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Nutrient Composition and Sensory Evaluation of Breakfast Cereals (Flakes) Made from Blends of Maize (*Zea mays*), African Yam Bean (*Sphenostylis stenocarpa*) and Carrot (*Daucus carrota*) Flours

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Abstract

The study evaluated nutrient composition and sensory evaluation of breakfast cereals (flakes) made from different blends of flours. Specifically, it determined proximate, mineral, vitamin and sensory properties of breakfast cereals (flakes) made from blends of maize (*Zea mays*), African yam bean (*Sphenostylis stenocarpa*) and carrot (*Daucus carrota*) flours. It adopted experimental design. Four different formulations were made for production of breakfast cereals with ratio- SP1; 80:10:10, SP2; 50:30:20, SP3; 40:40:20, SP4; 40:55:5 of maize/African yam bean and carrot flours. Appropriate analytical methods were used to determine nutrient and sensory properties of samples. Data were analyzed with means, standard deviation and one-way ANOVA at 0.05 level of significance. Control sample had the highest general acceptability score (8.48±0.92). African yam bean enhanced protein content at 8.96%, 9.31%, 9.59% and 10.09% respectively. Crude fibre was significantly enhanced with the inclusion of African yam bean and carrot flour at 1.94%, 2.19%, 1.84% and 2.72% respectively. Mineral analysis showed ranges in mg/100g: calcium (13.89-27.78), potassium (111.15-182.55), manganese (0.00- 0.34), iron (1.28- 3.82). Vitamin analysis revealed ranges (mg/100g): B_1 (0.36-0.57), B_2, (0.20-0.35), B_3(0.06-0.41) and pro-vitamin A (2.90-5.50 µg/100g).

Keywords: Nutrient, Composition, Sensory evaluation, Breakfast, Maize, African Yam Bean, Carrot.

Introduction

Breakfast cereals are grain-based foods produced from starchy raw materials such as wheat, oats, corn, and rice. They can be minimally processed, through methods like drying and rolling, or more extensively processed by boiling, flaking, or puffing (Lewis et al., 2021). These convenient foods can also be formulated by incorporating other food materials such as legumes, tubers, fruits, and vegetables. Breakfast cereals may be consumed directly, reconstituted, or pre-heated prior to consumption. They are often fortified with essential vitamins and minerals, making them an important source of nutrients (Williams, 2014). Ready-to-eat breakfast cereals are gaining increasing popularity in many developing countries, particularly among children and adolescents. Their convenience and nutritional value have led to their gradual replacement of traditional breakfast diets (Okafor & Usman, 2014).

With growing consumer interest in health and wellness, many people are willing to pay more for foods perceived as healthier options. Consequently, breakfast cereals occupy a distinctive position in the market, being viewed as both convenient and nutritionally beneficial (Ferreira et al., 2021). In addition to providing vitamins and minerals, they also contain antioxidants and phytoestrogens, which contribute to overall health (Ryan et al., 2011). Regular consumption of breakfast cereals can help reduce cravings for unhealthy snacks later in the day (Shrestha et al., 2024). However, most conventional breakfast cereals remain expensive and are largely carbohydrate-based, often lacking essential nutrients such as protein, calcium, and potassium (Okafor et al., 2017). In Nigeria, ready-to-eat breakfast cereals are typically produced from refined grains, predominantly maize, which limits dietary diversity.

There is currently growing awareness of the need for high-quality foods that can combat protein-calorie malnutrition and address health issues such as diabetes and cardiovascular diseases (Sotunde et al., 2021). Protein-energy malnutrition, which results from inadequate intake of both protein and calories, remains a major public health challenge in developing countries, especially among infants and young children (World Health Organization, 2009). The increasing consumption of highly processed, energy-dense foods with low nutrient diversity has further contributed to nutritional deficiencies and related health problems (Ridgway et al., 2019). In response, food manufacturers are exploring alternative methods of producing breakfast cereals using nutrient-rich local ingredients (Ishiwu et al., 2019). A combination of maize, African yam bean, and carrot flours offers a balanced blend of carbohydrates, proteins, fiber, vitamins, and minerals that can significantly enhance the nutritional profile of the product compared to single-ingredient formulations.

