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NUTRITIONAL COMPOSITION AND SENSORY EVALUATION OF BREAKFAST CEREAL FROM PEARL MILLET-COCONUT COMPOSITE FLOUR

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Abstract: *Nutritional composition [proximate composition, vitamins (A, C, B1, B9, B3), mineral (Calcium, Zinc, Iron, Potassium, Magnesium)] and sensory acceptability of breakfast cereal from pearl millet-coconut composite flour were evaluated in this study. Pearl millet (M) and coconut flour (C) were blended into five proportions (100M:0C, 90M:10C, 80M:20C, 70M:30C, 60M:40C) to produce breakfast cereal. Data obtained were subjected to analysis of variance (ANOVA). The proximate composition had mean values of 3.35-15.55% crude fat, 8.50-12.04% crude protein, 1.70-6.00% moisture content, 0.53-0.74% crude fibre, 0.80-1.50% crude ash, and 71.00-78.25% carbohydrates. Breakfast cereal from 60M:40C had the highest fat content (15.55%) while the least (3.35%) was observed for 100M:0C. The increasing substitution with coconut flour significantly decreased the protein, ash and carbohydrate content of the product. The mineral content of the breakfast cereal ranged between 274.83-483.51, 0.32-0.58, 0.82-1.47, 345.56-485.01, 105.27-189.13mg/100g for calcium, zinc, iron, potassium and magnesium, respectively. Breakfast cereal from 60M: 40C had the highest mineral content and potassium was the dominant mineral. The vitamin content ranged between 3.09-3.16, 3.18-3.50, 0.42-0.59 and 0.45-0.64 mg/100g for vitamins A, C, B9 and B3, respectively and 0.26 mg/100g for vitamin B1. All breakfast cereals were accepted by sensory panellists, however, breakfast cereal from 80M:20C had the highest overall acceptability (7.44), followed by 60M:40C (7.38), and 90M:10C (7.32), while the least accepted (5.98) was breakfast cereal without coconut flour (100M:0C). Therefore, coconut flour significantly improved the nutritional content of the breakfast cereal and the composite flour had nutrient composition that could provide better opportunity for its use in future food innovations.*
Keywords: *Breakfast cereal, Coconut flour, Pearl millet flour, nutritional composition.*

1. Introduction

Cereal grains make up a large amount of human and animal feed, they directly supply important nutrients and energy to humans through the consumption of animal-based products, as well as through their consumption [1]. Although, humans rely on a wide variety of plants for food, cereals have historically been the most significant source of nutrition [2]. They are grown for their edible seeds, which are a cheap and highly nutritious food source [3]. For many years, researchers have examined the role that morning cereals play in a balanced diet; the National Health and Medical Research Council states that morning cereals are an excellent source of important nutrients due to their high nutrient density, particularly when it comes to whole grain or high cereal Fibre varieties [4]. Even though there are many cereal grains, the majority of cereal-based products that are obtained industrially and traditionally, undoubtedly, come primarily from staple cereal crops like wheat and maize. Wheat, rice, and maize have long been important parts of diets worldwide, unfortunately, they are now occasionally thought to be a contributing factor in the malnutrition issue because they are high in calories and do not serve as significant sources of "nutrient-rich" meals. It is without doubts, that research must be redirected towards the advantages that

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other cereal grains like pearl millet, which have received less attention-can provide. Also, with the growing emphasis on combating food scarcity and achieving food security, as well as the call for sustainable agriculture, which aims to meet present-day food needs without compromising the ability of future generations to meet their own, pearl millet's importance cannot be underestimated. Coconut is referred to as a 'functional food' for its many health benefits in addition to its nutritional content (fat and protein) [5]. Because it does not contain any grains, coconut flour is a favourite among people following a gluten-free diet [6] and contains low amount of digestible carbohydrates. It is rich in dietary fibre which can enhance the overall fibre content of the cereal, contributing to better digestive health and maintaining a healthy weight. In addition to the nutty flavour of pearl millet, coconut flour has a sweet flavour profile, slightly sweet taste and a unique texture that can enhance sensory appeal. Additionally, it has important minerals including magnesium, potassium, iron with a modest quantity of protein and healthy fats for it to be discarded away or referred to as 'waste'. Its unique composition and health benefits make it a popular choice for individuals. Gluten-free food products enriched with coconut flour are a healthy and viable option for people with celiac disease [7], therefore combining coconut flour with pearl millet creates a more balanced nutrient profile, offering a variety of vitamins and minerals that may not be as abundant in either flour alone.

