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NUTRITIONAL COMPOSITION OF AFRICAN YAM BEAN, CASSAVA, AND MAIZE FLOUR BLENDS AND THEIR BISCUIT-MAKING POTENTIAL

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ABSTRACT

Composite flour was produced from African yam bean (AYBF), cassava (CF), and maize (MF) and its potential in producing biscuit were investigated. Five samples were produced at AYBF: CF: MF ratios of 100:00:00; 70:20:10; 60:25:15 and 00:00:100. The proximate and mineral compositions of the composite flours and the sensory properties of the biscuit produced from these flour blends were evaluated using standard methods. From the results obtained, the moisture, fibre, and carbohydrate contents increased from 9.46 – 9.74%; 6.02 – 6.21%, and 56.91 – 60.91% respectively as the level of CF and MF increased in the blends while the protein, ash, fat, and energy values decreased from 20.70 – 17.12%; 3.26 – 3.19%; 3.65 – 3.03% and 343.29 – 339.39kcal respectively. The moisture contents obtained fell below the 14% recommended for shelf-stable storage of flour products. There was a significant reduction in all the mineral elements evaluated apart from magnesium, which increased from 40.50 – 97.14mg/100g. However, the results of the sensory evaluation show that biscuit produced from 100% MF was the most acceptable with the highest mean sensory scores in colour (5.60); taste (6.30); aroma (5.30); texture (5.90) and general acceptability (6.80). No significant difference exists among the five samples in terms of all the quality attributes aside from general acceptability. These results show the potential of AYBF, CF, and MF in the biscuit industry.

INTRODUCTION

One of the most well liked baked goods created from cereal, biscuits are enjoyed by almost everyone in the globe. They are treats made from dough that haven't been sweetened and is baked into something intriguing (Kure *et al.*, 2018). According to Sudha (2017), they are manufactured with wheat flour, sugar, milk, fat, flavorings, and other raising agents. Biscuits are readily available, affordable food items that provide nutritional and digestive fibres that are essential to human health (Kulkarni, 2017). Because biscuits are a strong supply of protein and minerals and a rich amount of fat and carbs, they are foods that provide energy (Kure *et al.*, 2018). Because of rising customer demand for quick-to-prepare and wholesome foods, they constitute a rapidly expanding food market (Masoodi and Bashir, 2012). Quality food products with taste, safety, convenience, and nutrition are in higher demand among consumers.

Since biscuits are the most popular snack among kids, who require more protein per unit of body weight than adults, biscuits' low nutritional content is quite concerning (Jaja and Yarhere, 2015). Compound flours were created as a result, and they are now used to make sweets, bread, and biscuits. The primary grain needed to make this snack product is wheat, but due to climate factors, it cannot be produced in Ghana's tropical regions. Therefore, there is a tendency for wheat flour prices to grow as well as the cost of importing it into the country for the manufacturing of baked products in places where the availability of wheat is constrained (Dotsey, 2019). The reason for this high price is that population growth has raised the demand for imported goods by driving up the consumption of baked goods. According to estimates, Ghana imported 700,000 metric tonnes of wheat flour in 2017 and 2018, which represents an increase of roughly 5.4% from 2016–2017 (Schroeder, 2018).

One of the underutilized tropical African tuberous legumes can be found in Nigeria, the Central African Republic, Gabon, Zaire, and Ethiopia. Its scientific name is *Sphenostylis stenocarpa*. (Ojewola et al., 2016). Given that, it contains two food products (grain and tuber), it has exceptional value. AYB is a significant source of protein in the diets of many tropical nations due to its high protein content. The protein content of the tuberous roots ranges from 11 to 19%, but the protein content of the seed ranges from 21-29% with 3,270 kcal/kg of metabolizable energy. Its methionine and lysine levels are equal to or higher than those of soybeans, according to the amino acid composition. However, AYB shares many of the same bad qualities as soybean, namely the beany flavour, the presence of anti-nutritional components, and the flaw of being difficult to prepare (Liener, 2009). According to Kinsella (2015), four important factors affect whether new foods or food additives are acceptable. This encompasses the cost, acceptability, safety, and nutritional value. AYB products can be a healthy food source that is a good source of fiber, carbs, and minerals by using the right processing methods and handling strategies (Enwere, 2008).

In sub-Saharan Africa, cassava (Manihot esculentus Crantz) is a common diet and a great source of energy (Laswai *et al.*, 2017). Approximately 291 million metric tonnes of the world's cassava are produced in West Africa and South America (FAO, 2020). Nigeria contributes about 20% of global production with a yearly output of 59 million metric tonnes (FAO, 2020). In cassava, carbohydrates predominate over all other nutrients. In addition, there are significant amounts of other nutrients like protein, carotene, calcium, and phosphorus (Chadare *et al.,* 2019). According to Chadare *et al.* (2019), cassava makes a substantial contribution to food security in third-world nations.

