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Production and Quality Evaluation of Maize, Cassava and Soybeans Composite Flour

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Abstract: ***The nutrient contents of maize/cassava flour used in the preparation of stiff porridges in Nigeria are low in protein (essential amino acids) as well as essential micronutrients required for healthy living, thereby predisposing consumers to several nutritional diseases. In this research, production and quality evaluation of maize, cassava and soybean composite flour was investigated. Standard procedures were adopted in flour production, chemical determinations and sensory analysis. Maize, cassava and soybean flours were composite at 70:25:5, 70:20:10, 70:15:15 and 70:10:20 blends while whole maize (100:0:0) and maize/cassava (70:30:0) blends served as controls. The results revealed that, for every 5% substitution of cassava flour with soybean flour there was a corresponding increase in protein, fats, ash, as well as pH, swelling and water absorption capacities of maize/cassava/soybean composite blends. Substitution however, decreased the moisture, fibre, carbohydrate and bulk density of the composite flour. The sensory scores indicate that stiff porridges prepared from composite blend 70:15:15 was generally the most accepted by the panelists with 8.30 mean score. The use of soybeans in composite flour production should be encouraged to boost the nutritional and health quality of our local flours.***

Keywords: Stiff porridges, Malnutrition, Nutrients and Composite flours

1. Introduction

In Nigeria, protein deficiency in diets is common and it is usually associated with deficiencies in calories leading to endemic protein malnutrition with its attendant health consequences particularly in children. Despite abundant global food supplied, widespread malnutrition persists in Nigeria and many other developing countries [1]. The World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) have been concerned about this trend, particularly of Protein Energy Malnutrition (PEM) and micronutrient deficiencies (Hidden Hunger) among infants, children and pregnant women. The United Nations' Standing Committee on Nutrition (SCN) pointed out that malnutrition is directly and indirectly associated with more than 50% of all children mortality, is the contributor to disease in developing world [2]. Seed proteins, especially from leguminous sources such as soybeans, have been put forward as potentially excellent sources of protein for the nutritionally quality upgrading of starchy roots and tubers for use in foods [3].

Maize (Zea mays, L.) is the most important cereal in the world after wheat and rice with regard to cultivation areas and total production. Its centre of origin is Mexico and was spread all over the world [4]. In most developing countries, starchy foodstuffs account for an estimated 70 to 90% of the total calories produced especially in Tropical Africa, and maize is one of the starchy-staple crops widely grown in this African region. Nutritionally, maize grain, as reported showed that, the major chemical component of maize kernel is starch, which provides up to 73% of the kernel weight [4]. Other carbohydrates are simple sugars such as glucose, sucrose and fructose in amounts that vary from 1 to 3% of the kernel. After starch the next largest chemical component of the kernel is protein. Protein content varies in common varieties from about 8 to 11% of the kernel weight.

Cassava (Manihot esculentae), is commercially cultivated in Nigeria. Cassava, when analyzed, contains 65% moisture, 32–35% starch, 0.7–2.5% proteins, 0.2–0.5% fat and 0.1–1.3% ash [5]. It also contains toxic cyanide glycosides, which are broken down at acidic pH to liberate free hydrogen cyanide. Products that are derivable from cassava include gari, fufu, cassava chips, cassava pellets, ethanol, monosodium glutamate, glucose syrup [5].

Soybean (Glycine max) belonging to the family leguminosae constitute one of the oldest cultivated crops of the tropics and sub-tropical regions, and one of the world's most important sources of protein and oil. Soybeans are probably the most important oil seed legume which has its origin in Eastern Asia, mainly China. Soybeans are among commonly used ingredients in enriching African traditional complementary food [6]. Nutritionally, soybean unique chemical composition on an average dry matter basis is about 40% of protein and 20% of oil with satisfactory ratio of essential amino acids which are necessary for human nutrition [7].

The study was aimed at production and quality evaluation of Maize, Cassava and Soybean composite flour.

