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Probing nutritional assessment of cereal and cowpea based weaning food

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Abstract— The rationale of this article is to endow with ample impression of the preparation of squat cost weaning food to congregate the requirements of the infant which are affordable to stumpy income groups. Protein energy malnutrition (PEM) persist a serious syndrome of malnutrition. In developing countries it is the most important nutritional dearth distressing more than 170 million preschool children and nursing mothers. To combat Protein Energy Malnutrition (PEM) among weaning infants, inexpensive sources of protein are investigated, which are low cost and affordable to the largest population. Hulless barely elite line (B-03003), Rice (Super basmati variety) and cowpea seeds were used for the development of weaning food. After germination a. Hundred weaned male albino rats were acquired to determine the protein efficiency ratio, net protein utilization, biological valuenand true digestibility. After protein quality evaluation the best selected treatments were used for the development of weaning food. Finished product was also analyzed for moisture, ash, crude protein, crude fat, crude fiber and nitrogen free extract. The gross energy, bulk density and reconstitution index was also estimated. It was observed that malted and processed flour give better results among all prepared diets. Malting caused significant increase in digestibility of product. The TD was varied between 69.25-87.60% among malted and unmalted diet. BV varied between 65.34-90.23% among all diets but highest value was observed in diet prepared from autoclaved rice flour and malted cowpea flour. Weaning food prepared from autoclaved, malted cowpea and malted barley flour rank highest in nutritional and gross energy.

Index Terms— Legumes, malnutrition, protein quality, weaning food

1 INTRODUCTION

Among infants, nutritional deficiencies escort to high death rate, disabilities, retardation in physical growth and mental development. This problem may continue in future because provision of protein from animal origin is difficult and expensive. So, ideal solution of this increasing problem would be to explore such vegetable protein sources that are accessible to low income groups of population and helped to meet their protein needs of various segments of population including infants and pre-school children [1] (Chau et al., 1998). Plant proteins can play a significant role in human nutrition on world basis. These proteins supply approximately 65% of per capita supply of protein. In order to meet human physiological requirements plant proteins can serve as a complete and well balanced source of amino acids [2] (Farzana and Khalil, 1999). Most commonly foods which are recommended by pediatricians to start weaning are cereal based because of their high energetic load.

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Cereals provide more than 60% of energy and 50% of global protein needs [3] (Moussa et al., 1992). However, most cereals are limited in essential amino acid such as threonine, lysine and tryptophan, thus making their protein quality poorer compared with animals. Their protein digestibility is also lower than that of animals, partly due to presence of fibers and tannins which binds to protein thus making it indigestible [4] (Amjad et al., 2003). Various methods have been determined to improve the protein quality of cereals such as amino acid fortification, supplementation or complementation with protein concentrates or other food sources. So the current efforts are to be focused on the utilization of legumes as a plant protein source because protein resources of animal origin are far short of requirement of an ever increasing world population [5] (Chove et al., 2001).

Plant proteins, especially from grain legumes, have been used as ingredients in food products because of their high amino acid contents. Cowpea can be incorporated into a variety of foods such as snack foods, crackers, composite flour and to make bread [6] (Gimani, 2005). For making bread or cookies, protein flour or isolate from cowpea, which is high in lysine, can be used as a supplement in wheat flour, which lacks lysine as a complementary mixture with other cereals based foods and as a functional food ingredient [7] (Iqbal et al., 2006).

Cowpea seeds contain 20-25% protein and are rich in essential dietary amino acids except methionine and cysteine [8] (Maia et al., 2000). It is also good source of minerals such as phosphorus and iron as well as vitamins. Cowpea is a potential source of dietary carbohydrates and B vitamins [9] (Mbofung et al., 1999).

Since cereal grains will continue to be the major basic diets of infants. So efforts should be geared towards improvement of traditional weaning foods which could be achieved by the incorporation of locally available protein rich materials such as grain legumes and proteinized seeds. The effort was focused on the low cost weaning food formulation from dietary staple and cheap sources of vegetable proteins to formulate nutritious and economical weaning food, affordable to section of target population and readily available.