The manufacture of snacks, bread, and biscuits from cassava has expanded recently. This is because wheat is expensive and has negative health effects when consumed (Ocheme *et al.*, 2018). In addition, the rate of urbanization is increasing, which has altered feeding and dietary habits (Maziya-Dixon *et al.,* 2017). The potential of cassava as a component in the creation of baked goods and snacks has been demonstrated in a number of studies (Okoye and Ezeugwu, 2019). In rural markets in the Southern region of Nigeria, cassava-based snacks including sakada, ajogun, and gurudi are currently being sold (Ocheme *et al.*, 2018). In terms of cultivation areas and overall production, maize (*Zea mays*), generally known as maize, is the third-most significant cereal crop in the world, behind rice and wheat (USDA, 2009). A high-carbohydrate food, maize contains minerals, 10.5% protein, 5.4% fat, and 68% carbohydrates. Various culinary products can be made using maize flour.

The study's goal was to assess the nutritional value and biscuit-making capability of African yam bean, cassava, and maize flour blends.

MATERIALS AND METHOD

Sample Collections

Fresh cassava tubers, African yam bean, and maize seeds were purchased from the local traders in Otapete farm and Ikoko market in Owo, Ondo state, Nigeria, respectively. The processing equipment used was obtained from the Department of Food Science and Technology Owo, Ondo state and the analysis was carried out at the Postgraduate Research Laboratory, Federal University of Technology, Akure, Ondo State.

Sample Preparation

Production of maize flour

The maize grains were sorted and cleaned to remove broken grains and foreign objects. The grains were washed, soaked in water and fermented for 72 hours (3days). The grains were wet milled in a commercial maize mill and filtered through muslin cloth to remove excess water. The slurry obtained was left to sediment ad ferment for 24 hours at room temperature (27 ± 2^0C). The water was decanted and the past obtained was dried in an oven at 70^0C for 12 hours. The dried paste was milled into flour in a maize mill and packaged for further use (Addel-Aal *et al.*, 2006).

Preparation of cassava flour

Fresh cassava tubers were washed, peeled, washed with potable water, and drained; it was then grated with the aid of a locally fabricated cassava grater into mash, after which it was dried and milled in flour (Agesunobi, 2000)

Preparation of African Yam Bean (AYB) flour.

The method used has been described in Aburime *et al.* (2020). Cream-colored AYB seeds were sorted to remove impurities and weighed. The sorted AYB was washed and fermented in a citric acid medium (0.5%) for 24hrs at room temperature (28°C) in a ratio of 1:4 (w/v). At the end of the fermentation, AYB seeds were washed and divided into two. One-half of the fermented portions dehulled, while the remaining were left whole. They were dried (4hrs) using a food dehydrator (40-70 °C) and milled into fine flour and stored in an airtight container and refrigerated until needed for chemical analysis and product development

Proximate Analysis

The procedures for the chemical analysis for the mixture, ash, crude protein, fibre, pH, fat and carbohydrate were as outlined by the Association of Official Analytical Chemist (AOAC, 2010).

RESULTS

Table 1: Proximate composition of flour blends produced from African yam bean (AYBF), cassava (CF) and Maize (MF) flours

Parameters	AYBF	ACM1	ACM2	ACM 3	MF
Moisture (%)	9.46	9.53	9.64	9.74	9.72
Ash (%)	3.26	3.31	3.25	3.19	1.41
Protein (%)	20.70	19.02	18.07	17.12	13.18
Fat (%)	3.65	3.29	3.16	3.03	4.05
Fibre (%)	6.02	6.21	6.11	6.01	1.50
Carbohydrate (%)	56.91	58.64	59.77	60.91	70.15
Energy value (kcal)	343.29	340.25	339.80	339.39	369.77

Table 2: Mineral contents of flour blends produced from African yam bean (AYBF), cassava (CF) and Maize (MF) flours

Parameters	AYBF	ACM1	ACM2	ACM 3	MF
Calcium (mg/100g)	244.50	205.35	184.38	163.42	1,320.63
Magnesium (mg/100g)	40.56	48.80	54.42	60.05	97.14
Zinc (mg/100g)	6.05	5.02	4.79	4.38	6.26
Iron (mg/100g)	13.20	11.26	10.27	9.27	81.23

Table 3: Mean sensory scores of Biscuits produced from African yam bean (AYBF), cassava (CF) and Maize (MF) flour blends.

Parameters	AYBF	ACM1	ACM2	ACM 3	MF
Colour	$5.30±1.49^{a}$	$5.20±1.48^{a}$	$5.00±1.49^{a}$	$5.20±1.14^{a}$	$5.60±1.96^{a}$
Taste	$5.10±1.60^{a}$	$5.40±1.17^{a}$	$5.90±1.29^{a}$	$5.20±1.48^{a}$	$6.30±0.82^{a}$
Aroma	$4.40±1.65^{a}$	$5.30±1.27^{a}$	$4.40±1.49^{a}$	$4.80±0.79^{a}$	$5.30±1.42^{a}$
Texture	$5.30±0.95^{ab}$	$5.30±1.23^{ab}$	$4.50±1.90^{b}$	$4.90±1.10^{ab}$	$5.90±1.29^{a}$
General Acceptability	$5.50±1.65^{b}$	$5.30±1.64^{b}$	$5.30±0.70^{b}$	$5.50±1.18^{b}$	$6.80±0.42^{a}$

Values with different superscripts in each row are significantly different ($p<0.05$)

Keys

AYBF: 100% AYBF

ACM1: 80% AYBF + 15% CF: 5%MF

ACM2: 70% AYBF + 20% CF: 10%MF

ACM 3: 60% AYBF + 25% CF: 15%MF

MF: 100%MF

DISCUSSION

The results of the proximate analysis (Table 1) show that the moisture content ranged from 9.46 to 9.72%. However, the moisture content increased as the cassava and maize flours increased in the blends from 9.46 to 9.74%, and the moisture content of the maize flour (9.72) was high compared to that of the blends. According to Adeleke and Odedeji (2010), the moisture content was below the recommended 14% for shelf storage of flour products.