2. Materials and Methods

Maize (Zea mays), Soybean (Glycine max) and Fresh Cassava roots for the study were collected from a local farmer in Mbabuande, Gwer-west Local Government Area of Benue State, Nigeria. White varieties of maize were chosen because it is commonly and widely grown in Benue State for human consumpt

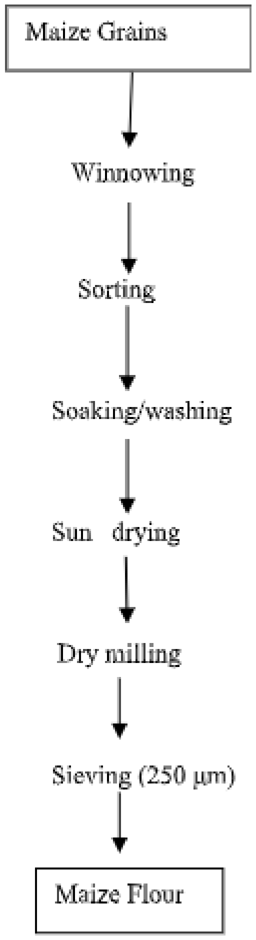

Figure 1: Source: Houssou and Ayemor [8]

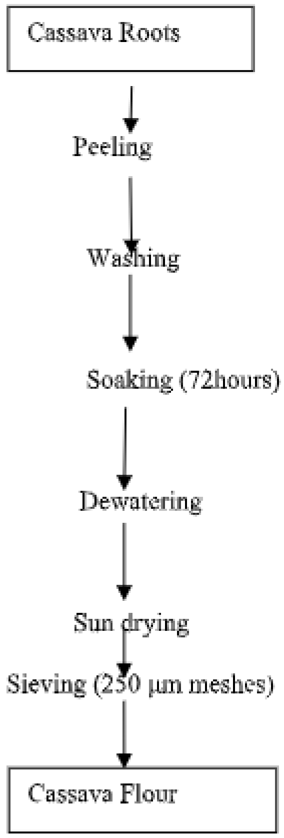

Figure 2: Source: Adekunle et al. (9)

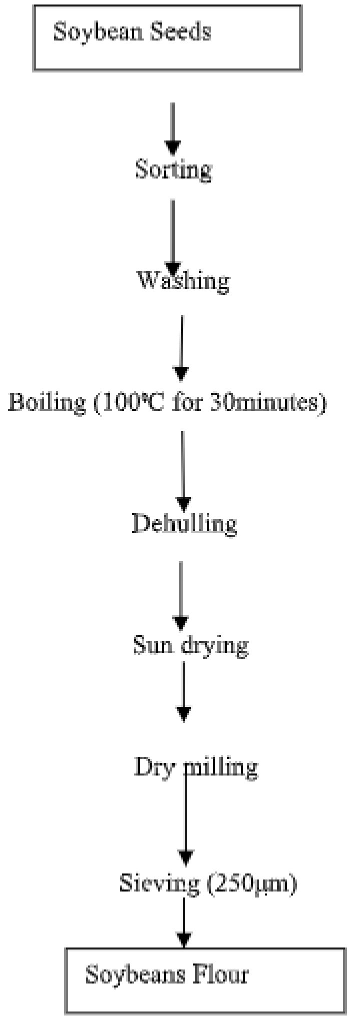

Figure 3: Source: Edema et al. [1

Table 1: Blend formulation for maize/Cassava/soybean composite flour (%)

Sample	Maize Flour (MF)	Cassava Flour(CF)	Soybean Flour(SF)
A	100	0	0
B	70	30	0
C	70	25	5
D	70	20	10
E	70	15	15
F	70	10	20

Preparation of Stiff Porridge

Stiff porridge was prepared by the method of Karim et al. [11]. Maize-Cassava-Soybean composite flour was be poured into boiling water with continuous stirring until a homogenous paste was formed.

The paste was covered and left on the fire for about 5 minutes to cook. It was further stirred, packed and wrapped with thin labeled polythene wraps.

Proximate Composition

Moisture, crude protein, fat, fibre, ash and carbohydrate were determined according to the Association of Official Analytical [12] methods on triplicate samples of the composite flour. Energy was calculated by the kanu et al method (protein x 4; fat x 9; carbohydrate x 4) [13].

Evaluation of functional properties of the flour

Bulk density was determined for each of the formulated samples using the method described by Onwuka[14]. The swelling capacity was determined by the method described by Okaka and Potter [15]. The water absorption capacities of the formulated samples and pH were determined using the method described by Onwuka [14].

Sensory Evaluation

Six different samples of the stiff porridge were evaluated using hedonic method for sensory characteristics and the overall acceptability by panelists of 50 judges from students of Benue State University; Makurdi using a 9 point hedonic scale preference test as described by Ihekoronye and Ngoddy [16]. The stiff porridges were assessed for organoleptic properties such as colour, aroma, mouldability, mouth feel and overall acceptability. The quantities evaluated were rated on a scale ranging from one to nine (1 to 9) 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.