2 MATERIALS AND METHODS

2.1 PROCUREMENT OF RAW MATERIALS: Hull-less barely elite line (B-03003) was procured from Ayub Agricultural Research Institute Faisalabad, Pakistan. Rice (Super basmati) variety was obtained from Rice Research Institute, Kala Shah Kaku Lahore, Pakistan, while cowpea seeds were purchased from local market.

2.2 PRETREATMENTS OF RAW MATERIAL: Barely grains were divided into two parts after cleaning and washing. One part was steeped in tap water for 16 h and was left for germination for 48 h. It was then sun dried and ground to fine flour. The other part was given no treatment and grounded to fine flour by means of Pin mill (china grinder). Cowpea grains were also divided into two parts after cleaning and washing. One part was steeped in tap water for 8 h and germinated for 24 h. After germination dehulling was done and then sun dried and was ground to fine flour. The other part of cowpea grain was washed, dried and ground to fine flour by means of Pin mill. After cleaning rice grains were also divided into two parts. One part was autoclaved at 121°C and 15 PSI pressure for 15 min and ground to fine flour by means of Pin mill. The other part was given no treatment and ground to flour by means of Pin mill (china grinder).

2.3 BIOLOGICAL ASSAY: Albino rats (Sprauge Dawley strain) were obtained from National Institute of Health (NIH), Islamabad. The percentage distribution of different ingredients in different experimental diets with their controls (casein and non protein) has been presented in Table. 1. All diets were kept isonitrogenous and isocaloric. All diets contained 10% protein on dry weight basis. Casein diet (10%) was used as reference diet. The protein free diet was also introduced to measure metabolic faecal nitrogen. Feed intake and body weight were recorded on daily basis. True digestibility (TD), Net Protein Utilization (NPU), Biological Value (BV) and Protein Efficiency Ratio (PER) was determined according to method of Miller and Bender [10] (1955).

2.4 EXPERIMENTAL PROCEDURE: Sixty weanling albino rats (21 days old) were used for biological assay of experimental diets. The rats were fed to a stock diet for 10 days so that they weighed 50-58g prior to experiment and then randomly divided into 12 groups having 5 rats each. Rats were kept under 12 h light dark cycles. The diets were randomly assigned to experimental groups and were fed *ad libitum* for a period of 10 days. The temperature of the animal room was maintained at 27±3°C. Each group was separately kept in wire screen mesh bottom; underneath each cage meal tray covered with a sheet of filter paper was placed.

Table: 1. Diet plan for biological study

Diets	Corn Starch (g)	Rice flour (g)	Cowpea flour (g)	Barley flour (g)	Corn oil (g)	Mineral mix (g)	Vitamin mix (g)	Casein (g)	Total (g)	CP
D_0	81	-	-	-	5	3	1	10	100	10
D_1	36	25	30	-	5	3	1	-	100	10
D_2	38	25	28	-	5	3	1	-	100	10
D_3	36	25	30	-	5	3	1	-	100	10
D_4	38	25	28	-	5	3	1	-	100	10
D_5	49	-	22	20	5	3	1	-	100	10
D_6	46	-	25	20	5	3	1	-	100	10
D_7	49	-	22	20	5	3	1	-	100	10
D_8	46	-	25	20	5	3	1	-	100	10
D_9	34	20	20	17	5	3	1	-	100	10

D_0 (Reference diet), D_1 (Autoclaved Rice Flour and Unmalted Cowpea), D_2 (Autoclaved Rice Flour and Malted Cowpea), D_3 (Un-autoclaved Rice Flour and Unmalted Cowpea), D_4 (Unautoclaved Rice Flour and Malted Cowpea), D_5 (Malted Barley Flour and Malted Cowpea), D_6 (Malted Barley Flour and Unmalted Cowpea), D_7 (Unmalted Barley Flour and Malted Cowpea), D_8 (Unmalted Barley Flour and Unmalted Cowpea), D_9 (Autoclaved Rice Flour, Malted Cowpea and Malted Barley Flour), D_{10} (Unautoclaved Rice Flour, Unmalted Barley Flour and Unmalted Cowpea), D_{11} (Protein free diet)

