

# Nutritional Composition, Functional and Organoleptic Properties of Breakfast Cereals Formulated from Acha, Wheat, Cashew Kernel and Prawn

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**Abstract** — Acha grains and cashew kernels were processed into flour while prawn was processed into powder. Acha flour was used to substitute wheat flour while a constant percentage of cashew kernel flour and prawn was used as an enrichment in the formulation of breakfast cereals at the ratios of 70:0:20:10, 60:10:20:10, 50:20:20:10, 40:30:20:10, 30:40:20:10, 20:50:20:10, 10:60:20:10 and 0:70:20:10 of acha/wheat/cashew kernel/prawn and labeled A-H samples, respectively. The nutritional, functional and organoleptic properties of the formulated breakfast cereal was studied. The result revealed that the proximate compositions of the breakfast cereals ranged between 3.94-9.46% for moisture content, ash 2.09-2.98%, fat 8.30-15.20%, protein 9.17-14.65%, crude fibre 1.28-1.60%, and carbohydrate 60.97-76.66% with significant different (SD) between some samples and no SD in some other samples. Functional properties' result showed that the bulk density of the breakfast cereals ranged between 0.49-0.55 g/g, water absorption capacity 1.74-2.20 g/ml, oil absorption 0.18 - 1.09g/ml and the least gelation capacity of 2% in all the samples. Based on the 9-point hedonic scale used in the assessment of the organoleptic properties of the breakfast cereals, all the samples were acceptable by the panelists but 40:30 of acha/wheat compared very well with the sample substituted with 0:70 of acha/wheat. This is an indication that acha grains can be a useful raw material in the substitution of wheat while cashew kernel and prawn can be used to enrich the product formulated from the flours of these raw materials. This will increase the utilisation of abundant Nigerian raw materials, reduce the importation of wheat flour and hence, improve the economy of the country.

**Index Terms** — Breakfast cereals, Acha grains, Cashew kernels, Prawns, Plant protein, Essential amino acids.

## I. INTRODUCTION

Breakfast cereal was defined to include ready-to-eat breakfast cereal, oats/porridge and muesli [1]. They are food products made from processed grains that is often eaten as the first meal of the day [2]. Breakfast cereals, though consumed dry in the early hours of the day, serve as a good source of strength which is vital requirement for the human body. They are not usually consumed alone but supplemented with other food classes [3]. They can be categorized into traditional hot cereals that require further heating or cooking before consumption or ready to eat cereals that is customarily eaten with cream or milk [4]. Ready to eat cereals are increasingly gaining acceptance in most developing countries and gradually displacing most

traditional diets that serve as breakfast due to convenience, nutritional values and job demands [5].

Acha (*Digitaria exilis*) is one of the world's fastest growing grains and its highly nutritious [6] like other cereals such as wheat, rice and maize. Temple and Bassa [7] stated that Acha contains 6.9% protein, 2.10% fat, 87.48% carbohydrate, 1.02% crude fibre and 2.44% mineral salts. Anyika [8] also indicated crude protein content of 5.75, fat 3.35, 1.08 total ash, 6.83 moisture and 83.38% carbohydrate values of acha. It is highly rich in carbohydrate and protein, as well as sulphur containing essential amino acids such as methionine and cystine compare to legumes [9]-[11]. Acha can be supplemented to a protein rich foods to make an adequate diet [7] or as a complement for standard diets [12], depending on the contents of the second limiting amino acids like threonine in cereals and tryptophan in legumes [13] such as pap and bean balls, a popular Nigerian breakfast made from maize and beans.

Cashew nut (*Anacardium occidentale*) is a heart-like shaped fruit grown in Africa and West Indies [14]. In the last few years, the production of cashew nuts in Nigeria has increased from 30,000 tons in 1990 to 176,000 tons in 2000 [15]. About 60% of cashew kernels are consumed in form of snacks while 40% are used in the manufacture of confectioneries [16]. Cashew kernel is a rich source of fat 46% and carbohydrates 25%, protein within a range of 20.5-21.0%, crude fibre 1.2-1.5% and a good source of calcium, phosphorus and iron [17], [18]. Brufau et al. [19] also stated that the edible part of the nut contains 47.8 g crude fat, 29.9 g carbohydrate, 16.8 g protein and 574 kcal energy per 100 g intake.