Although various ingredients have been used to improve the nutritional and sensory qualities of breakfast cereals, there is no research on products developed from maize, African yam bean, and carrot flours. Maize (*Zea mays*) is a staple food crop widely consumed across Africa due to its versatility and nutritional content. It is rich in carbohydrates, proteins, vitamins, and minerals, and contains carotenoids responsible for its yellow pigmentation (Bello & Oluwalana, 2017). Maize grains typically comprise about (72%) starch, (10%) protein, (4.8%) oil, (8.5%) fiber, (3.0%) sugar, and (1.7%) ash (Huma et al., 2019).

African yam bean (*Sphenostylis stenocarpa*) is a highly nutritious legume gaining attention for its impressive protein content (20–30%) and balanced amino acid profile, particularly lysine and methionine (Arukwe et al., 2021). Its high dietary fiber content has been linked to a reduced risk of colon cancer, with studies suggesting up to a 50% risk reduction (Alahmari, 2024).

Carrot (*Daucus carota* L.) is a widely cultivated root vegetable valued for its rich nutrient composition and vibrant orange color. It contains various phytonutrients, including phenolics, polyacetylenes, and carotenoids, which contribute significantly to its health benefits (Hansen *et al*., 2003). Formulating breakfast cereals using blends of maize, African yam bean, and carrot flours presents an opportunity to diversify the utilization of indigenous, underutilized crops. Such innovation not only enhances the flavor, texture, and nutritional quality of breakfast cereals but also supports national food security and addresses key issues such as protein-energy malnutrition and micronutrient deficiencies. This research, therefore, aims to explore the potential of these locally available and affordable ingredients in developing healthy and nutritious breakfast cereal products.

Objectives of the study

This study investigated nutrient composition and sensory evaluation of breakfast cereal made from blends of maize (*Zea mays*), African yam beans (*Sphenostylis stenocarpa*) and carrot (*Daucus carota* L.) flours**.** Specifically, it determined the following aspects of the developed breakfast cereal:

1) sensory properties;
2) proximate composition (crude protein, ash, crude fat, moisture, crude fiber and total carbohydrate);
3) vitamin (pro-vitamin A, vitamin B_1, B_2, B_3) contents;
4) mineral (iron, calcium, manganese, potassium) contents.

Materials and Methods

Study design**:** The study adopted an experimental design.

Procurement of raw materials**:** Maize grains (*Zea mays*), African yam bean seeds (*Sphenostylis stenocarpa*), mature carrot (*Dacus carota*), and other ingredients for breakfast cereal preparation were obtained from a local market (Ogige main market) in Nsukka Local Government area of Enugu State.

Sample preparation**:** This involved processing the following:

Maize flour: Two kilograms of maize grains were sorted and cleaned. It was conditioned by sprinkling one cup of distilled water, milled coarsely, winnowed. Grits were finely milled and sieved using (0.3 mm sieve aperture) and packaged in well labelled air tight container for further use.

Africa yam bean flour: Two kilograms of African yam bean (AYB) seeds were sorted, washed and soaked in potable water for 12 hours. Thereafter, the seeds were drained, dehulled manually, boiled at 100°C for 30 minutes, dried in oven of 65°C for 6hrs, milled, and sieved using 1mm mesh screen, then packaged in a well labelled air tight containers for further use.

Carrot flour: Two kilograms of carrot was sorted out, thoroughly washed and peeled. Sample was sliced, blanch in hot water three minutes and dried in a blast-air electric oven (NAAFCO B5, model OVH 102, Germany) set at 50ºC for 24 h. The dried carrot was dry-milled using (Binatone Grinder BL 1500 PRO, China), sieved with a 425 mm aperture and packaged in a well labelled air tight container for further use.

Formulation of flours blend: The flour blends were formulated by mixing maize flour, African yam bean flour and carrot flour in different ratios 80:10:10, 50:30:20, 40:40:20, 40:55:5 coded as sample, SP1, SP2, SP3 and SP4 respectively.

