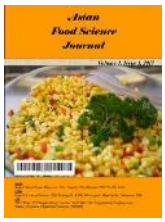

Asian Food Science Journal

5(4): 1-6, 2018; Article no.AFSJ.44611

Chemical and Nutritional Evaluation of Complementary Food from Blends of Quality Protein Maize and Conophor nuts (*Tetracarpidium conophorum*)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors OAA and TNF designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OAA, TNF and GO managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2018/44611
Editor(s):
(1) Dr. Abdelsalam Tidjani, Associate Professor, University of N'Djamena, Chad.
Reviewers:
(1) Aldo Di Luccia, University of Foggia, Italy.
(2) Vincent Nyau, The University of Zambia, Zambia.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/27233

Original Research Article

Received 16 August 2018
Accepted 20 October 2018
Published 15 November 2018

ABSTRACT

Complementary food was formulated from Quality protein Maize (QPM) and Conophor Nuts (*Tetracarpidum conophorum*). The effectiveness of the blend in meeting nutritional requirement in complementary diet was investigated. Proximate composition of the samples were evaluated which include crude protein, fat, moisture content, crude fibre and ash. Rat feeding method was used for nutritional quality determination. Compounded experimental and control diet were fed to albino rats for 28 days. The results observed in this study revealed that blend of Quality protein maize and conophor nut produced good complementary food with an increase in protein content. Protein content of formulated diet was 17.69% compared to 9.0% of the Quality protein maize. Evaluation of protein quality revealed that the formulated diet compared favourably with casein diet at 10% iso nitrogenous protein level. The formulated diet has high protein quality that can support the growth of infants in developing countries. The diet microbial quality is within acceptable level.

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Keywords: Quality protein maize; Conophor nuts; complementary food; protein quality; microbial quality.

1. INTRODUCTION

Childhood malnutrition is prevalent in many part of the world, particularly in the developing countries like Nigeria. Nutritionists and Food Scientist has focused on the problem of providing nutritious, low cost protein supplement to the diet of young children in developing countries including Nigeria [1]. According to Osundahunsi and Aworh [2], considerable efforts to improve the health and nutritional status of growing children have focused on the production of low complimentary foods from combinations of legumes and cereals. A number of convenient fortified proprietary formulas are available in developing countries but are often too expensive and out of reach of most families [3]. Researchers have recommended the use of home-based complementary foods that can be readily prepared, available and affordable, and the ingredients must be derived from dietary staples available and affordable in the region of interest [4,1,2,3,5,6].

Complementary foods of most developing countries are mainly from cereals with animal protein being used as supplement. As a result of the high cost of animal protein, attempts were shifted into alternative sources of protein especially from plant sources [7].

Cereals are low in protein and are limited in some essential amino acids such as lysine and tryptophan, while legumes represents a major source of nutrients including valuable but incompletely balance protein [8,1]. Supplementation of cereals with locally available legumes that are high in protein and essential amino acids such as lysine which has been in practice are adopted.

Quality protein maize is an improved variety of maize which contains a higher amount of lysine and tryptophan with a lower amount of leucine and isoleucine in the endosperm than those contained in common maize which are necessary for protein synthesis in humans. Such a balanced combination of amino acids in the endosperm results into its higher biological value ensuring more availability of protein to human and animal than common maize or even all cereals and pulses [9].

The total amount of protein in QPM is not actually increased, but rather the protein is enhanced so that it delivers a higher benefit when consumed by monogastric beings like humans and pigs. Conophor nuts (*Tetracarpidium conophorum*) is found in Nigeria and Cameroon while coulaedulis (family olacaceae) which is also referred to as African walnut is found in Congo, Gabon and Liberia. *Tetracarpidium conophrum* is a climbing shrub 10-20 ft long, it is called in southern Nigeria by the Igbo as ukpa, the Yoruba in western Nigeria as “Awusa/ asala”, to the littoral and western Cameroon“kaso or ngak” [10].

