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NUTRITIONAL EVALUATION AND SENSORY PROPERTIES OF MAIZE BASED CARROT FORTIFIED SNACKS (MASA) WITH BAMBARA GROUNDNUT FLOUR BLEND

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Abstract

Masa is a traditional fermented snack widely consumed in West Africa, particularly in Nigeria. It is typically prepared from cereals such as rice, millet, maize, or sorghum, which are fermented and fried to produce a soft, spongy, cake-like product. This study was carried out to investigate the Nutritional Evaluation and Sensory Properties of Maize based carrot fortified snacks (Masa) with Bambara ground nut flour blend. The maize grains and Bambara groundnut seeds were cleaned to remove dirt, stones, and damaged seeds. The grains were soaked in water at room temperature for 12 hours to soften the coat and initiate fermentation. The soaked grains were drained and dried in an oven at 60°C until moisture content was reduced. The dried maize and Bambara groundnut seeds were then toasted to reduce anti-nutritional factors after which they were separately milled into fine flours using a hammer mill. The flours were passed through a 250-micron sieve to obtain uniform particle sizes. The fruits of carrot were washed with water, cut into smaller pieces with the aid of a kitchen knife and oven dried to a constant weight at 500C for 60 minutes. The dried fruits were then milled using a hammer mill and then packaged until needed for use. The results of proximate composition of are presented in Table 1. The findings indicated that Sample C was significantly ($p<0.05$) higher in Moisture (6.17±0.42) and Ash content (1.86±0.07). Similarly, the results also indicated that Sample A was significantly higher ($p<0.05$) in fat (3.80±0.08). Unlike protein content, Sample C (23.19±0.03) was significantly

Keywords: Snacks, Fortified Carrot, Bambara nut, Maize and Sensory Evaluation

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(p<0.05) higher. However, the results of fibre revealed that Sample A (2.29±0.14) was significantly (p<0.05) higher among other samples. The findings also observed that Sample B (83.61±0.20) was significantly (p<0.05) higher in nitrogen free extracts, while Sample C (386.92±4.03) was significantly (p<0.05) in Energy value. Table 2 revealed the mineral composition of, the sodium content was found to be statistically (p<0.05) higher in Sample D (5.45±0.19 mg/100g). Also, potassium content was found to be statistically (p<0.05) higher in Sample C (9.90±0.21 mg/100). Similarly, Calcium content was highest in Sample C (8.40±0.07mg/100g). Phosphorus content was found to be statistically (p<0.05) higher in Sample D (3.74±0.19 mg/100g). Magnesium content was statistically (p<0.05) higher in Sample C (5.68±0.04 mg/100g). Similarly, Sample C showed the highest iron content of (6.81±0.04 mg/100g). Also zinc content of (5.66±0.49 mg/100g) was statistically higher in Sample C (5.66 ±0.049mg/100g). Table 3 revealed the Functional Properties of, the bulk density was found to be statistically (p<0.05) higher in Sample E (3.00±0.07 mg/100g). Also, water absorption capacity was found to be statistically (p<0.05) higher in Sample E (3.92±0.14 mg/100). Similarly, Oil absorption capacity was highest in Sample D and E (7.03±0.04mg/100g). Swelling capacity was found to be statistically (p<0.05) higher in Sample A (19.40±0.64 mg/100g). Table 4 revealed the Sensory Evaluation of, the Taste was found to be statistically (p<0.05) higher in Sample A (7.66±1.11). Also, appearance was found to be statistically (p<0.05) higher in Sample B (7.53±0.14 mg/100). Similarly, Aroma was highest in Sample C (7.80±0.07mg/100g). Colour was found to be statistically (p<0.05) higher in Sample D (7.73±0.19 mg/100g). Also, texture was found to be statistically (p<0.05) higher in Sample D (7.73±0.14 mg/100). Similarly, Aroma was highest in Sample C (7.80±0.07mg/100g). General Acceptability was found to be statistically (p<0.05) higher in Sample A (7.83±0.19 mg/100g).