Breakfast cereal flakes production: The breakfast cereal (flakes) was produced using the method as described by (Nkiru et al.,2019) with slight modification as follows:

***Ingredients*:** 100g of flour blend, sugar 20g, salt 4g, water 750ml.

Procedural steps:

1) Mix the formulated blend with sugar, salt, and water until a batter is formed.
2) Pour the resultant batter thinly on a baking pan.
3) Place the pan in the middle rack of preheated oven at 350°C for 15 minutes.
4) Bring out from the oven and cut into a desirable shape.
5) Place back into the oven for further drying at 250°C for 30 minutes until crunchy. Allow to cool completely. 6) Store the flakes in a well labelled airtight container in a cool dry place away from sunlight

Preparation of breakfast cereal:

Pour the 35g of flakes in a plate.

Add 200ml of liquid milk and one teaspoon of sugar and serve.

Sensory evaluation of the products: The sensory evaluation of the products prepared using the different blend was conducted in the food and nutrition laboratory of Home Science and Management, University of Nigeria, Nsukka.

A nine-point hedonic scale was used to determine the colour, flavor, taste, texture, and degree of general acceptability of the breakfast cereals prepared. The degree to which a product is accepted is expressed as: Like extremely (9 point), like very much (8 point), like moderately (7 point), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points), dislike moderately (3 points), dislike very much (2 points), dislike extremely (1 point). This instrument is standard and needs no validation.

A panel of 30 judges was selected by random sampling from the staff and students of the Department of Home science and Management to determine the attributes of the test products. The sensory evaluation was conducted in one day in the food and nutrition laboratory.

The food samples were presented to each of the panelist as coded in the hedonic scale. Each panelist was given a take away serving bowl, with spoon and a table water to rinse the mouth after testing each food sample to avoid a carryover effect. The food samples were evaluated by the panelists for colour, flavor, taste, texture and degree of general acceptability.

***Proximate analysis*:** Association of Analytical Chemist AOAC (2010) and Pearson (2005) method were used to determine the proximate composition of the samples, as follows:

Protein: The micro Kjeldahl method was used for the determination of protein. Sample was digested with concentrated sulphuric acid, distilled and titrated. The crude protein was obtained by multiplying N by the conversion factor of 6.25 (cP =TN x 6.25).

Fat: Two milliliters of each sample was extracted with acetone (BP 400C – 600C) using "Sohxlet extractor" for 1 hour. The solvent free samples were dried in an oven, cooled in a dissector and reweighed prior to calculation of crude fat content.

Ash: Sample was weighed, labelled and put into the furnace, heated gradually until temperature of 550 - 6000C was reached for 6 hours. After ashing, crucibles were put in desiccators and cooled, samples were reweighed and percentage ash calculated.

Crude fiber: Sample was hydrolyzed sulphuric acid (H2SO4), boiled, diluted with 100ml of 1.25% NaOH and heated for another 30minutes and filtered using suction method. Residue was rinsed with 1% HCl (hydrogen chloride), and added to neutralize the NaOH present, washed with methylated spirit, dried in an oven set at 100 C for 30minutes, cooled in a desiccator and reweighed. The residue was put into a muffled furnace set at 550 C for 2hours for complete ashing. The ash was weighed and the percentage fiber in the sample calculated.

Moisture: Petri dishes were washed, dried and reweighed. The 2ml of sample was put into each dish dried for 2 hours, , reweighed and dried to a constant weight. The percentage moisture was calculated.

Carbohydrate was determined by Difference that is, subtracting the sum of the % of protein, fat, moisture, and ash from 100%. Carbohydrate percentage was calculated.

Vitamin Analysis

Pro vitamin A was determined using Pearson (2005) method while Vitamin B_1, B_2 and Vitamin B_3 were determined using Association of Analytical Chemist AOAC (2010).

Pro vitamin: Two (2) milliliters of each sample was put into a film container and 20ml of petroleum ether was added. The solution was filtered through Whatman filter paper No 42. The filtrate was evaporated to dryness, later dissolved with 0.2mls of chloroform acetic anhydride, 2mls of TCA chloroform was added and read at 620nm using a spectrophotometer.