Statistical Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) and mean separation was done by Duncan multiple range test (p=0.05), using Statistical Package for Social Sciences (SPSS, Version 20).

3. Results

Table 2: Proximate composition of maize-cassava-Soybeans composite

Sample	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carbohydrate (%)	Energy(kcal)
A(100:0:0)	$11.91^{a}\pm0.01$	$8.66^{e}\pm0.02$	$4.16^{e}\pm0.06$	$1.47^{a}\pm0.01$	$1.05^{e}\pm0.02$	$73.41^{b}\pm0.48$	365.72^{c}
B(70:30:0)	$11.81^{b}\pm0.01$	$6.96^{f}\pm0.02$	$1.71^{f}\pm0.01$	$1.08^{b}\pm0.01$	$0.82^{f}\pm0.01$	$78.28^{a}\pm0.02$	356.35^{d}
C(70:25:5)	$11.63^{c}\pm0.01$	$12.10^{d}\pm0.02$	$4.33^{d}\pm0.04$	$1.00^{c}\pm0.01$	$1.13^{d}\pm0.01$	$69.79^{c}\pm0.10$	366.61^{b}
D(70:20:10)	$11.57^{d}\pm0.02$	$14.13^{c}\pm0.02$	$4.53^{c}\pm0.03$	$0.97^{dc}\pm0.03$	$2.56^{c}\pm0.03$	$66.24^{d}\pm0.07$	362.25^{f}
E(70:15:15)	$11.53^{d}\pm0.01$	$16.65^{b}\pm0.03$	$4.73^{b}\pm0.02$	$0.93^{cd}\pm0.01$	$2.75^{b}\pm0.02$	$63.40^{e}\pm0.04$	362.77^{e}
F(70:10:20)	$11.45^{e}\pm0.02$	$19.57^{a}\pm0.02$	$5.82^{a}\pm0.02$	$0.91^{e}\pm0.02$	$2.81^{a}\pm0.02$	$59.43^{f}\pm0.08$	368.38^{a}

Values are means +Standard deviation (n=3)

A (100:0:0) = 100% Maize + 0% Cassava flours+0% Soybeans flour; B (70:30:0) = 70% Maize flour+30%Cassava flour + 0% soy flours; C (70:25:5) = 70% Maize flour+25%Cassava flour + 5% soy flours; D (70:20:10) = 70% Maize flour+20%Cassava flour+ 10% soy flours; E(70:15:15) 70% Maize flour+15%Cassava flour + 15% soy flour; F (70:10:20) = 70% Maize + 10% Cassava flours+20% Soybeans flour.

Table 3: Functional Properties of maize-cassava-soybeans composite flour

Samples	Bulk Density (g/ml)	Swelling capacity (%)	P^{H}	Water absorption capacity (%)
A(100:0:0)	$0.85^{a}\pm0.01$	$1.37^{e}\pm0.06$	$5.30^{f}\pm0.01$	$1.82^{f}\pm0.06$
B(70:30:0)	$0.72^{b}\pm0.01$	$1.53^{d}\pm0.10$	$5.60^{e}\pm0.00$	$1.95^{e}\pm0.03$
C(70:25:5)	$0.69^{cb}\pm0.01$	$1.58^{c}\pm0.08$	$6.13^{d}\pm0.02$	$2.02^{d}\pm0.03$
D(70:20:10)	$0.67^{dc}\pm0.02$	$1.63^{b}\pm0.06$	$6.40^{c}\pm0.10$	$2.07^{c}\pm0.01$
E(70:15:15)	$0.65^{ed}\pm0.02$	$1.80^{a}\pm0.10$	$6.53^{b}\pm0.06$	$2.12^{b}\pm0.03$
F(70:10:20)	$0.64^{fe}\pm0.01$	$1.82^{a}\pm0.03$	$6.67^{a}\pm0.06$	$2.17^{a}\pm0.01$

Values are means +Standard deviation (n=3)