This research study was conceptualized to fill in the gaps in value addition efforts of pearl millet-coconut flour and to determine the nutritional composition and sensory characteristics of its breakfast cereal.

2. Materials and methods

2.1. Sample Preparation

2.1.1. Source of materials

Pearl millet used for this research work was procured from Eleweeran market in Abeokuta, Ogun, while processed and packaged whole coconut flour was purchased from Tosh Coconuts Limited, Omole, Lagos an agro-processing factory.

2.1.2. Production of breakfast cereal from pearl millet-coconut composite flour

Pearl millet flour was processed from the raw grains using a modified method [8]. The grains were washed in clean water, and decanted, after which they were oven-dried at 80 °C for 3 h in batches. The dried millets were then milled into flour using attrition mill and sieved through a 0.22 mm mesh. Pearl millet and coconut flour were weighed out in the derived formulation ratio and sieved (100M:0C, 90M:10C, 80M:20C, 70M:30C, 60M:40C), pearl millet and coconut flour, respectively as presented in Table 1.

To each sample, 125 mL of water, 7 g of sugar and 1 g of salt were added, after which all ingredients were homogenized and formed into a semi-solid paste (gruel). The paste was spread thinly on oven trays lined carefully with food-grade non-stick parchment paper, and was subjected to dehydration followed by toasting in a convection oven at a temperature of 130 °C for 25 min to obtain thin crispy flakes (Figure 1).

The flakes were cooled in closed air for about 2 min after which the end-product was packed into polythene zip-lock bag, and stored for further analysis.

2.2. Determination of proximate composition

Moisture content, crude fat, crude Fibre, and crude ash were determined according to the standard methods

Table 1.
Formulation ratio for pearl millet and coconut composite flour for breakfast cereal

Samples	Millet flour (%)	Coconut flour (%)
100M:0C	100	0
90M:10C	90	10
80M:20C	80	20
70M:30C	70	30
60M:40C	60	40

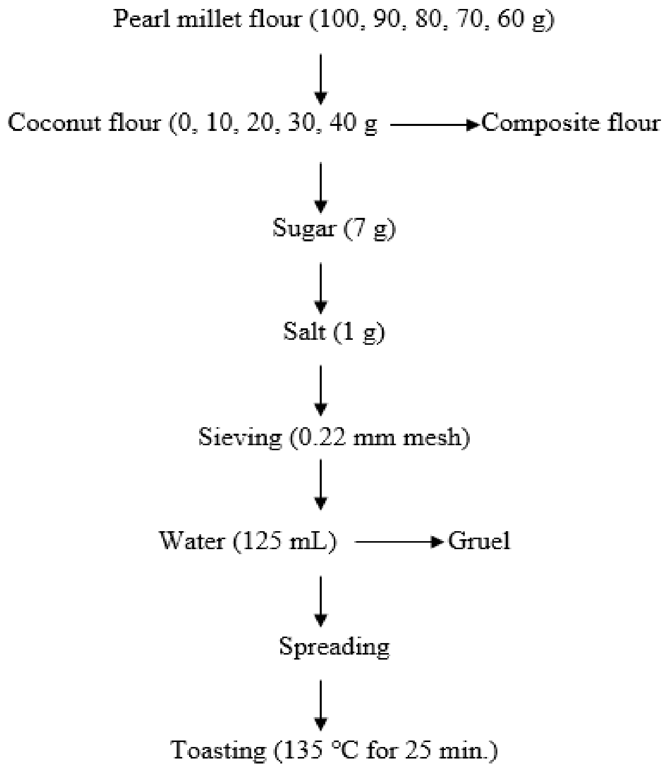

Fig. 1. Production of breakfast cereal from pearl millet-coconut composite flour [8]

of analyses described by the Association of Official Analytical Chemist [9]. Protein was determined using Kjeldahl method (AACC, 46-12.01). The carbohydrate content was estimated by difference as shown below:

