-being of infant depends majorly on both the quality and quantity of food stuff they consume (Ghasemzadeh and Ghavidel, 2011; Ikpeme-Emmanuel *et al*.,2009). When both conditions are not met malnutrition result. According to Ojofetimi *et al.* (2001) malnutrition is responsible high percentage of death in the developing countries.

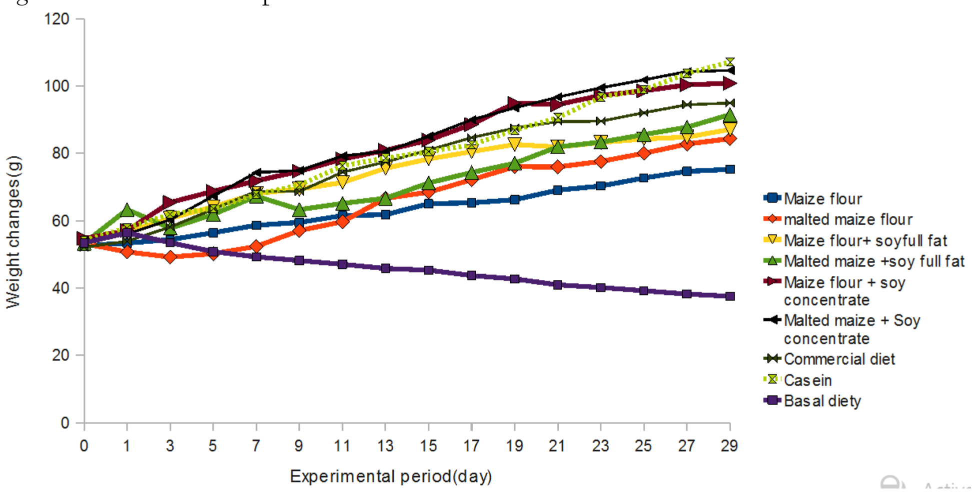

Fig. 3: Growth performance of the experimental animals

Table 3. The Mean Weight of Selected Organs of the Experimental Animal (g)

Sample	Muscle	Kidney	Liver
Unmalted Maize flour	0.16^{c}	0.14^{c}	0.14^{b}
Malted Maize flour	0.20^{b}	0.17^{ab}	0.20^{a}
Unmalted Maize flour+Soyfull fat	0.20^{b}	0.17^{ab}	0.20^{a}
Malted maize flour + Soy full fat	0.20^{b}	0.15^{b}	0.18^{a}
UnmaltedMaize flour + Soy Concentrate	0.28^{a}	0.20^{a}	0.20^{a}
Malted maize flour + Soy Concentrate	0.24^{a}	0.17^{b}	0.19^{a}
Commercial diet	0.19^{ab}	0.19^{a}	0.18^{a}
Casein	0.28^{a}	0.18^{a}	0.19^{a}
Basal diet	0.15^{c}	0.11^{c}	0.14^{b}

Means of the same column followed by different letters are significant ($p < 0.05$)

Table 4: The Corrected Protein Efficiency Ratio (CPER), Food Efficiency Ratio (FER) and Food intake of formulated diets

Sample	CPER	FER	Food Intake
Unmalted maize flour	1.46^{c}	0.15^{c}	175.8^{c}
Malted maize flour	1.59^{c}	0.16^{c}	178.4^{bc}
Unmalted maize flour +Soy full fat	2.00^{b}	0.20^{b}	180.2^{ab}
Malted maize flour + Soy full fat	2.15^{ab}	0.22^{ab}	176.8^{c}
Unmalted maize flour + Soy Concentrate	2.25^{ab}	0.23^{ab}	188. 6^{ab}
Malted maize flour + Soy Concentrate	2.38^{a}	0.24^{a}	205.4^{a}
Commercial diet	2.30^{a}	0.23^{a}	208.6^{a}
Casein	2.50^{a}	0.25a	206.6^{a}
Basal diet	-	-	- 165.5^{d}

Means of the same column followed by different letters are significant ($p < 0.05$).

The true digestibility (Fig. 4) of the diets varied between 74.70 (unmalted maize diet) and 90.30% (Casein). There was no significant difference ($p > 0.05$) between the commercial diet and the formulated diets containing soy concentrate. The casein has true digestibility higher than commercial and formulated diets. Formulation based on malted maize has higher true digestibility than the unmalted maize diet. The level of crude fibre affects the digestibility of the diets. Malting is usually carried out to increase digestibility and reduce the buklk density (Hofvander and Underwood,1987). Gupta and Sehgal (1992) reported a similar true digestibility for complementary foods based on germinated cereal grains. The biological value and the net protein utilization of the formulated complementary diets varied between (64.50 - 78.24%) and (48.18 - 66.70%) respectively. The casein has the highest biological value and net protein utilization (Fig. 4), the commercial diet was not significantly higher ($p > 0.05$) than the diets containing soy concentrate. The biological value expresses the percentage of the nitrogen which was retained by the body for repair or the construction of nitrogenous tissue.