Vitamin B_1: Five (5) grams of samples are homogenized with 50ml of ethanoic sodium hydroxide solution. This will be filtered into a 100ml flask. A 10ml of the filtrate was pipetted into a beaker and color developed by the addition of 10ml potassium dichromate. The absorbance was read at 360nm. A blank sample was prepared and read at same wavelength. The values were extrapolated from a standard curve.

Vitamin B_2: Five (5) grams of each of the samples was extracted with 100ml of 50% ethanol solution shaken for 1 hour. This was filtered into a 100ml of 30% hydrogen peroxide (H_2O_2) and allowed to stand over hot water bath for 30mins. 2ml of 40% sodium sulphate was added to make up the 50ml mark and absorbance read at 510nm in a spectrometer.

Vitamin B_3: 1.5 g was accurately weighed into 200 ml volumetric flask. Hydrochloric acid solution (5 N; 5 ml) and 5.0 ml of dichloromethane and 90 ml of deionized water were added to the mixture, stirred, and heated on a boiling water bath at 100°C for 30 min. The niacin standard solution of 0.5 mg was prepared, and 10 ml of the stock solution was taken and treated same as sample above. The absorbance of the standard and sample solutions was taken at 410 nm wavelength using spectrophotometer.

***Mineral Analysis*:** Association of Analytical Chemist AOAC (2010) was used to determine the mineral composition of the samples

Iron: Five milliliters of Phenanthroline solution and two milliliters of concentrated HCl were added in the test-tube. One milliliter of hydroxylamine solution was added and left to boil for 2mins. Nine milliliters of ammonium acetate buffer solution were added and diluted with 50ml of water. The absorbance was read at 510nm wavelength.

Calcium: Previous ash sample was dissolved in 5ml of 30% HCl and 45ml of distilled water. The diluted samples were filtered and the filtrates were used to analyze for calcium using atomic absorption spectrophotometer.

Potassium: Two grams (2g) of the sample were digested with 20ml of acid mixture (650ml of Conc. HNO3, 80ml PCA, and 20ml conc. H2SO4) and aliquots of the digested sample taken for photometry using Flame analyzer. Absorbance for potassium was read at 767 nm. potassium concentrations were then obtained from the calibration curves obtained from the standard.

Manganese: One gram of dried sample was digested with 2.5ml of 0.03N hydrochloric acid (HCl). The digest was boiled for five minutes, allowed to cool to room temperature and transferred to 50ml volumetric flask and made up to the mark with diluted water. The resulting digest was filtered with ashless Whatman No. 1 filter paper. Filtrate from the sample was analyzed using an Atomic Absorption Spectrophotometer.

Data Analysis Methods: Data generated from the study were analyzed with means and standard deviation and one- way ANOVA at 0.05 level of significance.

Results

Table 1: Sensory Evaluation of Breakfast Cereal Developed Using Different Ratios of Maize, African Yam Bean and Carrot Flours Blends

SEPR	SP1	SP2	SP3	SP4	SP5
Colour	**6.28±1.40a**	**5.72±1.84a**	**6.68±1.60a**	**7.48±1.19b**	**8.44±1.00c**
Flavour	6.04±1.70a	5.84±1.62 a	5.84±1.43 a	6.36±1.50 a	8.36±0.99b
Taste	6.08±1.55a	6.04±1.54 a	6.04±1.70 a	6.00±1.30 a	8.56±0.87 b
Texture	5.88±1.83a	6.24±2.04 a	6.56±1.56 a	6.60±1.55 a	8.52±0.77 b
General Acceptability	5.80±1.55a	5.52±1.33 a	5.64±1.87 a	5.60±1.41 a	8.48±0.92 b

Values are means ±Standard deviation. Values having different superscripts are significantly (p < 0.05) different. SP1=Maize flour, African yam Bean flour and carrot flour (80:10:10), SP2=Maize flour, African yam bean flour and carrot flour (50:30:20), SP3=Maize flour, African yam bean flour and carrot flour (40:40:20), SP4=Maize flour, African yam bean flour and carrot flour (40:55:5), SP 5=Maize, African yam bean and carrot flour blends (0:100); SEPR =Sensory Properties

Table 1 shows the sensory evaluation of breakfast cereal developed using different ratios of maize, African yam bean and carrot flours blends. Sample SP5 had the highest mean score for colour, flavour, taste, texture and degree of general acceptability while sample SP2 had the least mean value for all tested parameters.