Total carbohydrate = 100 – (fat + Fibre + ash + protein + moisture) (1)

2.3. Minerals and Vitamin Composition

The samples were reduced to powdery form, 5 g was weighed into a crucible and then transferred into a muffle furnace at 550 °C for 6 h in order to burn off organic matter and obtain the total inorganic matter. The crucible was cooled in a desiccator and then weighed. The mineral elements Ca, K, Mg, Zn, and Fe were determined by Atomic Absorption Spectrophotometry (DW-AA320N) [9]. The standard range for every element was prepared, and all operational guidelines for configuring the analysis tool were closely adhered to. The resulting ash residue was diluted with five milliliters of concentrated nitric acid, filtered, and then moved to a 100 mL volumetric flask where it was diluted with one hundred mL of distilled water. This was carried out for every sample, which was then kept at room temperature for additional AAS analysis. Vitamins A, B1, B3, B9, and C were also determined using standard methods [9]. The extract sample (0.5 g) was homogenized and saponified with 2.5 mL of 12% alcoholic potassium hydroxide in a water bath at 60 °C for 30 min. The saponified extract was transferred to a separating funnel containing 10-15 mL of petroleum ether and mixed well. The lower aqueous layer was then transferred to another separating funnel and the upper petroleum ether layer containing the carotenoids was collected. The extraction was repeated until the aqueous layer became colorless. A small amount of anhydrous sodium sulphate was added to the petroleum ether extract to remove excess moisture. The final volume of the petroleum ether extract was noted. The absorbance of the yellow color was read in a UV-Visible spectrophotometer (752 N Searchtech, USA) at 450 nm using petroleum ether as blank to determine Vitamin A. Vitamin B1 (Thiamine) was determined by measuring 50 mL of ethanolic sodium hydroxide and 5 g of the sample were homogenized and filtered in a 100 mL flask. To 10 mL of the filtrate, 10 mL of potassium dichromate was added. A blank was prepared simultaneously and the color developed was read at 360 nm. Determination of Vitamin B3 (Niacin) was carried out in a flask, 5 g of the sample was allowed to react with 50 mL of 1 N Sulphuric acid. The contents in the flask were shaken for 30 min. To this solution, 3 drops of ammonia solution was added and filtered. A volumetric flask comprising of 10 mL of the filtrate and 5 mL of potassium cyanide was taken and the solution was acidified with 5 mL of 0.02 N Sulphuric acid. The absorbance was measured by using a UV-Visible spectrophotometer (752 N Searchtech, USA) at 470 nm. Vitamin B9 (Folic acid) was determined by measuring 5 g of the sample and extracting100 mL of 50% ethanol. This solution was shaken for about 1 h and followed by filtration in a 100 mL flask. In a 50 mL of volumetric flask, 10mL of the extract was pipetted out. To this, 10 mL of 5% potassium permanganate and 10 mL of 30% hydrogen peroxide were added. It was allowed to stand on a hot water bath for 30 min. At this stage, 2 mL of 40% sodium sulphate was added and the solution was made up to 50 mL in a standard flask, aliquots were prepared. The absorbance was measured at 510 nm, spectrophotometrically. Ascorbic acid was determined according to the method of Klein and Percy (1982). Each method extract (20 mg) was extracted with 10 mL 0f 1 percent metaphosphoric acid for 45 min at room temperature and filter through Whatman no 4-filter paper. The filtrate (1 mL) was mixed with 9 mL of 2,6- dichloroindophenol and the absorbance was measured within 15 s at 515 nm against a blank content of ascorbic acid was calculated on the basis of the calibration curve.

