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Development and Quality Assessment of Breakfast Cereals from Blends of Whole Yellow Maize (*Zea mays*), Soybean (*Glycine max*) and Unripe Banana (*Musa sapientum*)

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ABSTRACT---- ***Breakfast cereals were produced from yellow maize, soybean and banana flours blended to form different percentage composites. Six composite samples were evaluated to determine the Proximate, Mineral and Vitamin composition, and Sensory qualities. Results of moisture content showed that sample F (0:20:80) had the highest value (6.13±0.02%) while sample E (40:20:40) had the least value (5.42±0.03%), this signifies that sample F (0:20:80) will experience early spoilage compared to sample E (40:20:40). The highest protein content (14.75±0.05) was recorded by sample A (80:20:0), the least value was observed in sample F (0:20:80). Sample A (80:20:0) also had the highest values in fat content (4.82±0.14%) and fibre (4.25±0.03%). Sample F (0:20:80) had the highest value in ash content (3.80±0.03%) and carbohydrate content (76.56±0.05%). For mineral content, there was a significant difference (P<0.05) among the samples. Sample F (0:20:80) had the highest value in iron (68.25±0.26mg/100g), calcium (170.00±0.20mg/100g), potassium (220.80±1.10 mg/100g) and sodium (470.10±0.10 mg/100g). Sample C (60:20:20) had the highest phosphorus content (10.74±0.02 mg/100g). Significant difference (P<0.05) existed among the samples for vitamin composition. Sample E (40:20:40) had the highest vitamin content in both vitamin A (22.01±0.25 mg/100g) and vitamin C (35.42±0.20 mg/100g). In sensory evaluation, the samples were evaluated with a control sample (Golden morn). Significant difference (P<0.05) existed among the Breakfast cereals. Breakfast cereal served with cold milk, indicated that sample D (50:20:30) had the highest level of acceptability (7.30±0.45) among other samples. Acceptable Breakfast cereals can be produced from 50:20:30 formulation of Yellow Maize:Soybeans:Banana composite flour blends.***

Keywords---- Breakfast Cereals, Yellow maize, Soybeans, Banana, Formulation, Composite flour

1. INTRODUCTION

Breakfast is regarded by many nutritionists as the most important meal of the day. This is because food consumed at breakfast seem to be more utilized than the same amount eaten at night. In simple terms it means "breaking the fast" of the night and is regarded as the most important meal of the day because it is the meal which is used to break the fast of the long night usually 10–12 hrs. Breakfast meals vary widely in different cultures around the world. It often includes a carbohydrate source such as cereals, fruit and or vegetable, protein, sometimes dairy, and beverage (Usman, 2012). In developing countries, particularly sub-Saharan Africa, breakfast meals for both adults and infants are based on local staple diet made from cereals, legumes, and cassava and potato tubers. However, the most widely eaten breakfast foods are cereals (Kent, 1983).

Many researchers have reported on the nutritional potential of the supplementation of nutritious fruits into cereal-based breakfast meals to fortify them with some mineral elements, fibre, antioxidants and vitamins (Ezeokeke and Onuoha, 2016; Tiencheu *et al.,* 2016). Lysine, which is limiting in cereals, is supplemented when cereals are combined with legumes rich in lysine (Oke, 1975). Although cereals (especially the yellow maize) are rich in lysine, they cannot provide effectively the nutrients required by the body, especially in the morning when the supply of nutrients from the previous day is exhausted (Onweluzo and Nnamuchi, 2009). Thus combining cereals with other foodstuffs will improve the nutritional value of such blends compared to individual components alone (Mbaeyi-Nwaoha and Uchendu, 2016). However, consumption of proteins from plant sources (legumes) is encouraged (Ofuya and Akhidue, 2005) since combination of legumes and grains provide high quality and cheaper protein that contains all essential amino acids in proper proportion, and their amino acids also complement each other (Okaka, 2005).