Table 2: Proximate Composition of Breakfast Cereal Produced Using Different Ratios of Maize, African Yam Bean and Carrot Flours Blends

PC (%)	SP1	SP2	SP3	SP4	SP4
Crude protein	8.96±0.03^{b}	9.31±0.03^{c}	9.59±0.01^{d}	10.09±0.01^{e}	8.17±0.01^{a}
Ash	1.10±0.07^{b}	2.82±0.42^{d}	3.07±0.01^{e}	2.42±0.05^{b}	0.90±0.07^{a}
Crude fat	2.17±0.03^{c}	2.40±0.01^{d}	2.12±0.02^{b}	2.65±0.01^{e}	1.97±0.03^{a}
Moisture	9.53±0.05^{d}	7.28±0.01^{b}	9.86±0.03^{e}	4.80±0.04^{a}	8.53±0.04^{c}
Crude fibre	1.94±0.06^{b}	2.19±0.01^{c}	1.84±0.05^{b}	2.72±0.03^{d}	1.55±0.06^{a}
Carbohydrate	76.31±0.06^{b}	76.02±0.01^{b}	73.54±0.02^{e}	77.33±0.01^{c}	79.30±0.58^{d}

Values are means ±Standard deviation. Values having different superscripts are significantly ($p < 0.05$) different; SP1=Maize flour, African yam Bean flour and carrot flour (80:10:10), SP2=Maize flour, African yam bean flour and carrot flour (50:30:20), SP3=Maize flour, African yam bean flour and carrot flour (40:40:20), SP4=Maize flour, African yam bean flour and carrot flour (40:55:5), SP 5=Maize, African yam bean and carrot flour blends (0:100); PC(%) = Proximate Composition Percent.

Table 2 shows the proximate composition of breakfast cereal produced using maize, African yam bean and carrot flours blends in different ratios. The protein content of the samples ranged from 8.17- 10.04%. The ash content of the sample ranged from 0.90 - 3.07%. The moisture content of the samples varied from 4.80 – 9.86%. The fat contents varied from 1.97 – 2.65%. The crude fibre content of the samples oscillated between from 1.55 to 2.72%. The carbohydrate content of the samples ranged from 73.54 to 79.30%.

Table 3: Vitamin Composition of Breakfast Cereal Developed Using Different Ratios of Maize, African Yam Bean and Carrot Flours Blends

V (mg/100g)	SP1	SP2	SP3	SP4	SP5
Pro Vitamin A (µg/100g)	4.05±0.07^{b}	4.45±0.07^{c}	3.90±0.14^{b}	5.50±0.14^{d}	2.90±0.14^{a}
Vitamin B1	0.40±0.00^{b}	0.47±0.01^{c}	0.52±0.00^{d}	0.57±0.01^{e}	0.36±0.01^{a}
Vitamin B2	0.23±0.01^{b}	0.28±0.00^{c}	0.31±0.01^{d}	0.35±0.01^{e}	0.20±0.00^{a}
Vitamin B3	0.06±0.00^{a}	0.11±0.01^{b}	0.14±0.00^{c}	0.17±0.01^{d}	0.41±0.01^{e}

Values are means ±Standard deviation. Values having different superscripts are significantly ($p < 0.05$) different. SP1=Maize flour, African yam Bean flour and carrot flour (80:10:10), SP2=Maize flour, African yam bean flour and carrot flour (50:30:20), SP3=Maize flour, African yam bean flour and carrot flour (40:40:20), SP4=Maize flour, African yam bean flour and carrot flour (40:55:5), SP 5=Maize, African yam bean and carrot flour blends (0:100); V = Vitamins

Table 3 shows the vitamin composition of breakfast cereal produced using maize, African yam bean and carrot flour blends in different ratios. The pro vitamin A content of the samples ranged from 2.90 to 5.50µg/100g. The vitamin B1 content of the samples ranged from 0.36 to 0.57mg/100g. Sample SP4 had the highest vitamin B2 content while sample SP5 had the lowest mean value. The vitamin B3 content of the samples ranged from 0.06 to 0.41 mg/100g.