This plant is grown principally for the nuts which are cooked and consumed as snacks [11]. It has a bitter taste which is observed upon drinking water immediately after eating the nuts. This is due to the presence of chemical substances such as alkaloid. The edible seeds are extensively eaten throughout the southern states of the country. These are available in June – September when other fruits are scarce, and people cherished eating the succulent seeds [12]. Several authors [13,14] reported that the fruits yield 47.72% crude protein and 50% fats and oils (Conophor oil) which are of domestic and industrial importance. It is revealed that the macerated leaves and roots are used traditionally for the treatment of asthma and hypertension [12].

Walnut has lot of health benefits. This nut containsomega-3 essential fatty acids, a special type of protective fat the body cannot manufacture. Walnuts' concentration of omega-3s (a quarter-cup provides 90.8% of the daily value for these essential fats) has many potential health benefits ranging from cardiovascular protection to the promotion of better cognitive function, to anti-inflammatory benefits helpful in asthma, rheumatoid arthritis, and inflammatory skin diseases such as eczema and psoriasis. Walnut contains an antioxidant compound called ellagic acid which supports the immune system with several anticancer properties. Generally, nuts are far richer in minerals than meat. Diets containing walnut has also been observed to lower serum cholesterol.

There is little or no information on the use of walnut for the production of complementary foods.

The objective of this study is to formulate high energy protein low cost complementary food

from a blend of QPM and walnut and to evaluate the nutritional quality of such foods using rat feeding.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

Sample of the Quality Protein Maize of yellow maize grains (ART 98/SW1) was obtained from the Institute of Agriculture, Research and Training (IAR&T) Moor Plantation Apata, Ibadan, Oyo State, Nigeria. Walnuts seeds were obtained from local market in Ibadan, Oyo State, Nigeria.

2.2 Sample Preparation

2.2.1 Fermented maize flour production

The method described by Adewusi et al. [15] was used. Quality Protein maize (1.5 kg) was steeped in 3 litres of tap water at room temperature for three days. The steep water was decanted, and the fermented grains were washed with clean fresh water and wet milled. The bran was removed by sieving and the remaining solid matter 'Ogi' was allowed to settle. The water was decanted, and the ogi was further drained of water and air-dried for 24 hr and in the oven at 50°C for 48 hr. The dry powder milled and kept in desiccators at room temperature until needed.

2.2.2 De-Fatted Conophor nut (Walnut) flour production

The seeds were dehulled, adhering testa were removed, sliced, washed and boiled for 1 hour as described by Giami and Bekebain [16] and dried. The seeds were all dried at 50°C, milled, sieved to pass through 200 µm sieve and defatted using n-hexane solvent for 8 hr and packaged in polyethylene containers for further analysis.

2.2.3 Formulation of the complementary diets

The complementary food was made into two samples: A (control) made up of 100% Quality protein maize and B made up of blend of 76% Quality protein maize and 24% Defatted Walnut flour. The mixes obtained were thoroughly blended with a laboratory blender, packed, and sealed in high density polythene bags until required.

2.3 Analytical Methods

Proximate analysis (moisture, protein, fat, ash and crude fiber) was carried out on the samples according to the methods described by AOAC [17]. Carbohydrate content was calculated by difference.

2.4 Microbial Analysis of the Diets

The microbial loads, bacteria and fungi were determined as total viable count of microbes using the method described by Pelczar and Chan [18]. The loads were expressed as the number of colony forming units (cfu) per gram of test sample. The spread technique was used. The solutions of the sixth (10^{-6}) and fourth (10^{-4}) dilutions were used for bacterial and fungal analysis, respectively.

For bacterial culture, nutrient agar was used, while potato dextrose agar was used for fungal culture, 0.1 cm^3 of the required dilution of the test sample was aseptically inoculated on the sterile growth media with the aid of a flamed glass hockey. The petri dishes were incubated in a gallenkamp incubator at 37°C for 24 h for bacteria and at room temperature for fungi. Counting of the colonies was done using Gallenkamp colony counter.

2.5 Biological Evaluation of the Products

Twenty one wistar rats (Male and Female) weighing between 64 -65 g were obtained from the animal breeding centre, Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Ibadan, Ibadan. They were randomly distributed into three groups each consisting of 4% casein for a period of 5 days. After the 5 day period, the animals were reweighed and regrouped for control, basal and experimental diets. Water and food were given ad libitum. The diets were fed to the animals for a period of 28 days. This period is nutritionally accepted to be long enough to observe biological and chemical changes in animal tissues. Weighed diet was given and unconsumed diet collected and weighed daily, while live weight of the animals were determined and recorded twice a week throughout the experimental period. At the end of test period, the rats were re-weighed.