Soybean is a legume, which has its proteins closely relating with animal protein and with a high-protein quantity, close to 40–45% of the total solids (Goyal *et al.,* 2012). They are among the best sources of plant-based proteins, their protein content ranges from 36-56% of the dry weight (Grieshop and Fahey, 2001). Soybeans contain significant amounts of phytic acid, dietary minerals and B vitamins (Britannica, 2019). The soybean is economically the most important bean in the world providing vegetable protein for millions of people and ingredients for hundreds of chemical products (Augustyn, 2019).

Bananas are edible fruits produced from several kinds of large herbaceous flowering plants in the genus *Musa* (Morton, 2009). They vary in color, size and firmness but are usually elongated and curved with soft flesh rich in starch covered with a rind which may be green, yellow, red, purple or brown when ripe depending on the cultivars (Wikipedia, 2019). Raw bananas (not including the peel) are 75% water, 23% carbohydrates, 1% protein and contain negligible fat (Duval, 2017). Bananas are a rich source of vitamin $B_{6,}$ moderate amounts of vitamin C, Manganese, Potassium, dietary fibre etc. (Arnarson, 2014).

Maize or corn grains consist of the outer hull or bran, which contains a lot of fibre, embryo (germ) rich in oil and the endosperm rich in starch. Whole maize contains about 11% protein, 4% fat, 3% fibre, 65% of starch.

This research was made to formulate breakfast cereal using yellow maize, soybean and banana. Modifying the cereals to impart some desirable characteristics and using graded levels of the modified cereal along with the legume and fruit, also aimed at evaluating the nutritional and sensory qualities of the formulated breakfast cereals.

2. MATERIALS AND METHODS

2.1. Materials procurement/collection

The soybeans (*Glycine max*), banana (*Musa sapientum*) and yellow maize variety (*Zea mays*) were purchased from Urua Nka market in Eket, Akwa Ibom State, Nigeria. The chemicals and other reagents used in this research work were of analytical grade and were obtained from the Department of Food Science and Technology, University of Uyo, Uyo.

2.2. Preparation of Maize Flour

Yellow maize kernels were sorted to remove spoilt grains, stones and other extraneous materials. The grains werer winnowed, washed, oven dried and milled with a hammer mill and sieved through a mesh of 425 micrometer apperture screen to fine flour. The flour was packaged in an airtight plastic container, labeled and stored at ambient temperature (27±2°C) for subsequent use.

2.3 Preparation of Soybeans Flour

Soybean flour was produced according to the method described by (Nkwakalor and Obi, 2014). The soybeans were sorted to remove pebbles, stones and other extraneous materials. It was wet cleaned and steeped for 10 hours. The steeped soybeans were drained and pre-cooked for 15minutes at 100°C after which it was dehulled (by rubbing between the palms) and the hulls were removed by rinsing with clean water. The dehulled soybeans were dried in the cabinet drier for 30 mins at 50°C and dry milled into flour. The soybean flour was sieved through a 425 micrometer pore screen and packaged in an airtight plastic container, labeled and stored at ambient temperature (27±2°C) for subsequent use.

2.4 Preparation of Banana Flour

The method of (Ezeokeke and Onuoha, 2016) was adopted for the production of banana flour. The bananas were washed with clean water, peeled manually, cut into slices of about 5mm thickness, dried in an oven (model:PP 22, US, Genlab, England) for 24h at 60°C, milled and sieved into fine flour. The flour was packaged in an airtight plastic container, labeled and stored at ambient temperature (27±2°C) for further use.

2.5 Products Formulation

Composite flour was formulated by mixing yellow maize, soybean and banana flours. Six samples of breakfast cereals were generated by mixing the composite flour in different proportions (80:20:0, 70:20:10, 60:20:20, 50:20:30, 40:20:20, 0:20:80), as in Table 1. The recipe for the breakfast cereals production is shown in Table 2.