Table 4: Mineral Content Scores of Breakfast Cereal Developed Using Different Ratios of Maize, African Yam Bean and Carrot Flours Blends.

M (mg/100g)	SP1	SP2	SP3	SP4	SP5
Manganese	0.34±0.10 [b]	0.27±0.00 [b]	0.27±0.00[b]	0.07±0.10 [a]	0.00±0.00[a]
Potassium	182.55±0.64[d]	111.15±0.92[a]	158.85±3.18[b]	173.30±5.94[c]	160.00±0.00[b]
Calcium	15.28±1.97[a]	26.39±1.97[c]	27.78±0.00[c]	18.06±1.97[b]	13.89±0.00 [a]
Iron	3.32±0.36[b]	1.28±0.36[a]	2.04±0.00[a]	3.82±0.37[b]	1.79±0.36[a]

Values are means ±Standard deviation. Values having different superscripts are significantly (p < 0.05) different; SP1=Maize flour, African yam Bean flour and carrot flour (80:10:10), SP2=Maize flour, African yam bean flour and carrot flour (50:30:20), SP3=Maize flour, African yam bean flour and carrot flour (40:40:20), SP4=Maize flour, African yam bean flour and carrot flour (40:55:5), SP 5=Maize, African yam bean and carrot flour blends (0:100), M =Minerals

Table 4 shows the mineral composition of breakfast cereal produced using maize, African yam bean and carrot flour blends in different ratios. The manganese content of the samples ranged from 0.00 to 0.34 mg/100g. The potassium content of the samples ranged from 111.15 to 182.55mg/100g. Sample SP3 had the highest calcium content while sample SP5 had the lowest mean value. The iron content of the samples ranged from 1.28. to 3.82 mg/100g.

Discussion

The sensory evaluation result obtained in this study for the different attributes are relatively higher when compared to 4.90-3.60 (color), taste (4.90 -4.10) texture (4.90 - 3.60), flavour (4.90-3.60) and degree of general acceptability (4.90 -3.60) reported by Abogunrin and Ujiroghene, (2022) on formulation and quality evaluation of breakfast flakes produced from blends of maize (*Zea mays*) and quinoa (*Chenopodium quinoa*) Flour.

The moisture content recorded in this study is comparable with the values 6.05% to 10.40% reported by Ishiwu et al (2019), on the production and evaluation of breakfast cereals from blends of African yam bean (*Sphenostylis stenocarpa*) and corn (*Zea mays*) flour. The moisture contents of the blends were within the acceptable limit of not more than 10% for long term storage of food products (Onimawo & Akubor 2012). The low moisture content of the blends would enhance storage stability by preventing the growth of mould and reduce moisture dependent chemical reactions.

The protein content of the samples varied significantly (p<0.05) with the control sample recording the lowest value and sample SP4 recording the highest value. The protein content of the blends recorded consistent increment with increase in the inclusion of African yam bean. This could be attributed to the high protein content of African yam bean. Protein is synergistically enhanced in cereal-legume blends due to the contribution of lysine by legume and methionine by cereal (Wakil & Kazeem, 2012). The result is in consonance with that of Arukwe et al (2022) who worked on complementary foods from pearl millet (*Pennisetum glaucum*), African Yam Bean (*Sphenostylis stenocarpa*) and carrot (*Daucus carrota*) flour Blends. The high protein contents obtained from this study will be of great importance in reducing protein-energy malnutrition resulting from high cost of animal protein and commonly consumed legumes.

Ash content of a food material is an indication of its mineral content and high ash content implies that the food material is rich in minerals (Arukwe et al; 2022). The ash content increased steadily with corresponding increase in addition of carrot flours and African yam bean flours in the blends. Sample SP3 had the highest ash content and this could be due to the increase content of carrot flour and the report that African yam bean is rich in ash (Arukwe & Arukwe, 2021).