Prawn is a popular food material for consumers because of its delicacy and rich nutrient density. Prawns are relatively inexpensive excellent source of animal protein and several vitamins and minerals. They have become the major source of animal protein to the low income earners due to their low price and availability [20], predominantly in developing countries where animal protein is pricey and beyond the reach of the underprivileged [21]. In addition to its supply of quality proteins and vitamins (A, C and D), they are good source of dietary minerals such as calcium, phosphorus, iron, magnesium among others, which are beneficial for human maintenance [22]. Minerals are essential chemical elements which are involved in the building of human body and are necessary for appropriate functioning of the immune system [23].

Most cereals are limited in some essential amino acids like threonine and tryptophan, though rich in lysine but cannot effectively provide nutrients required by the body especially during the early hours of the day when the supply

Published on September 17, 2020.  
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of nutrients from the previous day is exhausted [24]. However, blends and consumption of proteins from plant sources and cereals in food product development is required [25], [26], since combination of legumes and grains provide high quality cheaper protein that contains all essential amino acids in proper proportion, because their amino acids complement each other [27]. Cereals can also be supplemented with most cheap and abundant oily seeds, nuts and animal products such as prawn to improve the nutritional value of the resulting cereal blends compared to the individual components alone [28]. Hence, this study aimed to formulate breakfast cereals from the blends of acha, wheat, cashew kernel flours and prawn powder and to evaluate the nutritional, functional and organoleptic properties of the resultant blends.

## II. MATERIALS AND METHOD

### A. Materials

Acha (*Digitaria exilis*) grains were purchased from Jalingo, Taraba State, cashew (*Anacardium occidentale*) nuts were purchased from 9<sup>th</sup> mile market, Enugu State while prawns, wheat flour, sugar and sunflower cooking oil were purchased from Shoprite Supermarket, Port Harcourt, Rivers State. All these materials were transferred to the Laboratory of Food Science and Technology Department, Rivers State University, Port Harcourt, Nigeria for processing and analysis. All chemicals used for this study were obtained from the same Department and of analytical grade.

### B. Sample Preparation

Acha grains and cashew nuts were properly cleaned and sorted to remove dirt and other extraneous matter, the prawns were selected to ensure they are free from diet and small stones while wheat was properly sieved before they were used for further processing.

### C. Processing of Acha Grains and Cashew Nuts into Flour and Prawns into Powder

Acha grains and cashew nuts were processed into fours using the method described by Ibrahim [29] and Emelike et al. [30], respectively. Prawns were processed into powder by removing their head after sorting out of unwanted ones. The main body of the prawns were grounded into powdery form using Kenwood kitchen blender (model A907D, U.K) and they were sieved using 0.4 mm particle size sieve and packaged in air tight container for further usage.

### D. Preparation of the Breakfast Cereals

Breakfast cereals were prepared using the method of Usman [5] with some modifications. Composite flour was formulated from varying quantities of acha/wheat and constant quantities of cashew kernel/prawn at the ratios of 70:0:20:10, 60:10:20:10, 50:20:20:10, 40:30:20:10, 30:40:20:10, 20:50:20:10, 10:60:20:10, 0:70:20:10 (acha/wheat/cashew kernel/prawn) and labeled A-H samples, respectively as presented in Table 1. Sugar, vegetable oil and water were appropriately mixed together with the individual samples at constant quantities of 5 g, 10 ml and 100 ml, consecutively and baked in an oven at 150°C for 40 min. The samples were cooled at room temperature and adequately packaged until required for further analysis.