Table 1: Composition flour formulation for breakfast cereals made from blends of yellow maize (YM): Soybean (SB): Banana (BN) flour:

Sample	Sample Code	Code Ratio	Percentage (%)
A	YM:SB:BN	80:20:0	80%YM+20%SB+0%BN
B	YM:SB:BN	70:20:10	70%YM+20%SB+10%BN
C	YM:SB:BN	60:20:20	60%YM+20%SB+20%BN
D	YM:SB:BN	50:20:30	50%YM+20%SB+30%BN
E	YM:SB:BN	40:20:40	40%YM+20%SB+40%BN
F	YM:SB:BN	0:20:80	0%YM+20%SB+80%BN

Table 2: Recipe for breakfast cereals made from blends of YM+SB+BN flour per 100g.

Ingredients	A	B	C	D	E	F
YM+SB+BN(g)	100	100	100	100	100	100
Sugar(g)	14	14	14	14	14	14
Salt(g)	1	1	1	1	1	1
Water(ml)	20	20	20	20	20	20

Key: YM=Yellow Maize, SB= Soybean, BN= Banana

2.6. Production of Breakfast Cereal

The method of Usman, (2012) as shown in Fig. 1 was adopted for the production of breakfast cereals. The breakfast cereals were generated by mixing the yellow maize, soybean and banana flours until a homogenized mixture was obtained. Sugar, salt and water were added and mixed manually. It was kneaded to form a pastry and made into strands by passing through a cold extruder (a crown star Pasta Maker, model: MC-8830, China), with a screw speed range of 1-9 and three (3) partitions-for pastry sheeting, noodles forming and snack forming/shaping die). The partition used in the production of the breakfast cereals in this study was snack forming/shaping die and the screw speed was at six (6). They were dried in an oven (NAAFCO BS Oven, model: OVH-102, Nigeria) for 1hr at 110°C. The breakfast cereals were allowed to cool and packaged in a transparent polythene bag and sealed with a Impulse sealer, (model: SP-200H, Taiwan). This production process was carried out at the processing laboratory of the Department of Food Science and Technology, University of Uyo. Uyo.

2.7. Methods of Analysis

2.7.1. Determination of Proximate composition of the samples:

Proximate analysis including: moisture content, ash, crude fiber, crude protein, crude fat, and carbohydrate were carried out on the ground breakfast cereals using standard methods described AOAC (2010). The determinations were done in triplicates and all reagents used for the analysis were of analytical grade.

2.7.2 Determination of Mineral Contents

The mineral contents of the formulated samples were determined using the method described by (Adedeye and Adewoke, 1992). One gram (1g) of the dried samples were digested with 2.5ml of 0.03N HCl. The digest was boiled for 5 minutes and allowed to cool to room temperature. It was transferred to 50ml volumetric flask and made up to the mark with diluted water. The resulting digest was filtered with Whatman No. 1 filter paper. Filtrate from each sample was analyzed for mineral (Sodium, Phosphorus, Iron, Calcium and Potassium) contents using an atomic absorption spectrophotometer (model: 205), using standard wavelengths. The real values were extrapolated from the respective standard curves. Values were obtained and adjusted for HCl extractability for the respective ions. All determinations were done in triplicates.

2.7.3. Vitamin Analysis

Pro-vitamin A was determined using the method described by (Jakutowick *et al*., 1997) and Vitamin C was determined following the standard method of (AOAC, 2010).

2.7.4. Sensory Evaluation

Sensory properties of the breakfast cereals were evaluated by twenty 20 semi-trained panelists from the Department of Food Science and Technology for various sensory attributes (appearance, taste, flavor, mouth-feel, aftertaste, crispiness and overall acceptability). A nine-point hedonic scale questionnaire was used where 9- like extremely; 8- like very much; 7- like moderately; 6- like slightly; 5-neither like nor dislike; 4- dislike slightly; 3- dislike moderately; 2- dislike very much; 1- dislike extremely; (Ihekoronye and Ngoddy, 1985). All panelists were briefed before the commencement of the process. The breakfast cereals were served in cold milk. Panelists were instructed to rinse their mouth with water before evaluating subsequent samples. A serene atmosphere of good lighting and ventilation was provided for the panelists to conduct the evaluation. All panelists were regular consumers of breakfast cereals. Data obtained were statistically analyzed to determine the level of general acceptability.