Introduction

Background of the Study

Masa is a traditional fermented snack widely consumed in West Africa, particularly in Nigeria. It is typically prepared from cereals such as rice, millet, maize, or sorghum, which are fermented and fried to produce a soft, spongy, cake-like product (Ifesan, 2017). Maize-based masa is popular due to its affordability and availability. However, maize lacks essential amino acids such as lysine and tryptophan, leading to protein deficiencies among consumers (Inyang et al., 2019).

To enhance the nutritional value of masa, supplementation with protein-rich legumes like Bambara groundnut (*Vigna subterranea*) has been explored. Bambara groundnut is a highly nutritious legume known for its rich protein content, essential amino acids, and

minerals (Murevanhema & Jideani, 2013). Despite its nutritional benefits, Bambara groundnut remains underutilized in food product development (Arise et al., 2015).
Combining maize with Bambara groundnut in masa production could address protein-energy malnutrition and improve the functional properties of the flour blends. Previous studies have shown that incorporating Bambara groundnut into cereal-based foods enhances their nutrient content, particularly protein (Mbata et al., 2009). For instance, fortifying maize-based snacks with Bambara groundnut flour has been reported to improve their protein content and overall nutritional profile (Arise et al., 2017).

Statement of the Problem

Maize, being the primary ingredient in traditional masa, lacks essential amino acids such as lysine and tryptophan, leading to protein deficiency in its consumers (Malomo & Abiose, 2018). Moreover, its mineral composition is limited, making it inadequate in meeting daily dietary requirements. The functional properties of maize flour, such as water absorption and gelation, also impact the texture and overall quality of masa .
Despite its nutritional potential, Bambara groundnut remains underutilized in food product development, including masa production. The lack of research on the effect of Bambara groundnut supplementation on masa limits its adoption as a strategy to improve nutritional intake (Jideani & Diedericks, 2014).

Objectives of the Study:

1. To evaluate the proximate composition of instant masa produced from two varieties of maize supplemented with Bambara groundnut flour.
2. To determine the mineral composition of instant masa from the different formulations.
3. To assess the functional properties of the flour blends and the resulting instant masa.
4. To determine the consumer a capability of the product

Materials

The raw materials used in this study were Maize, Carrot and Bambara groundnut. The maize grains and Carrot were obtained from a Central market Bida, while the Bambara groundnut was obtained from National Research Institute Badeggi. Other ingredients such as salt and water were used in the formulation of fortified Masa. All chemicals and reagents used for the analysis were of analytical grade.

Preparation of Maize, Bambara Groundnut Flour and Carrot

The maize grains and Bambara groundnut seeds were cleaned to remove dirt, stones, and damaged seeds. The grains were soaked in water at room temperature for 12 hours to

soften the coat and initiate fermentation. The soaked grains were drained and dried in an oven at 60°C until moisture content was reduced. The dried maize and Bambara groundnut seeds were then toasted to reduce anti-nutritional factors after which they were separately milled into fine flours using a hammer mill. The flours were passed through a 250-micron sieve to obtain uniform particle sizes.

The fruits of carrot were washed with water, cut into smaller pieces with the aid of a kitchen knife and oven dried to a constant weight at 500C for 60 minutes. The dried fruits were then milled using a hammer mill and then packaged until needed for use.

Formulation of the Blends

The Maize based fortified carrot snacks were blend by mixing the maize flour with varying proportions of Bambara groundnut flour and carrot. The formulations were as follows:

Table 1: Formulation of the Blends

Samples	Maize (%)	Carrot (%)	Bambara nut (%)
Sample A	90	0	10
Sample B	80	5	15
Sample C	70	10	20
Sample D	60	15	25

Functional properties

The water absorption capacity, bulk density, swelling index, oil absorption were determined by the method described (AOAC, 2010).

Proximate Analysis

The sample were analyzed for proximate composition such as carbohydrates, crude fat content, crude fiber, crude protein, ash content and moisture content using the method of (AOAC, 2010).

Mineral Analysis

Zinc (Zn), Iron (Fe), Calcium (Ca), Sodium (Na), Potassium (K) and Magnesium (Mg) were determined by Atomic Absorption Spectrophotometers (AAS); according to the method of (AOAC, 2010).