TABLE 1: FORMULATION FOR BREAKFAST CEREALS FROM THE FLOURS OF ACHA, WHEAT, CASHEW KERNELS AND PRAWN POWDER

Ingredients	Samples							
	A	B	C	D	E	F	G	H
AF (g)	70	60	50	40	30	20	10	0
WF (g)	0	10	20	30	40	50	60	70
CF (g)	20	20	20	20	20	20	20	20
PP (g)	10	10	10	10	10	10	10	10
Sugar (g)	5	5	5	5	5	5	5	5
Oil (ml)	10	10	10	10	10	10	10	10
Water (ml)	100	100	100	100	100	100	100	100

Key: AF: Acha Flour, WF: Wheat Flour, CF: Cashew Flour, PP: Prawn Powder.

### E. Analysis of the Produced Breakfast Cereal Blends

#### a) Proximate evaluation

The cereal breakfast blends were evaluated of moisture, crude fat, crude protein, total ash and crude fibre using the approved standard of AOAC [31] method while carbohydrate was determined the Clegg Anthrone method as described by Osborne and Voogt [32].

#### b) Functional evaluation

Bulk density, water absorption, oil absorption and gelation capacities of the breakfast cereal blend samples were determined using the method described by Onwuka [33].

#### c) Sensory evaluation

The eight formulated samples of the cereal blends were served to 20 panelists consisting of students and staff of the Department of Food Science and Technology, Rivers State University, Port Harcourt at about 9:30am using a 9-point

hedonic scale ranging from 1-9 which represented dislike extremely and like extremely, respectively. The samples were served with warm water and milk for the final preparation of the breakfast cereals. The panelists were instructed to assess the product for taste, aroma, appearance, mouth feel, crispness and overall acceptability. Portable drinking water and disposable cups were provided for the panelists for raising of their mouths in between the assessment of each sample to prevent the transfer of sensory parameters from one sample to another [34].

### F. Statistical Analysis

All data obtained were subjected to a one-way Analysis of Variance (ANOVA) using Statistical Package for Social Science (SPSS), version 20.1, year 2011. Least Significant Differences (LSD) test was used to separate the means where significant difference existed at 5% levels of probability.

Results were expressed as mean values and standard deviation of triplicate determinations.

### III. RESULTS AND DISCUSSION

#### A. Proximate Compositions of the Breakfast Cereal Blends

The proximate composition of the blends formulated from acha, wheat, cashew kernel and prawn revealed that there was a significant difference ( $p < 0.05$ ) in the moisture content of some samples while there was not in some others with the range of 3.94-9.45% for samples H as the highest and B the lowest as presented in Table 2. It was observed that the increasing substitution level of acha flour caused a decreased in the moisture content of the blends. Generally, the samples had low moisture content which implied that they could have an extended shelf life in their raw form. It has been stated that moisture content of a food affects its stability and overall quality [35].

The ash content of the blends ranged from 2.09-2.98% with no significant difference ( $p < 0.05$ ) among all the samples. Ash content of the breakfast cereals decreased with increased in acha flour substitution. Ash content is the residue remaining after destroying combustible organic matter. The value of the ash obtained is comparable to the value of 1.98% to 2.40% reported by Usman et al. [36] for breakfast cereals formulated from local rice, soya beans and defatted coconut flours. The ash content gives an overall estimate of the total mineral elements present in the food.

Values for crude fat ranged from 8.30 - 15.20% (E and B samples, respectively) with significant difference ( $p < 0.05$ ) among all the samples excluding G and H samples. Dietary fat that provides essential fatty acids has been shown to

enhance the taste and acceptability of food products, slows gastric emptying and intestinal motility. Thus, prolonging satiety and facilitating the absorption of water soluble vitamins [37].

There was no significant difference ( $p < 0.05$ ) in the protein content of samples B, C, E and F while samples D, G and H had significantly highest values of 14.64, 14.35 and 14.65%, respectively. The protein content of the blends was higher than that of pap known as ogi in Yoruba and akamu in Igbo tribes, a popular Nigerian breakfast cereal which has been reported to contain 10.92% protein [35]. This implies that the formulated breakfast cereals in this study will serve as a good source of protein. Hence, consuming it will enable the body to derive good amount of protein which will enhance day-to-day activities of the body system than the popular known ogi. This could however help in preventing protein-carbohydrate malnutrition which is wide spread in Africa.