Weight of each group of rats was recorded daily with electronic top loading balance. The faecal material was collected and brought to constant weight by drying at 105°C and stored in polyethylene bags for estimation of nitrogen. The spilt food collected from each cage was dried and weighed. At the end of experiment, rats were sacrificed by chloroform anesthesia. The skull and abdominal cavities were opened and whole body was dried in oven at 105°C till constant weight. The dried carcass was run through electric grinder and stored for nitrogen determination.

2.5 DEVELOPMENT OF WEANING FOOD: Weaning food was prepared by slight modification in formulation given by Onilude et al. [11] (1999) from best selected samples of flour. The rice flour, cowpea flour, skim milk powder and sucrose were blended in ratio 40: 40: 15: 5 respectively to provide 15-17% protein contents. Barley flour, cowpea flour, skim milk powder and sucrose were blended in ratio 50: 30: 15: 5 respectively, to provide 15-17% protein contents. Slurry of each blend was prepared and precooked for 15 min. The slurry was spread on a tray and hand pressure was applied with spatula to produce 1-2mm thick sheet. The slurries were dried for 2 h at 90°C. The flakes were scraped from tray and cooled to room temperature. Flakes were ground into a meal and sieved through a 60 mesh screen. The finished product was stored at 5°C in polyethylene bags for further analysis.

2.6 CHEMICAL COMPOSITION AND FUNCTIONAL PROPERTIES OF WEANING FOOD: Weaning food was analyzed for moisture, ash, crude protein, crude fat, crude fiber and nitrogen free extract (NFE) according to their respective methods described in AACC [12] (2000). Gross energy of prepared weaning food was determined by Parr Oxygen Bomb Calorie Meter method described by Ejigui et al. [13] (2005). The procedure adopted by Akpapunam and Markakis [14] (1981) was used for the determination of bulk density. The reconstitution index was determined by mixing flour with boiling water for 90 sec. as method described by Oluwatooyin and Aworh [15] (2002). The viscosities of weaning foods were evaluated in a Rheometer (Model 286 Baroid Hauston, Texas, USA) as described by Brandtzaeg et al. [16] (1992).

2.7 SENSORY EVALUATION OF WEANING FOOD: To assess quality and acceptability, weaning food was presented to a panel of judges and the sensory evaluation was carried out for color, taste, aroma, appearance, texture and overall acceptability characteristics according to method as described by Larmond [17] (1977).

2.8 STATISTICAL ANALYSIS: The obtained data for each studied parameter was subjected to statistical analysis to determine level of significance according to the method described by Steel et al. [18] (1997).