The ash content of the maize flour (1.41) differed significantly from the other flour blends, which ranged between 3.19 and 3.26%. A slight increase in the ash content was observed in the blends as CF and MF increased, probably due to the addition effect. There was a decrease in the protein content of the blends as the levels of CF and MF increased from 20.70 to 17.12%. This might be attributed to the low protein content of cassava (Adeniran and Afifolokun, 2015) and maize (Shaista *et al.*, 2017). A similar trend of reduction was also observed in the fat content of the flour blends produced in this study, with increased inclusion of CF and MF, from 3.65 to 3.03%. This reduction in fat and protein contents might be partially due to the reduction in energy value in the blends from 343.29 to 339.39 kcal. It should be noted that protein and fat are major factors in calculating the energy values of food products. The high-energy value is of great importance to human activity and health. Wardlaw (2004) reported that high-energy foods tend to have a protective effect on the optimal utilization of other nutrients.

The crude fiber of the sample ranged from 6.01 to 6.21%, with sample ACM1 having the highest value and sample ACM3 having the least value. However, MF had a very low crude fiber content of 1.50% compared to the blends of flour. However, the carbohydrate content increased from 56.91% to 60.91% in the flour blends, and a high value of 70.15% was recorded for MF. The carbohydrate content obtained in this study was high enough, and this might have resulted in the high-energy value range of the flour blends. Azeez *et al*. (2022) reported a similar trend for cookies produced from AYBF, CF, and MF blends.

The results of the mineral analysis of the flour blends are shown in Table 2. The calcium content of the samples ranges from 163.42 to 244.50 mg/100 g among the blends, and the MF had a very high value of 1320.63 mg/100 g. The values obtained for calcium in this study were high enough, and this suggests that food should be fortified with AYBF to improve the calcium level. The calcium content decreased as the levels of CF and MF increased in the blends. A similar trend was also observed in the zinc content, which decreased from 6.05 to 4.38 mg/100 g, and in the Iron content, from 13.20 to 9.27 mg/100 g, respectively. The decrease in Iron content in the samples suggests that anti-nutrients such as oxalate and phytate could be present in the samples, thereby making the mineral unavailable by forming complexes with them, as reported by Enonfon-Akpan and Umoh (2004).

However, out of all the mineral elements evaluated in this study, only magnesium increased in the blends as the CF and MF inclusion increased from 40.56 to 60.05 mg/100 g. Maize flour had higher values in all the mineral elements evaluated in this study, with values of 1320.63 mg/100 g (calcium); 97.14 mg/100 g (magnesium); 6.26 mg/100 g (zinc); and 81.23 mg/100 g (iron).

The mean sensory scores of biscuits produced from African yam bean, cassava, and maize flour blends are shown in Table 3. The scores of all the sensory attributes evaluated in this study were low in all the biscuit samples from the different blends. In general, biscuits produced from 100% maize flour were rated best in terms of colour (5.60), taste (6.30), aroma (5:30), texture (5.90), and general acceptability (6.80) and were not significantly different from the biscuits produced from AYBF in all the attributes.

There was no significant difference among all the biscuit samples produced in this study in terms of colour, taste, aroma, or texture. However, the biscuit produced from 100% MF differs significantly from all other samples in terms of general acceptability, while not all the other samples differed. This result suggests the potential of AYBF, CF, and MF in biscuit production.

CONCLUSION

Biscuits of acceptable quality similar to those made from wheat flour were produced from African yam bean, cassava, and maize flour blends at different ratios. Substitutions of African yam bean flour (AYBF) with cassava flour (CF) and maize flour (MF) up to 25% and 15%, respectively, produced good results. The study showed that mixing AYBF with CF and MF increased the moisture content (9.46–9.74%), fibre (6.02–6.21%), and carbohydrate (56.91–60.91%) but decreased the protein (20.70–17.12%), ash (3.26–3.19%), fat (3.65–3.03%), and energy value (343.29–339.39 kcal). All the mineral elements evaluated decreased as the levels of CF and MF increased in the blends, apart from magnesium, which increased from 40.56 to 97.14 mg/100 g.

The result of the sensory evaluation showed that there was no significant difference among all the biscuit samples in terms of colour, taste, aroma, and texture, but that they differed in general acceptability. A biscuit produced from 100% MF was rated best in terms of all sensory attributes. The results of the sensory evaluation show that the combination of AYBF, CF, and MF has potential in the snack industry.

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