2.6 Biological Assessment of the Diets

A basal diet was prepared according to Fanimo [19] as reported by Osundahunsi and Aworh [2].

2.7 Statistical Analysis

Data obtained were subjected to statistical analysis using t-test.

3. RESULTS AND DISCUSSION

Table 1 show the proximate composition of the complementary food from Quality protein maize and Conophor nuts. The result showed the control diet (100% Quality protein maize) contained 9% protein, 4.22% fat, 76.68% Carbohydrate, 1.17% Fiber, 0.61% ash and 8.20% moisture while the formulated blend (Quality Protein Maize and Defatted Conophor nut) have 17.69% protein, 1.64% fat, 70.64% Carbohydrate, 2.19% Fibre,1.00% ash and 9.03% moisture. There was significant difference observed between the results for protein, fat, carbohydrate, fiber and moisture ($p>0.05$). The protein (17.57%), fibre (2.19%), Ash (1.00%) and Moisture (9.03%) contents of the complementary food were higher than the control samples (9.00%, 1.17%, 0.61%, and 8.20%). The results of the fat (1.64%) and carbohydrate (68.45%) for the formulated diet were lower than the control samples (4.22% and 76.68%). The decrease in fat and carbohydrate content of the formulated diet was as a result of substitution of the Conophor nut flour with the quality protein maize, while the level of substitution favoured increase in protein content, fiber, Ash and moisture level. The calculated energy value of the control sample was 380.7 kcal/g and formulated diet was 380.92 kcal/g. These results were similar to those reported by Osundahunsi and Aworh [2] and Fashakin and Ogunsola [4].

3.1 Nutritional Component and Microbial Quality of Animal Fed with the Complementary Diet

Results of the biological evaluation of protein quality of the formulated diet and control diet are presented in Table 3. Protein qualities results for the formulated diet were 0.22, 2.15, 1.28 and 20.51 for FER, PER, NPR and PRE respectively. There was no significant difference ($P<0.05$) among the protein quality attributes of experimental diet compared to casein control diet. Similar results were observed for maize based complementary foods enriched with cowpea and soybean tempe (Osundahunsi and Aworh, 2012) and complementary foods from blends of fonio [1]. The PER values reported were 2.3-2.5, these values were the same with results obtained in similar study [20]. The presence of pathogenic microorganisms in weaning diet is not desirable because they

Table 1. Proximate composition of the formulated complementary diet

Samples	Protein	Fat	Carbohydrate	Fiber	Ash	Moisture	Energy
A	9.00±0.3	4.22±0.52	76.68±0.16	1.17±0.05	0.61±0.01	8.32 ±0.32	380.7 ±2.2
B	17.69±1.02	1.64±0.52	68.45±1.7	2.19±0.1	1.00±0.05	9.03 ±0.51	368.08±4.4

Values are means ± standard deviations of triplicate determinations.
Key: A (Control): 100% Quality protein Maize; B (Diet): Formulated diet (76% Quality protein maize and 24% defatted conophor nut flour)

Table 2. Biological response of rats fed with the formulated diets

Diet	Mean wt. gain	Feed intake	Protein intake	Feed efficiency ratio (FER)	Protein efficiency ratio (PER)	Corrected PER**	Net protein retention	Protein retention efficiency	Feed conversion ratio (FCR)
Casein	66	256	25.6	0.25	2.54	2.5	1.88	30.00	3.94
(B) Diet	42	195	19.5	0.22	2.15	2.12	1.28	20.51	4.64

Table 3. Microbial quality of formulated complementary diet

Samples	Total bacterial counts (cfu/g)	Total coliform counts (cfu/g)	Total fungi counts (cfu/g)	Staphylococcus counts (cfu/g)	Salmonella counts (cfu/g)
Control	1.1×10^5	NG	NG	1.0×10^4	NG
Diet	1.1×10^5	NG	NG	1.0×10^4	NG

Values are means ± standard deviations of triplicate determinations

usually cause diarrhea and vomiting in children leading to dehydration. The total bacterial count for formulated diet is within the permissible level [20]. The presence of *Staphylococcus aureus* in the diet is directly a function of the environment, handling, processing, packaging and storage condition [20].