Sensory Evaluation

The sensory evaluation of the products were performed using a 9 point hedonic scale ranking 1-9, where 1 = extremely dislike, 2=dislike moderately 3=dislike slightly 4=dislike very much 5= neither like or dislike 6= like very much 7= like slightly 8= like moderately and

9 = like extremely with 20 panelist which comprises of Staff and students in Federal Polytechnic Bida who will assess the product for flavor, Aroma, color, taste and overall acceptability.

Results and Discussions

The mean values of proximate composition of the developed samples are shown in Table 2. The results revealed some significant changes at $p<0.05$. The findings indicated that Sample C was significantly ($p<0.05$) higher in Moisture (6.17±0.42). The higher value observed could be due to high content of legumes that have the ability to imbibe moisture from environment and swell. Similarly, legumes have been shown to have hygroscopic or water absorbing properties (Wasserman, 2010). Low moisture in other sample could add advantage of prolonging the shelf life of the product if properly packaged. The result of ash content ranges from (1.86±0.07) with highest values observed in sample C. Lower ash content were observed in all the samples which could reduce the flammability of the products that could easily produce ash on combustion (Wasserman, 2010). The result of analysis showed that fat content of developed products were significantly higher ($p<0.05$) in fat (3.80±0.08) with sample A having the highest sample. Significant differences were observed among the samples. High fat content could be responsible for addition of oil and legumes to the products, since most legumes contain reasonable amount of fat (Ihekoronye and Ngoddy, 1985). Unlike protein content, Sample C (23.19±0.03) was significantly ($p<0.05$) higher. in protein content. These values were higher than other related previous studies (Agunbaide and Ojezele, 2010). The high protein content could be attributed to the presence of legumes used in the products. The progressive solubilization and leaching out of the nitrogenous substances during processing could be responsible for changes in protein (Ukachukwu and Obioha, 2000). The result of fibre content indicated that all the samples were within the range. Fibre is needed to assist in digestion and keep the gastrointestinal tract healthy including glucose stability. It also slows down the release of glucose during digestion which requires less insulin to absorb the glucose by the cell. It has been reported that people with metabolic complication should consume 25-50g of fibre per day (Tridinidal *et al*., 2006). Regarding Nitrogen free extracts, the higher values observed could be attributed high content of cereals and legumes used as the principal ingredients during preparation (Kanu *et al*., 2009). Unlike energy, the values represent the amount of energy in food that can be supplied to the body for maintenance of basic body function including breathing, circulation of blood, physical activities and thermic effect of food.

Table 2 Proximate composition of Maize based Fortified Carrot snacks (Masa) with Bambara groundnut

Parameters	Sample A	Sample B	Sample C	Sample D
Moisture	4.05±0.70	4.20±0.42	4.71±0.28	2.45±0.70
Ash	1.33±0.28	1.53±0.18	1.45±0.07	2.45±0.14
Crude fat	8.46±0.08	6.24±0.06	8.90±0.07	6.75±0.07
Crude protein	20.12±0.03	15.81±0.18	19.59±0.03	15.74±1.97
Crude fibre	4.46±0.14	4.70±0.07	4.60±0.21	3.50±0.07
Carbohydrates	61.73±0.63	67.57±0.20	60.55±0.66	69.21±0.55b
Energy value	363.54±1.66	349.67±1.06	362.16±4.03	360.55±0.77

Values are mean± SD. Values with different superscripts on the same row are significantly different at $p<0.05$.

The result of mineral composition of the samples showed that there were significant differences ($p\leq0.05$) in all the parameters, but when compared with Chima *et al.* 2012, the result showed that the mineral composition of the samples increased above the values of the control with increase in the addition of legumes. Thus, the addition of Bambara ground nut improved the content of both the major and trace mineral ions. This observation may be as a result of proportional increment in the content of the minerals possibly as a result of enzyme solubilization and leaching of the anti-nutritional factors binding them through leaching. Minerals like iron, calcium and zinc are often added to food for the improvement of nutritional composition (Camire*et al.,* 1990). In this study, the result of both iron and zinc contents were observed to be statistically higher in all the samples. This increase could be attributed to destruction of antinutrients (phytic acid) during cooking. Similarly, iron and zinc act as cofactors for enzymes during normal metabolic processes (Agunbiade and Ojezele, 2010). In addition, iron is needed for the prevention of anaemia; while zinc is a component of living cells and essential for assisting enzyme reaction and wound healing (Agunbiade and Ojezele, 2010).