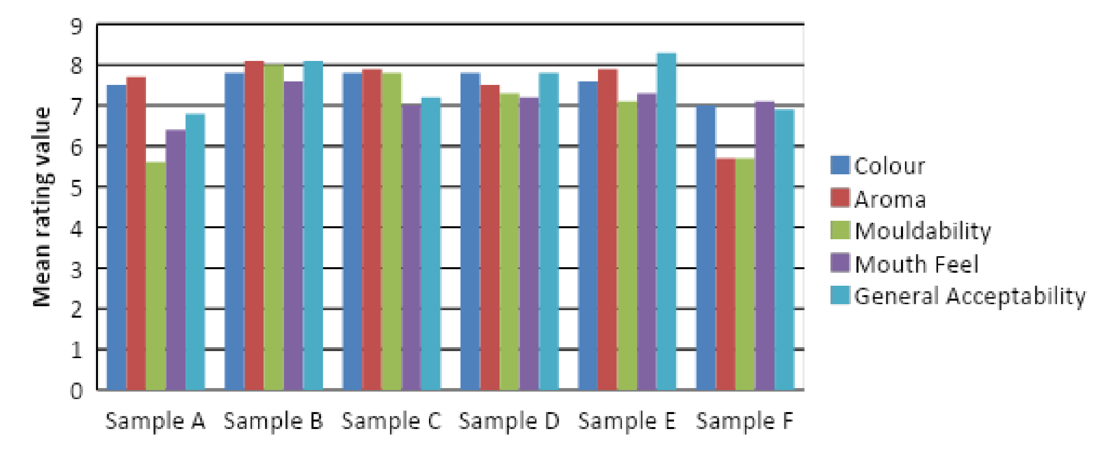

Figure 4: Mean sensory scores of maize-cassava-soybean stiff porridges

4. Discussion

The moisture of the formulated samples are shown in (table 2).The moisture content of the blends ranged from 11.45% to 11.91% with the highest value observed in the sample containing 100% maize. This may be due to the high fibre content of maize that has the ability to absorbed moisture from the environment and swell. The low moisture content observed in the samples is an indication that the composite flour samples may have advantage of prolongs shelf life of the products, if properly packaged. The result of the study (11.45 to11.91%) was lower than the reported value of (12.0%) for maize [4]. The crude protein content of the samples ranged from 8.66 to 19.57%, with that of the maize-cassava (70:30) flour blend being the lowest (6.9%) as compared to 12.12%, 14.13%, 16.65% and 19.57% for the blends containing 5%, 10%, 15% and 20% soybeans flour, respectively while the value for 100% maize was 8.66%. These values are similar to 8.92-20.77% as reported in literature [17]. The high protein content of the flour blends may be attributed to the presence of soybeans flour used in the blends. Raw soybeans have been reported to contain between 38-44% proteins [7]. There was significant increase ($p<0.05$) of protein with the addition of soybeans flour. The general high level of protein, however, demonstrates the effect of soybeans supplementation. The fat content of the samples were ranged from 4.16 to 5.82%. There were significant differences ($p<0.05$) among the samples. The fat content increased with increase in the substitution of soybeans flour. This is an indication that soybeans are a good source of fat. High fat values were recorded for maize-soybeans blends as 4.85-7.99% [17]. The presence of the graded level of fibre in maize and cassava may be responsible for generally low fat content of the formulation. The low fat content of flour would be suitable for weight watcher. The crude fibre content of the formulated samples ranged from 0.91 to 1.47%. Higher values 1.92-2.74% [17] were previously reported for maize-soybeans composite flour. The fibre content decreased with increasing substitution level of soybeans. The decrease in the fibre content could be as a result of dehulling soybeans to improve the protein content. Dehulled soybeans flour contains 6.5% neutral fibre and 5.7% acid detergent fiber [18]. Fibre is needed to assist in digestion and keep gastrointestinal tract health. It adds bulk to the stomach and can also keep blood sugar stable and reduces constipation[18].The results of the ash content of the samples showed significant differences ($p<0.05$) with values ranging from 0.82 to2.72%. The ash content increased with increasing level of soybeans. The lower value was found in the sample containing 30% cassava while the highest value of ash content was recorded in the sample containing 20% soybeans. The ash content of this study was higher than 0.99-1.39% reported in literature [17] in maize-soybeans composite flour. Lower value of 0.3%-1.33% were also recorded for cassava[6].The higher value of ash recorded in this study may be attributed to the high mineral contents of soybeans[19]. The carbohydrate content of the formulated samples ranged from 59.43% to 78.28%. There were significant differences ($p<0.05$) among all the samples with the highest value observed in the sample containing 70:30% maize-cassava, while the lowest value observed in the sample containing 20% soybeans flour. The carbohydrate content of the blends decreased considerably from 78.28% maize-cassava flour to 59.43% in the blends containing 20% soybeans flour. Higher carbohydrate values have, earlier, been reported in maize-soy flour blends 67.11%-84.31% [17]. The lower content of carbohydrate in the composite flours could be due to the soybeans flour that contributed to high proteins and low carbohydrate. The total energy values obtained for the samples are shown in table 1, which ranged from 356.35 to 368.38 kcal/100g and were found to be lower than the range d value recorded for maize-soybeans composite flour (416.57 to 434.07 kcal/100g)[17]. The lower energy value could be as a result of the incorporation of cassava flour which has low fat content. These energy values recorded in the study is an indication that stiff porridges produced from the blends would be good source of energy as they met daily.