4. CONCLUSIONS

There was improvement in the nutrient quality of the formulated complementary foods from malted maize supplemented with soy concentrate which supported better growth. This study also infered that malted maize- soy concentrate blend has better tendency of retaining high nitrogen in the body which will be needed for growth and development. These diets could be prepared at household level for infants in regions where maize is a staple and malnutrition is prevalent.

REFERENCES

A.O.A.C., Official Methods of Analysis 15th Edn. Association of Official Analytical Chemist. Washington D.C.,1990.

Adelekan, D.A., Childhood Nutrition and Malnutrition in Nigeria. *The International Journal of Applied and Basic Nutritional Science*,19, Issue 2:179-181, 2003.

Akingbala, J.O., Rooney, L.W. and Faubion, M.A., Laboratory Procedure for the Preparation of Ogi- a Nigerian Fermented. *Journal of Food Science*, 46:1523-1526,1981.

Alika, J.E., Statistics and Research methods. Ambik Press Benin City, First edition. 1-103,1997.

Anigo, K. M., Ameh, D. A., Ibrahim, S. and Danbauchi, S. S., Nutrient composition of complementary food gruels formulated from malted cereals, soy beans and groundnut for use in North-western Nigeria. *African Journal of Food Science*, 4 (3) 65-72, Available online http://www.acadjourn.org/ajfs, 2010.

Brown, K.H., Appropriate diets for the rehabilitation of malnourished children in the community setting. *Acta Paediatric Scand.*, 374:151-159,1991.

Dahiya, S. and Kapoor, A.C., Biological evaluation of protein quality of home processed supplementary foods for pre- school children. *Food Chemistry*, 48 : 183 - 188,1993.

Desikachar, H.S.R.,Development of Weaning foods with high caloric density and low hot paste viscosity using traditional technology. *Food and Nutrition Bulletin*, 2 (4):21-23,1980.

FAO,Guidelines for Development of Supplementary Foods for Older Infants and Young Children. Report of the 14th session of the codex committee on Foods for special Dietary Uses: Appendix 12, 1985.

FAO/WHO/UNU, Energy and Protein requirements. Reports of a joint FAO/WHO.UNU Expert consultation World Health Organization Technical Report Series, 724:86-98,1991.

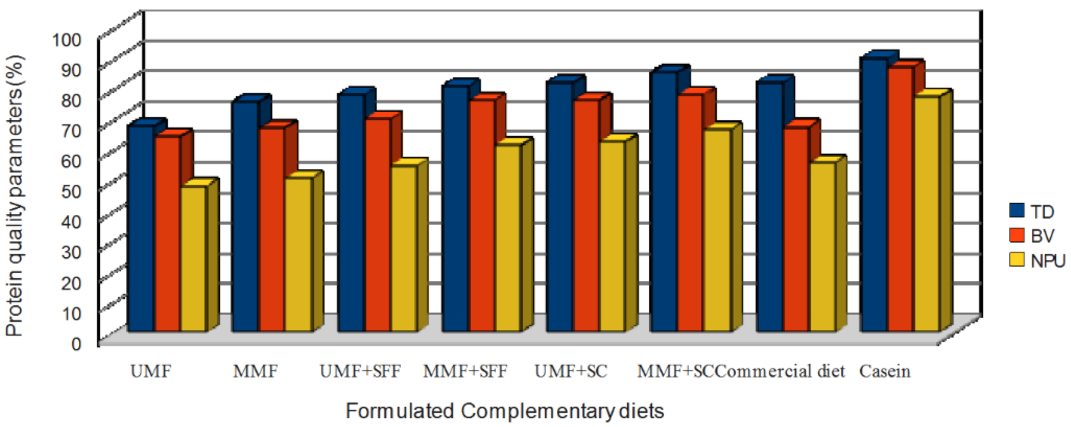

Fig. 4: The true digestibility, Biol;ogical value, and net protein utilization

Fashakin, J.B. and Unokiwedi, C.C.,Nutritional Evaluation of Warankasi and Wara egusi prepared from cow milk partially substituted with melon milk. *Nigerian Food Journal*, 2: 128 -134,1993.