3 RESULTS AND DISCUSSION

3.1 BIOLOGICAL ASSAY: The biological assay of composite flours was conducted on Sprague Dawley rats to assess protein quality. The results regarding biological assay of prepared diets are presented in Table 2**.** The true digestibility of different diets ranged from 69.25-87.6%. The true digestibility of diets prepared from different composite flour differ significantly among diets and was found significantly higher in reference diet D_o 87.6% followed by D_9 84.6%, while lowest TD was recorded in experimental diet D_8 69.25%. It is also further substantiated from results that experimental diet D_o (casein), diet D_9, D_2 and D_5 were statistically at par with regard to true digestibility. The increase in true digestibility may be attributed due to presence of substantial quantity of essential amino acid in cowpea protein. The increase in true digestibility of diets containing autoclaved flours is well supported by Khalil and Mansour [19] (1995) who reported that true digestibility of faba bean was improved by heat processing and germination which supports to our results observed in this study. It has also been reported Mensa-Wilmot et al. [20] (2001) that extrusion of cereal and legume blends also results in TD ranged 87.4-92.1%. The net protein utilization of different experimental diets ranged 42.24-79.04%. It is obvious from results that reference diet D_o (casein) yielded highest NPU value 79.04% followed by experimental diet D_9 73.28% prepared from autoclaved rice flour, malted cowpea and malted barley flour, while lowest NPU was recorded in experimental diet D_8 42.24%. It was also further substantiated from the results that experimental diet D_o (casein), D_9, D_2 and D_5 (malted barley flour and malted cowpea) were statistically at par with regard to NPU. The results of present study demonstrated that supplementation of cowpea in diets improved net protein utilization. This increase in NPU is because of the presence of higher contents of essential amino acids particularly, lysine and threonine which are limiting in cereal. The improvement in net protein utilization due to more lysine is well documented by Estevez et al. [21] (1991), who reported increase in net protein utilization from 52.3-67.50% by incorporation of 15% chickpea flour in diet formulation. The present study suggested that an increase in net protein utilization occurred as a result of enrichment of cereals with legumes which is in well agreement to previous studies. The protein efficiency ratio of different diets ranged from 1.42-2.53 among different experimental diets. It is evident from analysis of variance that PER differed significantly among experimental diets prepared from cereal and legume blending. The PER was found to be significantly highest 2.53 in experimental diet D_o (casein) followed by experimental diet D_2 2.42 prepared from autoclaved rice flour and malted cowpea, while lowest PER was recorded in experimental diet D_8 1.42 which was prepared from un-malted barley flour and unmalted cowpea. The difference for PER between experimental diets D_2 and D_5 was found non-significant. It was also further substantiated from results that experimental diet D_o (casein), D_2 and D_5 were statistically at par with regard to PER. The results indicated that there was a significant increase in protein efficiency ratio when diets were supplemented with autoclaved rice flour and malted cowpea. The protein efficiency ratio of proteins is severely dependent on essential amino acids present in samples as well as ability of human or animal to digest and utilize these amino acids. Some research workers Mensa-Wilmot et al. [20] (2001) suggested that incorporation of cowpea with cereals as a protein supplement results to increase PER from 2.1-2.4. These results suggested that intake of food supplemented with malted cereal and cowpea results to increase PER. The biological value of different diets ranged from 65.34-90.23% among different diets. The significantly highest biological value 90.23% was exhibited by reference diet D_o (casein) and lowest BV 65.34% was given by D_8. The BV was found to be significantly highest 90.23% in experimental diet D_o (casein) followed by D_9 86.63% as also further substantiated from results that experimental diet D_2 exhibited 85.23% BV and D_5 exhibited 84.54% BV.

The results have showed that there was a significant increase in biological value when diets contained treated flour such as autoclaved or malted. The improvement in biological value of diets containing chickpea flour supplementation in malted barley is well demonstrated by Wondimu and Malleshi [22] (1996) who observed an increase in biological value of diets supplemented with barley flour. The improvement in biological value is attributed to improvement in pattern of limiting amino acids in rice and barley as a result of supplementation of cowpea flour. The other reasons for higher BV observed in case of autoclaved and malted blends may be because autoclaving malting treatment significantly reduced presence of antinutritional factors like phytic acid and trypsin inhibitor. After conducting suitable animal feeding experiments, the best selected diets were D_2, D_5 and D_9 which are designated as T_1, T_2 and T_3 for product development. These blends were incorporated into weaning food because grains of cowpea may be advocated as an alternate source of low cost protein in infant food which might aid eradication of protein calorie malnutrition in developing countries such as Pakistan.