2.4. Sensory Evaluation of Breakfast Cereal from Pearl Millet-Coconut Composite flour

Every participant was made aware of the samples' contents (ingredients), and their consent was sought before they took part in the sensory analysis. Fifty semi-trained panelists who frequently consume breakfast cereals participated in a preference test on the six samples of the pearl millet-coconut breakfast cereal [10]. A 9-point Hedonic scale, "dislike extremely" was scored as 1 and "like extremely" as 9, was used to score the following attributes: taste, crispiness, aroma, texture, color, appearance, and overall acceptability. After testing any of the samples, the panelists were told to thoroughly rinse their mouths with water before moving on to the next one. This is to keep the samples' tastes from affecting one another.

2.5. Statistical Analysis

The Statistical Package for Social Sciences (SPSS) software version 21 was used to determine mean values, standard deviations, and Tukey post hoc test was used to detect significant differences between test samples at a 95% confidence level. All analyses were carried out in triplicates.

3. Results and discussions

3.1. Proximate composition of breakfast cereal from pearl millet-coconut composite flour

The results of the proximate composition of the breakfast cereal are presented in Table 2. The moisture content of the breakfast cereal ranged from 1.70 to 6.00%, with sample 70% M: 30% C and 100% M: 0% C recorded the lowest and highest, respectively. Results showed that moisture content of the samples are significantly different from each other. Moisture levels were observed to be within the safe limit (<14%) for storage which reduces the risks of microbial attacks and extending the shelf-life of the products when properly packaged and stored [11].

The amount of ash in the samples indicates their mineral content [12]. Ash contents ranged from 0.80 to 1.50, with no significant difference (p<0.05) between samples 90% M: 10% C (1.40%) and 70% M: 30% C (1.40%). Since it is unlikely that the processing temperature and moisture will significantly alter the minerals' composition, they are generally stable.

Table 2.
Proximate composition (%) of breakfast cereal produced from different compositions of pearl millet-coconut composite flour

Sample	Crude Fat (%)	Crude Protein (%)	Moisture Content (%)	Crude Fiber (%)	Crude Ash (%)	Carbohydrate (%)
100M:0C	3.35 ± 0.21^{a}	10.56 ± 0.06^{d}	6.00 ± 0.00^{d}	0.65 ± 0.00^{d}	1.20 ± 0.00^{b}	78.25 ± 0.28^{d}
90M:10C	6.25 ± 0.35^{b}	12.04 ± 0.05^{e}	3.75 ± 0.21^{c}	0.74 ± 0.00^{e}	1.40 ± 0.14^{bc}	75.82 ± 0.07^{c}
80M:20C	10.25 ± 0.35^{c}	10.29 ± 0.06^{c}	2.50 ± 0.71^{ab}	0.64 ± 0.01^{c}	1.50 ± 0.00^{c}	74.83 ± 0.42^{b}
70M:30C	12.65 ± 0.21^{d}	8.50 ± 0.06^{a}	1.70 ± 0.00^{a}	0.53 ± 0.01^{a}	1.40 ± 0.00^{bc}	75.24 ± 0.01^{bc}
60M:40C	15.55 ± 0.07^{e}	9.33 ± 0.06^{b}	2.75 ± 0.35^{b}	0.58 ± 0.01^{b}	0.80 ± 0.14^{a}	71.00 ± 0.35^{a}

Means with different letters within the same column differ significantly (p<0.05)
M: Millet; C: Coconut.