Fibre content ranged from 1.28-1.60% for samples G and H with significantly lowest and highest values, respectively. Fibre is important for the removal of waste products from the body thereby preventing constipation, colon cancer, heart failure and many other health disorders. Consumption of plant fibre has been shown to reduce cholesterol level, risk of coronary heart diseases and insulin sensitivity [35]. The fibre content of the breakfast cereals was lower as compared to that formulated from blends of local rice, soybeans and defatted coconut flour with values of 2.11-3.30% [36]. This could be attributed to the natural fibre contents of the food materials used in the blends.

TABLE 2: PROXIMATE COMPOSITIONS OF THE BREAKFAST CEREAL BLENDS

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
A	6.93±0.05 <sup>b</sup>	2.09±0.10 <sup>ab</sup>	12.99±0.01 <sup>c</sup>	9.17±0.00 <sup>d</sup>	1.35±0.02 <sup>bc</sup>	67.48±0.15 <sup>c</sup>
B	3.94±0.25 <sup>d</sup>	2.14±0.24 <sup>ab</sup>	15.20±0.00 <sup>a</sup>	13.06±0.00 <sup>bc</sup>	1.42±0.01 <sup>b</sup>	64.25±0.02 <sup>d</sup>
C	7.49±0.47 <sup>b</sup>	2.54±0.95 <sup>a</sup>	14.35±0.05 <sup>b</sup>	13.06±0.00 <sup>bc</sup>	1.32±0.00 <sup>c</sup>	61.25±0.43 <sup>e</sup>
D	4.19±0.10 <sup>d</sup>	2.39±0.30 <sup>a</sup>	10.80±0.10 <sup>d</sup>	14.64±0.22 <sup>a</sup>	1.33±0.01 <sup>c</sup>	76.66±0.28 <sup>a</sup>
E	4.91±0.02 <sup>cd</sup>	2.13±0.05 <sup>ab</sup>	8.30±0.00 <sup>f</sup>	13.30±0.22 <sup>b</sup>	1.42±0.00 <sup>b</sup>	69.95±0.15 <sup>b</sup>
F	5.21±0.07 <sup>c</sup>	2.22±0.13 <sup>a</sup>	12.41±0.01 <sup>c</sup>	13.46±0.35 <sup>b</sup>	1.55±0.05 <sup>a</sup>	65.17±0.60 <sup>d</sup>
G	5.11±0.07 <sup>c</sup>	2.33±0.05 <sup>a</sup>	9.40±0.00 <sup>e</sup>	14.35±0.00 <sup>a</sup>	1.28±0.03 <sup>c</sup>	67.54±0.16 <sup>c</sup>
H	9.46±0.08 <sup>a</sup>	2.98±0.00 <sup>a</sup>	9.36±0.04 <sup>c</sup>	14.65±0.00 <sup>a</sup>	1.60±0.00 <sup>a</sup>	60.97±0.11 <sup>e</sup>
LSD	0.70	1.22	0.15	0.47	0.07	1.04

Values with the same superscript letter within the column are not statistically different ( $p < 0.05$ ).

Key: A = Acha/Wheat/Cashew kernel/Prawn (70:0:20:10), B = (60:10:20:10), C = (50:20:20:10), D = (40:30:20:10), E = (30:40:20:10), F = (20:50:20:10), G = (10:60:20:10), H = (0:70:20:10).

#### B. Functional Properties of the Breakfast Cereal Blends

Bulk density of the breakfast cereals ranged from 0.49-0.55 g/g for C and H samples, respectively with no significant different ( $p < 0.05$ ) in all the formulations as shown in Table 3. Bulk density gives an indication of the volume of packaging materials required, transportation of food products and it decreases porosity of materials due to surface properties [38]. High bulk density is a good physical attribute when determining the mixing quality of a particulate matter [39]. Bulk density is a reflection of the load the flour samples can carry if allowed to rest directly on one another. Higher bulk density is desirable for greater ease of dispensability of flours. In contract, however, low bulk density would be an advantage in the formulation of

complementary food. The low bulk density values recorded in this study could therefore be advantageous in the preparation of weaning food formulas.