Table: 2. Biological parameters of different experimental diets

Diets	TD%	NPU%	PER	BV%
D_1	76.4±0.62	60.11±0.83	2.34±0.01	78.65±0.85
D_2	82.25±0.24	70.1±0.27	2.42±0.02	85.23±0.67
D_3	70.23±0.51	48.14±0.74	1.93±0.02	68.56±0.68
D_4	72.3±0.21	52.72±0.26	2.12±0.01	72.92±0.95
D_5	82.95±0.85	70.05±0.27	2.39±0.02	84.54±0.81
D_6	75.67±0.65	60.03±0.43	2.05±0.04	79.34±0.74
D_7	72.34±0.82	51.16±0.98	1.95±0.08	70.73±0.28
D_8	69.25±0.73	42.24±0.81	1.42±0.05	65.34±0.64
D_9	84.6±0.19	73.28±0.37	1.91±0.02	86.63±0.57
D_{10}	75.45±0.84	54.64±0.21	1.52±0.02	72.43±0.81
D_o (Casein)	87.6±0.27	79.04±0.25	2.53±0.01	90.23±0.34
D_{11} No protein	-	-	-	-

Values are given as Mean+SD

D_o (Reference diet), D_1 (ARF and UMC), D_2 (ARF and MC), D_3 (UARF and UMC), D_4 (UARF and MC), D_5 (MBF and MC), D_6 (MBF and UMC), D_7 (UMBF and MC), D_8 (UMBF and UMC), D_9 (ARF, MC and MBF), D_{10} (UARF, UMBF and UMC), D_{11} (Protein free diet)

3.2 PROXIMATE COMPOSITION OF WEANING FOOD: The weaning foods prepared from best selected treatments (T_1, T_2, T_3) were analyzed for their moisture, crude protein, crude fiber, ash and NFE and results are presented in Table 3. It is obvious from results that all constituents differ significantly except crude protein. The crude protein contents do not vary significantly among all the treatments. It is obvious from results that the T_1 which was prepared from the autoclaved rice flour and malted cowpea flour contained 6.57% moisture, 15.67% crude protein, 3.17% crude fat, 2.5% crude fiber, 1.89% ash, 70.2% NFE and provided 400.59cal/g. T_2 which was prepared from malted barley flour and malted cowpea flour contained 6.13% moisture, 16.35% crude protein, 3.8% crude fat, 5.6% crude fiber , 2.26% ash, 65.68% NFE and provided 415.3cal/g. T_3 which was prepared from autoclaved rice flour, malted barley flour and malted cowpea flour contained 7.02% moisture, 17.45% crude protein, 4.23% crude fat, 4.76% crude fiber , 3.56% ash, 62.97% NFE and provided 436.24cal/g. The order of protein and gross energy contents of all treatments was $T_3 > T_2 > T_1$. The results of present study are supported by [23] (FAO, 2006) that infants required 4-5kcal/g from cereal based foods in which fat should be 15–30% of Total Calories (TC), carbohydrate should be 55–75 % of TC and protein should be 10–15 % of TC. With increase in germination time there was a reduction in chemical composition. The best suited length of time found to be 24 h for germination of cowpea from which weaning food was prepared which also well supported our findings [24] (Jirapa et al., 2001).

Table: 3. Proximate composition of weaning food

Parameters	Treatment		
	T_1	T_2	T_3
Moisture%	6.57±0.08	6.13±0.05	7.02±0.65
Crude Protein%	15.67±0.05	16.35±0.05	17.45±1.51
Crude Fat%	3.17±0.05	3.8±0.03	4.23±0.35
Crude Fiber%	2.5±0.04	5.6±0.03	4.76±0.83
Ash%	1.89±0.05	2.26±0.04	3.56±0.51
NFE	400.59±12.6	415.30±11.82	62.97±0.84
Gross energy cal/g	6.57±0.08	6.13±0.05	436.24±0.09
Bulk Density g/ml	0.59±0.03	0.62±0.04	0.73±0.65
Reconstitution Index (ml)	92.60±0.05	95.26±0.06	96.367±4.62
Viscosity (cp)	4147.7±7.91	3134.3±8.06	3565.7±11.50

Values are given as Mean±SD

T_1 (ARF and MC)

T_2 (MBF and MC)

T_3 (ARF, MC and MBF)

The results regarding functional properties of weaning food are presented in Table 3. It is obvious from results that treatment T_3 had a high bulk density 0.73g/ml than T_1 and T_2. There was not a significant difference among bulk density of treatment T_1 and T_2 and these were at par with regard to bulk density. The results of present study are well supported by Oluwatooyine and Aworh [15] (2002). According to which loose and packed weaning food cause a change in the bulk density of weaning food. So high bulk density of food indicates that packaging would be economical. Germination had been known as an effective method of reducing bulk and improving nutrient density of weaning foods.