2.7.5 Statistical Analysis

Statistical Package for Social Science (SPSS, version 20) was used for the statistical analysis. The differences between samples in each parameter tested was done using One Way Analysis of Variance (ANOVA) and New Duncan's Multiple Range Test as a post-hoc test when the analysis of variance indicates significant difference in their means. A significant level of $P<0.05$ was used throughout the study.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Table 3 shows the proximate composition of breakfast cereals produced from blends of yellow maize, soybeans and unripe banana flours. Results of the moisture composition revealed that there were significant differences ($P<0.05$) in all the breakfast cereals however, samples B (70:20:10) and sample D (50:20:30), and samples C (60:20:20) and sample F (0:20:80) formulations were statistically the same. The highest value (6.13±0.02%) of moisture content was observed in Sample F (0:20:80) formulation. The least value (5.42±0.03%) was observed in sample D (40:20:40) formulation. The increase in moisture content could be due to an increase in the percentage composition of banana flour. (Mbaeyi-Nwaoha and Uchendu, 2016) also observed low moisture content of breakfast cereals from blends of acha and fermented soybean to be within the range of 4.71±0.06 to 9.88±0.24%. The breakfast cereals generally had low moisture content, which implied that they could have an extended shelf life. Since the moisture content of a food affects its stability and overall quality (Samuel and Otegbayo, 2006).

Protein content decreased with increasing addition of banana flour. Protein content of the samples ranged from 9.25±0.07% to 14.75±0.05%. These values are lower than those recorded by Usman, (2012) with a range of 15.68±0.07% to 18.26±0.13% for maize, African yam bean and defatted coconut based breakfast cereal. The highest protein value was observed in sample A (80:20:0) formulation. The high level of protein in the samples indicates the effect of supplementing legumes in breakfast cereals (Usman, 2012). Although protein from plant sources are nevertheless "complete" because they contain at least trace amounts of amino acids that are essential in human nutrition, eating various plant foods in combination can provide a protein of higher biological value (McDougall, 2002).

Fat content decreased with decreased, in yellow maize composition in the breakfast cereals formulation. Fat content had values ranging from 2.15±0.02 to 4.82±0.14%. Sample F (0:20:80) formulation had the least fat content and sample A (80:20:0) had the highest fat content. The fat content of Samples A (80:20:0), B (70:20:10) and C (60:20:20) were not significantly different ($p>0.05$) from each other but were significantly different ($p<0.05$) from the other samples. The decrease in fat content could be attributed to a decrease in the percentage composition of yellow maize. Mbaeyi-Nwaoha and Uchendu, (2016) reported a range from 1.57 to 16.29 % fat. The higher fat content of Sample A (80:20:0) formulation could be due to the fact that cereals like maize, millet etc. are rich in oil due to the presence of germ (Manley, 2000). For weight watchers, the low fat content of the developed products would be suitable for them. (Agunbiade and Ojezele, 2010).

Ash is an indication of mineral content in food materials. Ash content of the breakfast cereals showed significant difference ($p<0.05$) with a range of values from 3.40±0.01 to 3.80±0.03%. Ash content increased with increasing addition of unripe banana flour in the breakfast cereals. Lower values (1.50 – 2.50%) were recorded by (Mbaeyi, 2005). The high ash values recorded in this work may be attributed to the presence of whole maize grains and unripe banana used as part of the ingredients in this study. Banana has high mineral content, the difference in ash content can also be due to the difference in the formulation of the samples. Ash content is the residue remaining after destroying combustible organic matter and it gives an overall estimate of the total mineral elements present in the food.