Fat content of the breakfast cereal ranged from 3.35 to 15.55%. Result showed that the fat contents of all samples were significantly different, following an increasing order with more substitution with coconut flour. It was observed that 100% M: 0% C recorded the lowest fat content (3.35%), followed by 90% M: 10% C (6.25%), then 80% M: 20% C with fat content 10.25% with a corresponding 12.65% for sample 70% M: 30% C, and 15.55% for sample 60% M: 40% C. The increasing order in fat content of the samples may be attributed to the substitution with coconut flour and its higher fat content. Essential fatty acids (EFA) found in dietary fats have been shown to improve food taste and acceptability while slowing intestinal motility and stomach emptying, which prolongs satiety and makes it easier for fat-soluble vitamins to be absorbed [13]. Studies have shown that millet is a cereal relatively low in protein compared to carbohydrate [14]. The values analyzed were similar to those reported by [15]. Crude protein content analyzed ranges from 8.50-12.04% for 70% pearl millet flour: 30% coconut flour and 90% pearl millet flour: 10% coconut flour respectively, with a significant difference observed in all samples. The percent of crude fiber for the breakfast cereals ranged from 0.53 to 0.74% for sample 90% M: 10% C to 70% M: 30% C, respectively. Addition of coconut flour to pearl millet flour complemented each other and no particular trend was observed in the crude fibre content. Polysaccharides, oligosaccharides, lignin, and related plant materials are examples of dietary fiber and their beneficial physiological effects include blood cholesterol and glucose attenuation, as well as laxation [16]. Constipation is the most noticeable side effect of diets that provide very little fiber. However, it is claimed that people who consume low amounts of dietary fiber over time experience a number of adverse physiological reactions, most notably an elevated risk for coronary heart disease [17]. Male adults aged 19 to 50 need 38 g per day, while female adults need 25 g per day. Children need less fiber; their daily needs range from 19 g for those aged 1 to 3 to 31 g for those aged 9 to 13 [13]. The carbohydrate content of the control sample (100% M: 0% C) was the highest (78.25%) and the lowest (71.00%) was obtained from 60% M: 40% C. This implies that, with increasing substitution of coconut flour, carbohydrate content of the breakfast cereal decreased, and so, pearl millet can be said to be richer in carbohydrate than coconut.

3.2. Mineral composition of pearl millet-coconut breakfast cereal

The results of the mineral (K, Ca, Zn, Mg, and Fe) composition of the breakfast cereal are presented in Table 3. 100% M: 0% C had the lowest (274.83 mg/100g) amount of Calcium (Ca) and 60% M: 40% C had the highest (483.51 mg/100g). The increasing order in concentration of Calcium in the samples could be likened to the result from the increasing substitution of pearl millet flour with coconut flour. The result was similar to the values obtained in the evaluation of wheat flour-coconut flour blends [13]. Coconut had been reported to have a high portion of potassium, as well as pearl millet. Growth retardation and a compromised immune response can result from a zinc (Zn) deficiency. Zinc is a cofactor that affects the activities of enzymes that affect growth and digestion [18]. The flour blends' zinc contents ranged from 0.32 mg to 0.58 mg, 60% M and 40% C had the highest and 100% M had the lowest value. The lowest zinc content was found in 0% coconut flour. It was observed that potassium contents differed significantly from each other except 100% M: 0% C and 90% M: 10% C.

Magnesium contents ranged from 105.27 mg/100g to 189.13 mg/100g and no significant difference was observed between samples 80% M: 20% C (173.75) and 70% M: 30% C (175.15).

Table 3.
Mineral composition of breakfast cereal produced from different compositions of pearl millet-coconut composite flour

Sample	Calcium (mg/100g)	Zinc (mg/100g)	Iron (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)
100M:0C	274.83±1.05[a]	0.45±0.00[b]	1.15±0.01[b]	345.56±2.47[a]	105.27±1.00[a]
90M:10C	375.19±4.93[b]	0.32±0.00[a]	0.82±0.01[a]	345.56±2.47[a]	147.20±1.00[b]
80M:20C	444.92±4.93[c]	0.54±0.01[c]	1.36±0.01[c]	485.01±2.47[c]	173.75±1.00[c]
70M:30C	450.35±2.18[c]	0.53±0.00[c]	1.35±0.01[c]	481.52±2.46[c]	175.15±1.00[c]
60M:40C	483.51±0.35[d]	0.58±0.00[d]	1.47±0.01[d]	450.15±2.47[b]	189.13±1.00[d]

Means with different letters within the same column differ significantly (p<0.05)
M: Millet; C: Coconut.