During sprouting, enzyme digests some of starch into dextrin and maltose which do not swell when cooked into gruel [25] (Ebrahim, 1983). Ideally a weaning food should have a high BD. The results regarding reconstitution index showed that treatment T_3 had a high reconstitution index than T_1 and T_2. There was a significant difference among reconstitution index of treatment T_1 and T_2. The present study findings are comparable with that of Oluwatooyine and Aworh [15] (2002). Germinated sample had better reconstituability and germination was found to be the best method for improving

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the reconstitutability [26] (Asinobi et al., 1998). It is also obvious from results that viscosity of weaning mixture of different treatments varies between 3134.4-4147.7 cp. The treatment T_2 had a lowest viscosity than other two treatments. The results of present study are well supported by Mahgoub [27] (1999) that viscosity of weaning mixture varies between 4150-5400 cp. These results supported present study that malting results a marked reduction in viscosity of the weaning mixture. Viscosity need to be lowered in order to produce a more nutritious and suitable weaning food. This could be achieved by reducing viscosity of starchy components by malting [28] (Malleshi and Desikachar, 1986). A low viscosity (less bulky) food contains a higher nutrient content since volume of food is low. Ideally a weaning food should have a low viscosity. The low viscosity is nutritional beneficial in infant formulas. Weaning foods had high paste viscosity required dilution with water prior to feeding.

3.3 SENSORY EVALUATION: The sensory attributes are very important towards the liking or disliking of weaning food. A trained panel of mothers assessed weaning food for their color, taste, aroma, mouth feel, consistency and overall acceptability and results in presented in Table 4. The average value for color of weaning mixture showed that treatment T_o which is a commercial weaning food exhibited highest score for color followed by T_1, T_3 and T_2. The major comment about T_2 was color because malting cause a change in color (light brown) which makes it objectionable. The conventional weaning foods are of milky and other attractive colors so this reason results that mothers were hesitant to accept it. The average value for the aroma of weaning mixture showed that treatment T_o which is a commercial weaning food exhibited highest score for aroma. Among all experimental weaning foods T_2 and T_3 exhibited highest score while T_1 exhibited lowest score 4.9. T_2 and T_3 are in close correlation to their aroma to T_o. Thus germination had a significant affect on aroma of product and improved aroma of product.

The results regarding taste of weaning mixture showed that treatment T_o which is a commercial weaning food exhibited score for taste 7.71. Among all tested mixtures T_1 had highest score 7.86 followed by T_2 which had a 7.74 score. Onyeka and Dibia [29] (2002) reported that malting had significant impact on taste of product because it results in production of simple sugars which have improved taste of product. The results regarding mouth feel of weaning mixture showed that treatment T_o which is a commercial weaning food exhibited score 9.0 followed by T_3 and T_2.

Table: 4. Mean values for sensory evaluation of weaning food

Parameter	Treatment			
	T_o	T_1	T_2	T_3
Color	9.0±0.74	6.06±0.08	5.0±0.56	6.0±0.09
Aroma	8.5±0.31	4.9±0.07	7.4±0.94	7.0±0.25
Mouth feel	9.0±0.09	6.0±0.03	7.0±0.65	8.0±0.64
Consistency	8.0±0.08	6.0±0.05	7.3±0.74	7.4±0.54
Taste	7.71±0.91	7.86±0.48	7.74±0.65	7.0±0.56
Over all acceptability	7.1±0.85	5.0±0.098	6.7±0.54	6.9±0.67

Values are given as Mean±SD

The T_1 exhibited lowest score for mouth feel because it gives grainy mouth feel. The average value for mouth feel of weaning mixture showed that T_o which is a commercial weaning food had a highest score for consistency followed by T_2 and T_3. The T_2 and T_3 are at par for consistency. The T_1 had a lowest score for consistency which is 6.0. The consistency of product can be improved by processing conditions for preparation of food. The results for acceptability of weaning mixture showed that T_o had good acceptability among all weaning mixtures with T_3. T_o and T_3 are at par for their acceptability. It could be concluded from present study results that product made from malted flours had a good acceptability by improving processing conditions.