The values of crude fiber content of the formulated breakfast cereals ranged from 2.11±0.01 to 4.25±0.03%. All samples were significantly different at $p<0.05$. Fibre content increased with increasing addition of maize and decreased in addition of banana flour in the blend. Breakfast cereal with 80:20:0 formulation (sample A) had the highest value of crude fiber while 0:20:80 formulation (sample F) had the least value. This is probably due to the use of whole maize grains in the breakfast cereal formulation. The crude fiber values (2.11±0.01 to 4.25±0.03%) are within the range of the lower values also observed by (Mbaeyi, 2005) (1.54 – 4.0%). Fiber is needed to assist in digestion and keep the gastro-intestinal tract healthy; fiber also aids in lowering blood cholesterol levels and slows down the process of absorption of glucose, thereby helping in blood glucose level control. (Anderson *et al.*, 2009*)*. It also ensures smooth bowel movements and thus helps in easy flushing out of waste products from the body, increase satiety and hence impacts some degree of weight management (Mickelson *et al., 1979)*. It slows down the release of glucose during digestion, so cells require less insulin to absorb that glucose. The American Diabetes Association recommends that people with diabetes should consume 25-50g of fiber per day (Trinidad *et al.*, 2006*)*. The fecal bulking action of insoluble fiber makes it useful in the treatment of constipation and diverticular disease (McKevith, 2004).

Carbohydrate content of breakfast cereals ranged from 67.28±0.04 to 76.56±0.05%. Carbohydrate content increased significantly with increasing addition of banana flour in the blend fomulations. All samples were significantly (P<0.05) different. Breakfast cereal with 80:20:0 (sample A) formulation had the least carbohydrate value and 0:20:80 (sample F) formulation had the highest carbohydrate value. The carbohydrate content of the samples increased with increase in percentage composition of banana flour. Bananas are a rich source of carbohydrate, mainly starch in unripe bananas. Green bananas contain up to 70-80% starch on a dry weight basis (Arnarson, 2014). High values (62.44±0.22 – 66.48±0.04%) of carbohydrate content for breakfast cereals formulated from blends of acha and fermented soybean paste (okara) were also recorded by (Mbaeyi-Nwaoha and Uchendu, 2016). However the carbohydrate values in this work are higher than those recorded by Usman, (2012) with values ranging from (60.96±1.42 – 64.53±0.05%).

Table 3 Proximate Composition of breakfast cereal made from yellow maize, soybean and unripe banana flour blends.

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	CHO (%)
A	5.42 ± 0.03^d	14.75 ± 0.05^a	4.82 ± 0.14^a	3.40 ± 0.01^e	4.25 ± 0.03^a	67.28 ± 0.04^f
B	5.50 ± 0.03^c	14.10 ± 0.14^b	4.62 ± 0.15^a	3.45 ± 0.01^d	3.81 ± 0.01^b	68.20 ± 0.06^e
C	5.82 ± 0.05^b	12.54 ± 0.11^c	4.55 ± 0.14^a	3.46 ± 0.01^d	3.30 ± 0.01^c	70.07 ± 0.14^d
D	5.84 ± 0.03^b	12.13 ± 0.15^c	4.05 ± 0.05^b	3.50 ± 0.02^c	3.02 ± 0.03^d	71.46 ± 0.11^c
E	6.08 ± 0.04^a	9.88 ± 0.08^d	3.70 ± 0.08^c	3.60 ± 0.01^b	2.87 ± 0.04^e	74.53 ± 0.03^b
F	6.13 ± 0.02^a	9.25 ± 0.07^e	2.15 ± 0.02^d	3.80 ± 0.03^a	2.11 ± 0.01^f	76.56 ± 0.05^a

Values are mean ± SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (P<0.05).
Sample A-80: 20:0, Sample B- 70:20:10, Sample C-60: 20:20, Sample D-50: 20:30, Sample E-40: 20:40, Sample F-0: 20:80 of Yellow Maize: Soybean: Banana

3.2 Mineral Composition

The mineral (Iron, Sodium, Calcium, Potassium and Phosphorus) contents of breakfast cereals produced from blend of yellow maize, soybeans and unripe banana are presented in Table 4. Results of Iron content showed that significant difference p<0.05 existed among all the samples. Breakfast cereal with 0:20:80 formulation (sample F) had the highest value (68.25±0.26mg/100g) while 50:20:30 formulation (sample D) had the least value (41.54±0.10mg/100g). These values are higher than the US RDA (10-15mg/100g). The values obtained in this study are higher than those recorded by Usman, (2012) (9.81±0.30 to 14.10±0.06mg/100g) for breakfast cereals made from African yam bean, maize and defatted coconut. When foods with iron are eaten, it is absorbed into proteins and helps these proteins carry and release oxygen throughout the body. An iron deficiency called iron-deficiency-anemia is very common around the world especially for women and children in developing countries. Symptoms of iron deficiency include fatigue, weakness and shortness of breath (Ryan *et al.*, 2009).