4. CONCLUSION

The investigation revealed that combinations of QPM and Conophor nut (Walnut) increased the protein quality and chemical composition of the formulated diet. The proximate composition of the formulated diet and biological evaluation showed that formulated diet quality is within the same range with casein diet as obtained from rat feeding experiment. The microbial load is within an acceptable limit.

ETHICAL APPROVAL

The research was approved by the Federal University of Technology Akure.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Olapade AA, Aworh OC. Evaluation of extruded snacks from blends of acha (*Digitaria exilis*) and cowpea (*Vigna unguiculata*) flours. Agric. Eng. Int. CIGR Journal. 2012;14(3):210-217.
2. Osundahunsi OF, Aworh OC. Nutritional evaluation, with emphasis on protein quality of maize based complementary foods enriched with soya bean and cowpea tempe. International J. Food Sci. Technology. 2003;38:809-813.
3. Solomon M. Nutritive value of three potential complementary foods based on cereals and legumes. Afr. J. Food Nutr. Sci. 2005;5(2):1-14.
4. Fashakin JB, Ogunsola E. The utilization of local foods in formulation of weaning foods. Trop. Paediatr. (London) 1982;28: 93-96.
5. WHO. International Code of Marketing of Breastmilk Substitutes. World Health Organization. Geneva; 1981.
6. WISHH. World initiative for soy in human Health in weaning foods: Characteristics, guidelines and the role of soy foods. St. Louis, MO, 63141, USA; 2006. Available:www.wishh.org
7. Obatolu VA, Cole AH. Functional property of complementary blends of soybean and cow pea with malted or unmalted Maize. Food Chem. 2000;70:147-153.
8. Ghadge PN, Vairagar PR, Prasad K. Physical properties of Chick Pea Split (*Cicer arietinum* L.) Agricultural Engineering International: The CIGR Ejournal. Manuscript: P 07039. 2008;X:1-8.
9. Ojofeitimi EO. A healthy life: Your birthright. OAU Press Ltd. OAU Ile-Ife; 2008.
10. Dalziel JM. The useful plants of west Tropical Africa. Whitefriars Press, London. 1937;164.
11. Oke, O.L., (1995). Leaf Protein Research in Nigeria Ibadan. University of Ibadan Press, USA.
12. Egharevba RK, Ikhatua MI, Kalu C. The influence of seed treatments and growing media on seedling growth and development of Africa Walnut, *Plukenetia conophorum*. African Journal of Biotech. 2005;4(8):808-811.
13. Okafor JC. Improving edible species of forest product. Unasylva. 1991;42(165): 17-22.
14. Udeala OK, Onyechi JO, Agu SL. Preliminary evaluation of Dika fat.A new tablet lubricant. J. Pharm. Pharmacol. 1984;32:6-9.
15. Adewusi SRA, Orisadare BO, Oke OL. Studies on the weaning diets in Nigeria 2 protein sources. Plant Foods Hum. Nutr. 1991;42:183-192.
16. Giami SY, Bekebain OA. Proximate composition and functional properties of raw and processed full fat fluted pumpkin (*Telfairia occidentalis)* seed flour. J. Sci. Food Agric. 1992;59:321-325.
17. AOAC. Official methods of analysis 22nd edition. Association of Official Analytical Chemist. Washington. D.C.; 2005.
18. Pelczar MJ, Chan ECS. Laboratory exercise in microbiology. Bank Pot. Inc, New York, USA; 1977.
19. Fanimo AO. Substitution of Soyabean and animal by-products for fish meal in pig

rations. Ph.D Thesis Department of Animal Science, University of Ibadan; 1991.

20. Adedokun OA. Nutritional evaluation of complementary diets formulated from blends of Conophor Nut (*Tetracarpidium conophorum*), fluted pumpkin (*Telfairia occidentalis*) and quality protein Maize flour. Ph.D Thesis of the Department of Food Science and Technology, Federal University of Technology Akure, Ondo State; 2015.

Peer-review history:
The peer review history for this paper can be accessed here:
http://prh.sdiarticle3.com/review-history/27233