4 CONCLUSIONS

The preparations of complementary diets from vegetable proteins enhance growth of young children. Such foods are easy to prepare and raw materials are readily available at affordable price. It can thus be concluded that legumes can be incorporated as protein supplement in weaning food because these are complement to cereals in amino acid. So, acceptable complementary diets could be prepared from germinated grains. Such diets have reduced viscosity and increased digestibility, which improve their potentials as adequate diets for children. Moreover, diets are suitable in total amelioration of Protein Energy Malnutrition (PEM) in the developing countries. Blends of germinated cereals and cowpea could meet nutritional needs of an infant providing 400kcal, 15-18% protein. Domestic processing methods like malting and roasting significantly lowered phytic acid, saponin and polyphenols of weaning mixtures and improved protein digestibility. The feeding of such locally developed weaning mixtures, if adopted, could be instrumental in raising nutritional status of children in developing nations.

REFERENCES

[1] C.F. Chau, C.K. Cheung and Y.S. Wong, "Chemical composition of three underutilized legume seeds grown in china", *Food Chem., volume. 6, pp. 505-509, 1998.*

[2] W. Farzana and I.A. Khalil, "Protein quality of tropi cal food legumes", *J. Sci Technol., volume. 23, pp. 13-19, 1999.*

[3] W.A. Moussa, M.D. Tadros, K. Kekhael, A.E.H. Darwish, A.H. Shakir and E.A.A El-Rahim, "Some simple methods of home processing and their implications in weaning foods", *Nahrung,. volume. 36, pp. 23-33, 1992.*

[4] I. Amjad, I.A. Khalil and H. Shah, "Nutritional yield and amino acid profile of rice protein as influenced by nitrogen fertilizer", *J. Agric., volume. 19, pp. 127-134, 2003.*

[5] B.E. Chove, A.S. Grandison and M.J. Lewis, "Emulsifying properties of soy protein isolate fractions obtained by isoelectric precipitation," *J. Food Sci. Agric., volume. 81, pp. 759-763, 2001.*

[6] S.Y. Gimani, "Compositional and nutritional properties of selected newly developed lines of cowpea", *J. Food Comp. Anal., volume. 18, pp. 665-673*, 2005.

[7] A. Iqbal, I.A. Khalil, N. Ateeq and M.S. Khan, "Nutritional quality of important food legumes*", J. Food Chem., volume. 97, pp. 331-335, 2006.*

[8] F.M.M. Maia, J.T.A. Oliveira, M.R.T. Matos, R.A. Moreira and I.M. Vasconcelos, "Proximate composition, amino acid content and haemagglutinating and trypsin inhibiting activities of some Brazilian *Vigna unguiculata* (L) Walp cultivars", *J. Food Sci. Agric., volume. 80, pp. 453-45, 2000.*

[9] C.M.F. Mbofung, N. Rigby and K.W. Waldron, "Nutritional and sensory evaluation of akara made from blends of cowpea and hard-to-cook mottled brown dry beans", *J. Food Chem. Agric., volume. 47, pp. 5232-5238, 1999.*

[10] D.S. Miller and A.E. Bender, "The determination of the net utilization of protein by a shortened method", *British J.Nutr., volume. 9, pp. 382-388, 1955.*

[11] A.A. Onilude, A.I. Sanni and M.I. Ighalo, "Effect of process improvement on the physico-chemical properties of infant weaning food from fermented composite blends of cereal and soybeans", *Plant Foods for Human Nutr., volume. 54, pp. 239-250, 1999*.