Ghasemzadeh, R. and Ghavidel,R. A., Processing and assesment of quality charactristic of cereals - legumes composite weaning foods . 2011 International Conference on Bioscience, Biochemistry and Bioinformatics. IPCBEE IACSIT Press, Singapore,5 :1-3,2011.

Gupta, C. and Sehgal, S., Protein quality of developed home made weaning foods. *Plant Foods Human Nutrition*, 42: 239 –246,1992.

Hofvander, Y. and Underwood, B.A.,Processed supplementary foods for older infants and young children, with special reference to developing countries. *Food and Bulletin*, 9:(1) 1-1,1987.

Hotz ,C. and Gibson, R.S.,Traditional Food Processing and Preparation practices to enhance the Bioavailability of micro-nutrients in plants-diets. *The Journal of Nutrition*, 137:1097-1100, 2007.

Ihekoronye, A.I. and Ngoddy, P.O., Integrated Food Science and Technology for the Tropics. Macmillan Publishing Co. London, 253-257,1985.

Ikujenlola, A. V.,Quality Evaluation of weaning food Produced from Malted cowpea and rice blends. *Knowledge Review*, 8 (1):83-87, 2004.

Ikujenlola, A.V. and Fashakin, J.B.,Bioassay assessment of a complementary diet prepared from vegetable proteins. *Journal of Food Agriculture and Environment*, Finland, 3(3): 23-26, 2005.

Ikujenlola, A.V.,The effects of malting and fermentation on the nutritional qualities of complementary produced from maize varieties and soy bean grains. Ph.D Thesis Obafemi Awolowo University, Ile-Ife, Nigeria, 2010.

Ikpeme-Emmanuel, C. A., Okoi, J. and Osuchukwu, N. C., Functional, anti-nutritional and sensory acceptability of taro and soybean based weaning food. *African Journal of Food Science*, Available online http://www.acadjourn.org/ajfs. Accessed on March 12, 2012, 3(11) 372-377,2009.

Inyang, C.U. and Idoko, C.A.,Assessment of the quality of "Ogi" made from malted millet. African Journal of Biotechnology, 5: 2334 – 2337,2006.

Iwe, M.O., The Science and Technology of Soybean: Chemistry, Nutrition, Processing and Utilization. 1st edn. Rojoint Communication Services Ltd. Enugu, Nigeria. 115-116, 2003.

Malleshi, N.G.,Daodu,M.A. and Chandrasekar,A., Development of weaning Food formulations based on malting and roller drying of sorghum and cowpea. *Int. J. Food Sci. Tech.*, 24: 511-519, 1989.

Marero, L.M., Payumo, E.M., Lirando, E.C. Larez, W.N., Gopez, M.D. and Horma, S.,Technology of Weaning food formulation prepared from germinated cereals and legumes. *Journal of Food Science*, 53: 1391-1398, 1988.

Obayanju, V.S. and Ikujenlola, A.V.,Formulation and Nutritional Assessment of Weaning food from soy bean and Acha. *Journal of Agricultural Technology*, 10 (2): 22-27,2002.

Ojofeitimi, E.O., Abiose, S.H., Ijadunola, R.T., Pedro, T. and Jinadu, M.K.,Modification and Improvement of Nutritive quality of corn pap Ogi' with cowpea and groundnut milk, *Nutrition and Health*, 15:47-53,2001.

Onuorah, C.E. and Akinjide, F.A., Comparative Evaluation of four formulated weaning foods and a commercial product. *Nigerian Food Journal*, 22: 48-53, 2004.

Owolabi, A.O., Ndidi, U.S., James, B.D. and Amune, F.A., Proximate, Antinutrient and Mineral Composition of Five Varieties (Improved and Local) of Cowpea, (*Vigna unguiculata*), Commonly Consumed in Samaru Community, Zaria-Nigeria, *Asian Journal of Food Science and Technology*, 4(2): 70-72, 2012.

PAG, Protein Advisory Groups of the United Nations Guideline No 8, New York, 1-7,1971.

Sajilata, G., Rekha, S., Singhal, O. and Kulkarni, P.R., Weaning Foods A review of the Indian Experience, *Food and Nutrition Bulletin*, 23 (2): 208-226,2002 .

Wardlaw, G. M., Contemporary Nutrition Issues and Insights. 4th ed. McGraw. Hall Higher Education, USA,450-475, 2000.

W.H.O.,Complementary feeding of young children in developing countries. A review of current scientific knowledge. Available at: http://www.who.int/nutrition/ publications/ infantfeeding/ WHO. NUT. 98.1/en/index.html. Accessed 29 June 2009.1998.