The fat content of the breakfast cereals varied significantly ($p<0.05$) with sample SP4 recording the highest value (2.65%). The fat content increased with increase in the supplementation with African yam bean flour. The values for fat obtained in this study are within the range 1.84 to 2.02 reported by Okafor and Usman (2014) on the production and evaluation of breakfast cereals from blends of Africa yam bean (*Sphenostylis stenocarpa*), Maize (*Zea mays*) and defatted coconut (*Cocos nucifera*) flours. Fat in the diet of infants and young children is necessary for the supply of essential fatty acids, eases the absorption of fat-soluble vitamins, and improves dietary energy density and sensory quality (Egbujie & Okoye 2019).

The values for crude fibre significantly ($p<0.05$) increased with increased percent incorporation of African yam bean and carrot flours. This increase might be due to the fact that African yam bean and carrot are good food sources of fibre (Arukwe & Arukwe, 2021; Arukwe et al., 2021). Edima-Nyah, et al., 2019) reported higher crude fibre values ((5.80-7.38) for development and quality evaluation of breakfast cereals from blends of local rice (*Oryza sativa)*, African yam beans (*Sphenostylis stenocarpa*) and coconut (*Cocos nucifera*) Flour. The crude fibre values obtained in this study 2.72 – 1.55% are below the recommended dietary allowance (4.0 mg/100g) for crude fibre in foods (FAO/WHO, 1998). The low crude fibre content of the samples is in line with the work of Michaelsen et al. (2010) who noted that complementary foods should contain low fibre because high fibre can lead to high water absorption and displacement of nutrients and important energy needed for growth of children. Fibre plays important role in greater use of nitrogen and absorption of some other micronutrients.

The carbohydrate content of the samples significantly ($p<0.05$) decreased with increase in the addition of African yam bean and carrot flours. Maize is a carbohydrate food, consequently the highest carbohydrate values recorded in the control (79.30%). The decrease in carbohydrate due to inclusion of African yam bean is in consonance with the report that addition of legumes decreases the carbohydrate content of cereal-based foods (Arukwe et al., 2021). The values for carbohydrate obtained in this study compared favorably with the values (76.12 – 62.61%) reported by Arukwe, et al., (2022) on complementary foods from pearl millet (*Pennisetum glaucum*), African yam bean (*Sphenostylis stenocarpa*) and carrot (*Daucus carrota*) flour blends.

The increase in potassium and calcium levels in the blends is due to the addition of African yam bean, maize, and carrot flours, which are rich in these minerals. Potassium supports fluid balance and helps manage high blood pressure, while calcium is vital for bone and teeth development, muscle and nerve function, blood clotting, and immune defense (Pravina et al., 2013). The iron content observed aligns with previous studies reported by Mbaeyi - Nwaoha & Uchendu, 2016) and is essential for red blood cell formation and anemia prevention in children.

Vitamin analysis revealed significant differences ($p<0.05$) in beta-carotene, thiamin, riboflavin, and niacin levels among the blends. The higher beta-carotene content, resulting from the inclusion of yellow maize and carrot flours, indicates their richness in provitamin A. This increase could help reduce vitamin A deficiency in the population. Bello et al; (2020) reported a lower pro-vitamin A value (1.80-2.14 µg/100g) on the formulation and assessment of nutritional functional and sensory attributes of complementary foods from maize-carrot-pigeon pea flour blends.

Conclusion

The findings show that the inclusion of African yam bean and carrot flours in the formulation of breakfast cereals increased the nutrient content of the blends. Hence, African yam bean seeds could serve as an affordable nutrient source, addressing deficiencies in expensive ready-to-eat foods and enhancing the nutritional value of foods. It could thus, serve the purpose of alleviating protein, energy malnutrition in Nigeria and could serve as protein supplement for the production of cereal-based diets for children and adolescents, thus creating a novel use for African yam bean.

Recommendations

The following recommendations were made based on the findings of this study:

1. Individuals and families should incorporate African yam beans into local dishes to improve the nutritional quality of their diets.
2. African yam beans should be used for the production of food supplements or nutrient concentrates.
3. Further researches should be carried out on utilization of flour blends from maize, African yam bean and carrot.
4. Increased farming of the African yam bean and carrots should be encouraged.

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