Calcium content obtained from the samples indicated values ranging between 131.28±0.30 to 170.00±0.20mg/100g with significant difference p<0.05 existing among all breakfast cereals. These values are less than the US RDA (1000mg). Breakfast cereal with 60:20:20 formulation (sample C) recorded the least value. Mbaeyi, (2005) reported calcium values (137.05-156.34 mg/100g) within the same range for breakfast cereals from blends of yellow maize, soybeans and unripe banana. Calcium is necessary for growth maintenance of strong teeth and bones, nerve signaling, muscle contraction and secretion of certain hormones and enzymes (Greenwood and Earnshaw, 1997). A deficiency in calcium can lead to numbness in fingers and toes, muscle cramps, convulsions, lethargy (Nordqvist, 2007). Calcium is by far the most important mineral that the body requires and its deficiency is more prevalent than any other mineral (Kanu *et al.*, 2009). Calcium, Phosphorus and vitamin D combine together to eliminate rickets in children and osteomalacia (the adult rickets) as well as osteoporosis (bone thinning) among older people (Adeyeye and Agesin, 2007).

Potassium content of the breakfast cereals ranged from 165.60±1.00 to 220.80±1.10mg/100g. The highest value was recorded by the sample A (0:20:80) formulation while Sample C (60:20:20) formulation had the least value. Significant difference (p<0.05) existed among all samples except 80:20:0 and 50:20:30 formulation. These range of values are higher than the US RDA for both men and women (3.5mg). Mbaeyi, (2005) also recorded high potassium values (107.0 – 238.0mg/100g). Potassium is primarily an intercellular cation, in large parts this cation is bound to protein and sodium influences osmotic pressure and contributes to normal pH equilibrium (Adeyeye and Agesin, 2007). Potassium is also needed for counteracting the adverse effects of sodium on blood pressure, nerve, muscle function and regulating electrolytes, which are minerals in the body that can carry an electrical charge (Shaposhnik, 2007). Bananas are good sources of potassium (Abdel-Wahab *et al.*, 1999). Increased potassium level could be an added advantage in product formulation like breakfast cereals where potassium is an important macronutrient among other minerals (Mbaeyi, 2005).

Results for Sodium content of the breakfast cereals showed a range of values from 341.00±0.64 to 470.10±0.10mg/100g. All samples showed significant difference (p<0.05). The least value was observed in 60:20:20 formulation and the highest value in 0:20:80 formulation. These values are less than the value for US RDA (500mg/100g) and higher than those recorded by (Mbaeyi, 2005) (97.5 -187.3mg/100g). Sodium intake needs to be monitored as it can become a major dietary problem where high blood pressure problems are concerned (Inyang and Ekop, 2015).

Phosphorus composition of the samples ranged from 8.12±0.05 to 10.74±0.02mg/100g. Significant difference (p<0.05) was observed among all samples except 60:20:20 and 50:20:30 formulations. Lower values (1.97±0.01 - 3.23±0.02mg/100g) were also recorded by (Mbaeyi-Nwaoha and Uchendu, 2016) for breakfast cereals formulated from blends of acha and fermented soybean paste. Higher values (108.12 – 959.9mg/100g) were recorded by Mbaeyi, (2005). The presence of Phosphorus in the samples is an indication that the products will help in the formation of teeth and bones in children and in their proper development (Bolarinwa *et al.*, 2015).

Table 4 Mineral Composition of breakfast cereal made from yellow maize, soybean and unripe banana flour blends.