The result showed that the breakfast cereal samples had significantly ( $p < 0.05$ ) high water absorption capacity (WAC) except samples F and G. There was a decrease in the WAC from 2.20-1.74 g/ml for samples A and G as the substitution level of Acha flour decreased. A sudden increase was observed at 70% substitution level of wheat flour maintaining no significant different with the sample substituted with 70% level of acha flour. This observation could be due to the water binding, properties of acha and wheat protein. Water absorption capacity is important in bulking and consistency of product as well as in baking applications [40].

The oil absorption capacity (OAC) of the breakfast cereals ranged from 0.18-1.09 g/ml. Samples A, B, E and H were not significantly ( $p < 0.05$ ) different from each other, as well as samples C and D while significant variation existed between F and G samples. The relatively high oil absorption capacity of the breakfast cereals suggest that it will be useful

in food formulation where oil holding capacity is required such as in bakery products.

The least gelation capacity of the formulated breakfast cereals was 2% in all samples. The result of this study suggests that Acha, wheat and cashew kernel flours would be useful in food formulations such as bakery products which require hydration to improve handling features.

TABLE 3: FUNCTIONAL PROPERTIES OF THE BREAKFAST CEREAL BLENDS

Samples	Bulk Density (g/g)	Water Absorption (g/ml)	Oil Absorption (g/ml)	Least Gelation (%)
A	0.51 ± 0.01 <sup>a</sup>	2.20±0.01 <sup>a</sup>	0.20±0.00 <sup>d</sup>	2
B	0.54 ± 0.01 <sup>a</sup>	2.04±0.05 <sup>a</sup>	0.19±0.02 <sup>d</sup>	2
C	0.49 ± 0.04 <sup>a</sup>	2.07±0.09 <sup>a</sup>	1.09±0.01 <sup>a</sup>	2
D	0.52 ± 0.01 <sup>a</sup>	2.05±0.00 <sup>a</sup>	1.02±0.01 <sup>a</sup>	2
E	0.52 ± 0.04 <sup>a</sup>	2.07±0.12 <sup>a</sup>	0.18±0.03 <sup>d</sup>	2
F	0.51 ± 0.02 <sup>a</sup>	1.76±0.03 <sup>b</sup>	0.80±0.00 <sup>b</sup>	2
G	0.50 ± 0.00 <sup>a</sup>	1.74±0.01 <sup>b</sup>	0.34±0.05 <sup>c</sup>	2
H	0.55 ± 0.03 <sup>a</sup>	2.19±0.00 <sup>a</sup>	0.20±0.00 <sup>d</sup>	2
LSD	0.20	0.07	0.03	

Values with the same superscript letter within the column are not statistically different ( $p < 0.05$ ).

Key: A = Acha/Wheat/Cashew kernel/Prawn (70:0:20:10), B = (60:10:20:10), C = (50:20:20:10), D = (40:30:20:10), E = (30:40:20:10), F = (20:50:20:10), G = (10:60:20:10), H = (0:70:20:10).

### C. Organoleptic Properties of the Breakfast Cereals

The result showed that the score for taste of the breakfast cereals ranged from 4.40 - 7.10 with sample A as the least preferred and sample G as the most preferred as presented in Table 4. There was no significant difference ( $p < 0.05$ ) between C, D, E, F, G and H samples while samples A and B had significantly low sensory scores. This implies that the taste of the breakfast cereals was acceptable up to 50:20 of acha/wheat flours but the most acceptable taste was the formulation of up to 40% level of acha. Chukwu and Abdul-Kadir [41] reported that acha contributed to the good taste of breakfast cereals. Scores for aroma and appearance ranged from 5.30 - 6.45 and 5.45-7.10 with samples F and H as least and most preferred and same as B and C samples, respectively. Mouth-feel ranged from 5.65-6.70 with sample F as least preferred and H the most preferred. There was no significant difference between samples C, D, E, G and H with