The magnesium content ranged from 105.27 mg/100g in 100% M: 0% C to 189.13 mg/100g in 60% M: 40% C. The increase in the magnesium content of the breakfast cereals could be attributed to the increase in coconut flour content, similar to the report by [19] in biscuits formulated from coconut flour.

The composition of iron in the breakfast cereals ranged from 0.82 to 1.47 mg/100g. Sample 60% M: 40% C had the highest value (1.47 mg/100g) while 90% M: 10% C had the lowest value (0.82 mg/100g) of Iron.

3.3. Vitamin Composition of Pearl millet-coconut Breakfast Cereal

The results of the vitamins content of the breakfast cereal are presented in Table 4. The range of mean values of concentration of vitamin A was 3.09 to 3.16 mg/100g, sample 70% M: 30% C recorded the highest and lowest, respectively. It was observed that there was no significant difference (p<0.05) in the mean values of Vitamin A in samples 100% M: 0% C (3.14 mg/100g) and 70% M: 30% C (175.15 mg/100g), likewise sample 100% M: 0% C (3.14 mg/100g) and 80% M: 20% C (3.13 mg/100g).

Mean values of vitamin C (ascorbic acid) present in the breakfast cereal was in the range of 3.18 to 3.50 mg/100g, with no significant difference (p<0.05) between samples 70% M: 30% C and 80% M: 20% C having mean values of 3.18, likewise the mean values of Vitamin B1 (Thiamine) which had the least value analyzed with a mean of 0.26 mg/100g for all samples which was within the range of values (0.23-0.77 mg/100g) reported by [20] for breakfast cereals from malted sorghum, tiger nut and cashew nut composite flour.

Table 4.

Vitamin composition (%) of breakfast cereal produced from different compositions of pearl millet-coconut composite flour.

Sample	Vitamin A (mg/100g)	Vitamin C (mg/100g)	Vitamin B1 (mg/100g)	Vitamin B9 (mg/100g)	Vitamin B3 (mg/100g)
100M:0C	3.14 ± 0.01^{b}	3.25 ± 0.00^{ab}	0.26±0.00	0.59 ± 0.01^{d}	0.56 ± 0.00^{d}
90M:10C	3.09 ± 0.00^{a}	3.50 ± 0.07^{c}	0.26±0.00	0.54 ± 0.00^{c}	0.64 ± 0.00^{e}
80M:20C	3.13 ± 0.00^{b}	3.18 ± 0.04^{a}	0.26±0.00	0.51 ± 0.01^{b}	0.55 ± 0.00^{c}
70M:30C	3.16 ± 0.01^{c}	3.18 ± 0.04^{a}	0.26±0.00	0.52 ± 0.02^{bc}	0.45 ± 0.00^{a}
60M:40C	3.15 ± 0.00^{c}	3.30 ± 0.00^{b}	0.26±0.00	0.42 ± 0.01^{a}	0.50 ± 0.01^{b}

Means with different letters within the same column differ significantly (p<0.05)
M: Millet; C: Coconut.

Vitamin B9 (Folate) was observed to follow a decreasing trend as the substitution of coconut flour increased (0.42-0.59 mg/100g). The result obtained was lower compared to the higher values of 0.65-1.06 mg/100g reported by [20], but was similar to the value of 0.487-0.585 mg/100g reported by [21]. When taken by pregnant women, vitamin B9 helps with DNA replication and the metabolism of vitamins and amino acids, which lowers the risk of spina bifida (neural tube defects) in newborns [21] and the Recommended Dietary Allowance (RDA) is 0.2 mg/100g/day for 4 to 8 years old children and 0.3 mg/100g/day for 9 to 13 years and 0.4 mg/100g/day for adults. The values obtained from this study were higher than the RDA requirement for all groups. Vitamin B3 content obtained in this research study ranged from 0.45 to 0.64 mg/100g which was within the range of values reported by [19] but low compared to values reported by [20] for breakfast cereals from cereals and legumes. The RDA for Vitamin B3 is 12 mg/100g/day for age 9 to 13 and 8 mg/100/day for ages 4 to 9 as reported by [19]. Niacin helps lower LDL cholesterol, lowers risk of cardiovascular diseases, and eases arthritis [22].