Sample	Fe	Ca	K	Na	P
A	62.10±0.30^{b}	144.80±1.04^{b}	192.40±1.10^{c}	352.10±0.40^{e}	8.12±0.05^{e}
B	55.37±0.10^{c}	138.02±0.55^{d}	187.30±1.91^{d}	364.57±0.55^{d}	9.31±0.09^{c}
C	46.40±0.50^{e}	131.00±0.60^{e}	165.60±1.00^{e}	341.00±0.64^{f}	10.74±0.02^{a}
D	41.54±0.10^{f}	131.51±0.41^{e}	190.48±1.80^{c}	391.30±0.53^{c}	10.61±0.10^{a}
E	53.22±0.30^{d}	140.28±0.30^{c}	195.10±0.80^{b}	438.05±0.15^{b}	9.76±0.05^{b}
F	68.25±0.26^{a}	170.00±0.20^{a}	220.80±1.10^{a}	470.10±0.10^{a}	9.12±0.06^{d}

Values are mean ± SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (P<0.05)
Sample A-80: 20:0, Sample B- 70:20:10, Sample C-60: 20:20, Sample D-50: 20:30, Sample E-40: 20:40, Sample F-0: 20:80 of Yellow Maize: Soybean: Banana

3.3. Vitamins Composition

Table 5 shows the pro-vitamin A (beta carotene) and Vitamin C composition of breakfast cereals produced from blends of yellow maize, soybeans and banana flour. The breakfast cereals showed significant difference (p<0.05) among the samples for vitamin A composition with values ranging from 12.30±0.15 to 22.01±0.25mg/100g. Sample D (50:20:30) formulation had the highest value while 0:20:80 formulation (sample F) had the least value. Mbaeyi-Nwaoha and Uchendu, (2016) recorded values as high as 11.13±0.04 to 83.05±0.04mg/100g for breakfast cereals made from blends of acha and fermented soybean paste (okara). Vitamin A is very essential for growth reproduction, good vision, healthy skin, hair and nail and to balance energy level in the human body. The deficiency of vitamin A in the body causes keratomalacia (night blindness) (Ojimelukwe *et al.,* 2005). Vitamin A plays a beneficial role in vision, bone growth reproduction, cell division and cell differentiation (IOM, 2001) and also regulate the immune system which helps to fight off infections by producing white blood cells that destroy harmful bacteria and viruses Ikpeme-Emmanuel *et al.,* 2012.

The range of values for vitamin C content of the samples ranged from 23.20±0.13 to 35.42±0.20mg/100g. Significant difference (p<0.05) existed among all samples. However, the following formulations: Samples C, D and E (60:20:20, 50:20:30 and 40:20:40) were not significantly different (p>0.05) from each other. The highest vitamin C content was observed in 50:20:30 formulation (Sample D) while 0:20:80 formulation had the least vitamin C content. Usman, (2012) recorded lower values for vitamin C content. The values in this study fall within the range of US RDA for men, women and children (30-60mg/100g). Vitamin C is required by the body for maintenance of health, gum, healing of wounds, mopping excess of oxygen from the system and is a powerful antioxidant; its deficiency will cause sore gum and scurvy (Ojimelukwe *et al.*, 2005). Vitamin C is needed to form collagen, a tissue that helps to hold cells together; it is essential for healthy bones, teeth, gums and blood vessels (Duarte *et al.*, 2010). Vitamin C also helps the body absorb iron and contributes to brain function (Pinchas and Eliezer, 1996).

Table 5 Vitamins Composition of breakfast cereal made from yellow maize, soybean and unripe banana flour blends.

Sample	Vitamin A	Vitamin C
A	17.30±0.21^{e}	28.10±0.01^{d}
B	18.43±0.05^{c}	30.48±0.01^{c}
C	19.35±0.11^{b}	34.30±0.10^{b}
D	22.01±0.25^{a}	35.42±0.20^{a}
E	17.85±0.06^{d}	34.93±0.23^{ab}
F	12.30±0.15^{f}	23.20±0.13^{e}

Values are mean ± SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (P<0.05).