the highest scores for mouth-feel while others had low sensory scores. Crispness ranged from 5.75-6.90 with samples A and B as least preferred in both cases and sample G as the most preferred. Overall acceptability of the breakfast cereals ranged from 5.25-6.95 with sample G as the most preferred and sample A as least preferred. The overall acceptability of the breakfast cereals produced with 40% acha substitution level to wheat compared favourably with those produced with 0% acha level. This is in agreement with the report of Mbaeyi-Nwaoha and Uchendu [42] who stated that the sensory qualities of breakfast cereals produced from the blends of acha and fermented soybean paste were acceptable by the panelists. This signifies that breakfast cereals can be formulated from the blends of acha/wheat/cashew kernel/prawn at the ratios of 40:30:20:10, respectively without altering the sensory characteristics of the product.

TABLE 4: THE ORGANOLEPTIC SCORES OF THE BREAKFAST CEREAL BLENDS

Samples	Taste	Aroma	Appearance	Mouth-feel	Crispness	Overall Acceptability
A	4.40 <sup>c</sup>	5.90 <sup>b</sup>	6.30 <sup>ab</sup>	5.80 <sup>b</sup>	5.75 <sup>b</sup>	5.25 <sup>c</sup>
B	4.75 <sup>c</sup>	5.80 <sup>b</sup>	5.45 <sup>c</sup>	6.00 <sup>b</sup>	5.75 <sup>b</sup>	5.50 <sup>b</sup>
C	5.90 <sup>b</sup>	6.05 <sup>ab</sup>	7.10 <sup>a</sup>	6.65 <sup>a</sup>	6.00 <sup>ab</sup>	6.15 <sup>bc</sup>
D	6.80 <sup>a</sup>	6.35 <sup>a</sup>	6.60 <sup>a</sup>	6.55 <sup>a</sup>	6.40 <sup>ab</sup>	6.20 <sup>ab</sup>
E	6.25 <sup>ab</sup>	6.00 <sup>ab</sup>	6.30 <sup>ab</sup>	6.20 <sup>ab</sup>	6.80 <sup>a</sup>	6.35 <sup>ab</sup>
F	6.20 <sup>ab</sup>	5.30 <sup>bc</sup>	6.45 <sup>a</sup>	5.65 <sup>b</sup>	6.20 <sup>ab</sup>	6.70 <sup>a</sup>
G	7.10 <sup>a</sup>	6.15 <sup>ab</sup>	7.05 <sup>a</sup>	6.65 <sup>a</sup>	6.90 <sup>a</sup>	6.95 <sup>a</sup>
H	6.00 <sup>b</sup>	6.45 <sup>a</sup>	6.95 <sup>a</sup>	6.70 <sup>a</sup>	6.00 <sup>ab</sup>	6.50 <sup>a</sup>
LSD	0.96	1.01	0.80	0.98	0.90	1.00

Values with the same superscript letter within the column are not statistically different ( $p < 0.05$ ).

Key: A = Acha/Wheat/Cashew kernel/Prawn (70:0:20:10), B = (60:10:20:10), C = (50:20:20:10), D = (40:30:20:10), E = (30:40:20:10), F = (20:50:20:10), G = (10:60:20:10), H = (0:70:20:10).

## IV. CONCLUSION

The produced breakfast cereals were rich in protein, fat, carbohydrates and ash contents. Hence, this product can solve the problems of protein energy malnutrition in developing countries and the flour blends can serve as functional ingredient in food formulations. Substitution of acha flour up to 40% compared favorably with the highest level of wheat substitution which is 70% in all the organoleptic properties measured. This signifies that acceptable breakfast cereals formulated from acha, wheat,

cashew kernel and prawn flours were produced. This study has provided another means for the utilisation of acha cereal grains, cashew kernel and prawns. The observed decrease in moisture content at increasing substitution levels of acha flour proves that the product will have an extended shelf life when passably packaged.



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- [2] Physico-chemical and sensory properties of cookies from wheat flour

and cashew-apple residue as a source of fiber. *Asian Journal of Agriculture and Food Science*, 3(2): 213-218.

- [3] Effect of treatments on the tannin content and quality assessment of cashew apple juice and the kernel. *European Journal of Food Science and Technology*, 5(4): 47-53.

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