3.4. Sensory Evaluation

Table 5 shows the score of the sensory characteristics such as color, texture, crispness, texture, aroma, taste, and overall acceptability of the ready-to-eat breakfast cereal samples from pearl millet-coconut composite flour.

Samples 80 M: 20 C and 90% M: 10% C had the highest values (7.60 and 7.48, respectively) for crispiness compared to other samples. Sample 60% M: 40% C was most accepted in terms of its aroma and color, which can be attributed to the higher proportion of coconut flour present in it, compared to other samples with more millet flour. Sample 80% M: 20% C was most accepted for its texture and taste, while 100% M was the least accepted for its textural and taste attributes. From the table, 70% M: 30% C and 90% M: 10% C had no significant difference in terms of appearance, likewise 80% M: 20% C and 60% M: 40% C. It was also observed that 80% M: 20% C had the highest score (7.44) for overall acceptability, while 100% M was the least (5.98) preferred among all samples. This could be due to the absence of coconut in the sample which made it darker than others with coconut flours enhancing its color. The panelists also favored composite breakfast cereal samples containing 40% and 60% Sprouted finger millet flour over the control made solely from maize flour as reported by [23].

Table 5.
Sensory evaluation of breakfast cereal produced from different compositions of pearl millet-coconut composite flour.

Sample	Color	Appearance	Crispness	Taste	Texture	Aroma	Overall acceptability
100M:0C	5.66±1.73^{a}	5.94±1.95^{a}	6.00±2.07^{a}	5.72±1.57^{a}	5.92±1.75^{a}	5.12±1.64^{a}	5.98±1.48^{a}
90M:10C	6.62±1.60^{bc}	6.56±1.59^{ab}	7.48±1.09^{b}	7.08±1.28^{bc}	7.28±1.14^{c}	7.00±1.07^{bc}	7.32±0.79^{c}
80M:20C	6.78±1.52^{bc}	6.68±1.60^{b}	7.60±0.95^{b}	7.24±0.98^{c}	7.42±0.95^{c}	7.26±1.14^{c}	7.44±0.88^{c}
70M:30C	6.26±1.63^{ab}	6.36±1.69^{ab}	6.24±1.69^{a}	6.54±1.73^{b}	6.48±1.75^{b}	6.66±1.61^{b}	6.68±1.63^{b}
60M:40C	7.08±1.40^{c}	6.80±1.39^{b}	7.14±1.11^{b}	7.20±1.21^{c}	7.08±0.92^{c}	7.36±0.94^{c}	7.38±1.01^{c}

Means with different letters within the same column differ significantly ($p<0.05$)
M: Millet; C: Coconut.

4. Conclusion

This study showed that there was a significant increase in the nutritional content of the breakfast cereal produced from pearl millet-coconut composite flour. With increasing proportion of coconut flour, fat, calcium, zinc, iron and magnesium contents significantly increased, however, carbohydrate content decreased significantly. The dominant vitamins in the breakfast cereal were vitamins A and C, however, B9 and B3 decreased significantly with increasing proportion of coconut flour. In conclusion, this research study showed that coconut flour significantly improved the nutritional composition of the final product and the composite flour had nutrient composition that could provide better opportunity for its use in new product development. Breakfast cereals from 80M:20C, 60M:40C and 90M:10C could be recommended for consumption to enhance the overall nutritional benefits available to consumers.

5. Acknowledgements

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