Table 3 shows the functional properties of maize-cassava-soybeans composite flour. The bulk density of the composite flour was found to be between 0.64 to 0.85 g/ml. The bulk density of the composite flour decreased with increasing level of soybeans flour substitution with 100% maize flour being denser than the substituted samples. This low bulk density of the flour indicates lesser package requirement with increasing level of soybeans flour substitution. The bulk density values of the study are higher than 0.67 to 0.60 g/cm^3 reported in literature

[20].The result is also higher than 0.46 to 0.42 g/cm^3 for plantain-soy flour blends [21]. The swelling capacity of the samples ranged from 1.37ml-1.82 %. The swelling capacity increased with increase in soybeans flour substitution. The difference in the swelling capacity of the blends is an indication of the presence of amylase which influences the quantity of amylose and amylopectin present in the maize and cassava flours [22]. The excellent swelling capacity of the flour suggests that they may be used in the preparation of sauces, bread and gravies. This result disagrees with earlier reported of a decrease in swelling capacity of soy flour substitution in the malted sorghum-soy flour [20]. The pH value of maize-cassava flour substituted with 20% soybeans flour was higher (6.67) than other samples. The pH value ranged between 5.30 to 6.67. The pH value increased with increase in soybeans flour substitution. This increase in pH showed that acidity decreased with increasing soybeans flour substitution, indicating that the composite flour is not acidic. The flour is recommended to produce acceptable products for those suffering from stomach or peptic ulcer. The pH of 5.30-6.67 of the composite flour is similar to the pH (5.60-6.70) reported for "Ogi" [23]. The result is also similar to pH of 5.73-6.33 as reported in sorghum-soybeans composite flour [20]. The water absorption capacities (WAC) of the samples were ranged from 1.82-2.17%. WAC of maize-cassava-soybeans composite flour increased with soybeans flour substitution. The high WAC may assure product cohesiveness while low WAC product will be easily digestible. The WAC of maize-cassava-soybeans composite flour 1.82 to 2.17% obtained is lower than the values of 18 to 72% reported for sorghum-fermented cassava flour blend [24]. The WACs were higher than 1.71 to 1.87% reported in sorghum-soy composite flour [20]

The results on sensory evaluation of the stiff porridges are shown in Figure 4. In terms of colour, sample B, C and D were the most acceptable by the panelist with the same average mean score (7.80) and were significant different ($p<0.05$) from those of sample A, E and F. However, colours of all samples were acceptable by the panelist. The aroma was most acceptable (8.10) in sample B and least acceptable (5.70) in sample F. sample B was significantly different ($p<0.05$) from all other samples. However, all samples were generally acceptable for aroma. The mouldability of all the samples were generally acceptable and there was significant difference ($p<0.05$). However, sample B was the most molded (8.00) among other samples while sample A was least moulded (5.60) by the panelists. In the mouth feel, sample B (7.60) was most acceptable by the panelists and least acceptable in sample A (6.40). There was significant difference ($p<0.05$) in the mouth feel of the samples and all were acceptable by the panelists. Generally, sample E was the most acceptable (8.30) by the panelists. There was significant different ($p<0.05$) from all other samples. However, all samples were generally acceptable by the panelists. This study agreed with reported mean sensory scores of maize-plantain-soybean complementary food [25]. However, all samples were generally acceptable by the panelists.

5. Conclusion

The study showed that acceptable composite flour could be produced from maize, cassava and soybeans flour. The substitution of cassava flour with dehulled soybeans flour elevated the protein, fat, ash as well as swelling and water absorption capacity of maize/cassava/soybean composite blends. However, the incorporation of soybean flour decreased the moisture, fibre, carbohydrate and bulk density of the flours. The sensory scores of stiff porridges prepared from the composite flours indicate that flour blend 70:15:15 was generally the most accepted (8.30).

Recommendations

Advocacy should be carried out to promote the incorporation of soybeans in flour production for use in stiff porridge preparation in order to derive its immense nutritional and health benefits.

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