[12] AACC. Approved Methods of American Association of Cereal Chemists. *The American Association of Cereal Chemists, Inc., St. Paul. MN, 2000.*

[13] J. Ejigui, L. Savoie, J. Marin and T. Desoosiers, "Beneficial changes and drawbacks of traditional fermentation process on chemical composition and antinitritional factors of yellow maize (*Zea mays*)", *J. Biol Sci., volume. 5, pp. 590-596, 2005.*

[14] M.A. Akpapunamand P. Markaskis, "Physico-chemical and nutritional aspects of cowpea flour", *J. Food Sci., volume. 46, pp. 972-973, 1981.*

[15] F. Oluwatooyine, C. Osundahunsi and O. Aworh, "A preliminary study on the use of tempe-based formula as a weaning diet in Nigeria", *Plant Foods for Human Nutr., volume. 57, pp. 365-376, 2002*.

[16] B. Brandtzaeg, N.G. Malleshi, D. Svanberg, H.S.R. Desikachar and O. Mellander, "Dietary bulk as a limiting factor for nutrient intake with special reference to the feeding of preschool children. III. Studies on malted flours from ragi, sorghum and green gram", *J. Trop. Paeditar., volume. 27, pp. 184-189, 1992.*

[17] E. Larmond, "Laboratory methods for sensory evaluation of foods", *Ottawa, Canada: Department of Agriculture Publication. P 74, 1977.*

[18] R.G.D. Steel, J.H. Torrie and D.Duckey, "Principles and Procedures of Statistics: A Biometrical approach", *3rd Ed. McGraw Hill Book Co. Inc, New York, 1997.*

[19] A.H. Khalil and E.H. Mansour, "The effect of cooking, autoclaving and germination on the nutritional quality of faba beans", *Food Chem., volume. 54, pp. 177-182, 1995*.

[20] Y. Mensa-Wilmot, R.D. Phillips and J.L. Hargrove, "Protein quality evaluation of cowpea-based extrusion cooked cereal/legume weaning mixtures", *Nutr research., volume. 21, pp. 849-857, 2001.*

[21] A.M. Estevez, E. Castillo, F. Figuerola and E. Yanez, "Effects of processing on some chemical and nutritional characteristics of precooked and dehydrated legumes", *Plant Food Human Nutri., volume. 41, pp. 193-201, 1991.*

[22] A. Wondimu and N.G., Malleshi, "Development of weaning foods based on malted, popped and roller-dried barley and chickpea", *Plant Foods for Human Nutr., volume. 23, pp. 56-7, 1996.*

[23] F.A.O, "Discussion paper on the revision of section 3.4 carbohydrates of the codex standard for processed cereal based foods for infants and young children", 2006.

[24] P. Jirapa, H. Normah, M.M. Zamaliah, R. Asmah and K. Mohammad, "Nutritional quality of germinated cowpea flour and its application in home prepared powdered weaning foods", *Plant foods for Human Nutr., volume. 56, pp. 203-216, 2001.*

[25] G.J. Ebrahim, "Energy content of weaning foods", *J. Trop Pediatrics., volume. 27, pp. 194-196, 1983.*

[26] C. Asinobi, P.C. Ojielukwe, M.C. Uzo and J.C. Oneweluzo, "Comparitive effects of various viscosity reducing treatments on the quality characteristics of a cowpea-sorghum infant", *J. Food Biochem., volume. 22, pp. 441-453, 1998.*

[27] S.E.O. Mahgoub, "Production and evaluation of weaning foods based on sorghum and legumes", *Plant Foods for Human Nut., volume. 54, pp. 29-42, 1999.*

[28] N.G. Malleshi and H.S.R. Desikarchar, "Influence of malting conditions on quality of finger millet malt", *J. Inst. Brewing., volume. 92, pp. 81-83, 1986.*

[29] U. Onyeka and I. Dibia, "Malted weaning food made from maize, soybean, groundnut and cooking banana", *J. Sci Food Agric., volumw. 82, pp. 513-516, 2002.*