Sample A-80: 20:0, Sample B-70: 20:10, Sample C-60: 20:20, Sample D-50: 20:30, Sample E-40: 20:40, Sample F-0: 20:80 of Yellow Maize: Soybean: Banana

3.4. Sensory Evaluation

Results of the mean scores of the sensory properties of breakfast cereals served with cold milk is presented in Table 6. There was no significant difference (P>0.05) in appearance and taste between the control and all the developed breakfast cereals. In terms of flavor, breakfast cereal developed with 0%, 10% and 40% banana were statistically the same. For mouth-feel, breakfast cereals with 0%, 10%, 20% and 40% banana were not significantly different (P>0.05). The control sample (Golden morn) was not significantly different (P>0.05) from 30% banana formulated breakfast cereal. The mean sensory score for overall acceptability ranged from 5.20±0.47 to 7.30±0.45 with breakfast cereal developed with 30% banana (Sample D) having the highest while 80% banana and 0% yellow maize had the lowest. There was no significant difference (P>0.05) between the control and the breakfast cereal produced with 0%, 10%, 20%, 30% and 40% banana flour. Sensory properties for appearance, taste, mouth-feel, aftertaste and crispiness showed no significant difference (P>0.05). This could be that the panelists liked the breakfast cereals in terms of these sensory properties. These results compare favorably with the results of Usman, (2012) for maize, African yam bean and defatted coconut based breakfast cereal.

Table 6: Mean Sensory Scores for breakfast cereals

Sample	Appearance	Taste	Flavor	Mouth Feel	After Taste	Crispiness	Overall Acceptability
Control(Golden Morn)	7.00±0.37^{a}	7.00±0.63^{a}	7.80±0.29^{a}	7.20±0.47^{a}	7.40±0.43^{a}	5.70±0.67^{bc}	7.00±0.42^{a}
A	7.30±0.37^{a}	6.70±0.56^{a}	7.00±0.37^{b}	6.30±0.56^{ab}	6.30±0.63^{ab}	6.80±0.47^{ab}	6.80±0.33^{a}
B	7.50±0.40^{a}	6.80±0.47^{a}	7.10±0.31^{b}	6.50±0.54^{ab}	6.70±0.50^{a}	7.20±0.25^{a}	7.10±0.35^{a}
C	7.20±0.44^{a}	6.90±0.55^{a}	6.90±0.38^{b}	6.60±0.45^{ab}	6.40±0.40^{ab}	7.00±0.45^{a}	7.00±0.45^{a}
D	7.00±0.33^{a}	6.80±0.44^{a}	7.10±0.31^{b}	7.20±0.29^{a}	6.40±0.48^{ab}	7.30±0.26^{a}	7.30±0.45^{a}
E	7.00±0.33^{a}	6.90±0.57^{a}	6.70±0.52^{b}	7.00±0.30^{ab}	6.10±0.48^{ab}	6.90±0.31^{ab}	7.10±0.57^{a}
F	6.30±0.37^{a}	5.70±0.70^{a}	5.90±0.50^{c}	5.70±0.52^{b}	4.90±0.62^{b}	5.40±0.40^{c}	5.20±0.47^{b}

Values are mean ± SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (P<0.05).
Sample A-80: 20:0, Sample B-70:20:10, Sample C-60: 20:20, Sample D-50: 20:30, Sample E-40: 20:40, Sample F-0: 20:80. Yellow Maize: Soybean: Banana

4. CONCLUSION

Data obtained in this study shows that acceptable ready-to-eat breakfast cereals could be produced from yellow maize, soybean and unripe banana. The sensory evaluation results indicated that the breakfast cereal produced in this study had good sensory attributes and compared favorably with the control sample (Golden morn). They have shown to be good sources of protein, vitamins and minerals. Data obtained in this study showed that producing breakfast cereals with seed legumes could boost the protein level (up to 14%) in the final products.

The roasting process of the cereals influenced the moisture content (5-6%) of the products, which is important for transportation, and extension of the shelf life of properly packaged products. Most of the formulated samples were scored above average by sensory judges and showed some close similarities with the control (Golden morn) implying the product's acceptability when commercialized. Feeding infants with the formulated cereal developed in this study will contribute to preventing infant malnutrition problems in developing countries.

Conflict of Interest

The authors declare that they have no conflict of interest

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