Table 3: Mineral composition of Maize based Fortified Carrot snacks (Masa) with Bambara groundnut

Parameters	Sample A	Sample B	Sample C	Sample D
Sodium	5.31±0.75	4.26±0.19	4.24±0.02	5.45±0.19
Magnesium	3.80±0.12	1.48±0.17	5.68±0.04	2.40±0.07
Calcium	4.90±0.08	4.90±1.47	8.40±0.07	7.53±0.07
Phosphorus	2.12±0.03	2.81±0.18	3.54±0.03	3.74±0.19
Potassium	6.46±0.14	8.60±0.07	9.90±0.21	8.30±0.07

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Parameters	Sample A	Sample B	Sample C	Sample D
Iron	6.23±0.07	6.56±0.21	6.81±0.04	6.71±0.15
Zinc	4.04±0.96	5.17±0.35	5.66±0.49	3.05±0.07

Values are mean± SD. Values with different superscripts on the same row are significantly different at p<0.05.

Bulk density serves as an important functional property which aids in assessing the bulk density of the products. (Filli *et al*., 2013). The processing methods strongly influenced the bulk density values as observed in this study, suggesting an optimum relationship since the lowest value of bulk density was observed. Similarly, high temperature have been linked to low bulk density which could be due to starch gelatinization under such conditions (Hagenimana*et al.,* 2006). Also, Ding *et al.* (2006) reported decrease the bulk density. The high dependence of bulk density and Swelling capacity would reflect its influence on elasticity characteristics of the starch-based material.

Water absorption index is a measure of starch digestibility and is dependent on the degree of gelatinization and dextrinization (Pardhi*et al.,* 2017). Thus, presence of polar head groups in the developed blend determines its interaction with water molecules. Cooking reduced the degradation of granules and increasing the water absorption index (Hagenimana*et al.,* 2006). Similarly, High temperature was reported to support low water absorption during cooking of starch based binders (Pan *et al.,* 1998). The amount of water associated to proteins is closely related with its amino acids and increases with the number of charged residues, conformation, hydrophobicity, pH, temperature, ionic strength and protein concentration (Suresh*et al.,* 2013).

Table 3: Functional Properties of Maize based Fortified Carrot snacks (Masa) with Bambara groundnut

Parameters	Sample A	Sample B	Sample C	Sample D
Bulk Density	2.57±0.05	2.69±0.07	2.71±0.02	2.78±0.07
Water Absorption	3.84±0.05	3.86±0.06	3.80±0.07	3.77±0.04
Oil Absorption	4.84±0.221	5.49±0.05	6.74±0.35	7.03±0.01
Swelling Capacity	19.40.±0.64	18.02.±0.67	16.92±0.11	15.39±0.71

Values are mean± SD. Values with different superscripts on the same row are significantly different at p<0.05.

The results of sensory properties of Maize based fortified carrot snacks (Masa) indicated highest significant differences in taste and flavor which could be attributed to increase in the addition of bamabara ground nut. This result is in agreement with report of Iwe (2001) who observed the increase in texture when cereal was blended with legumes. He also

suggested that taste and flavor are physiologically and physically connected with one another depending on the respondents. Similarly, results from this work indicated that taste and flavor of the masa were enhanced during processing. Furthermore, Iwe (2001) explained that slight variation of values observed in taste and flavor could be due to higher cooking temperature. In addition to color rating and general acceptability all the samples were statistically ($p<0.05$) higher compare to other samples. These results were in agreement with Rampersad*et al.* (2003) who reported the degree of likeness in all the sensory attributes.

Table 4: Sensory Evaluation of Maize based Fortified Carrot snacks (Masa) with Bambara groundnut

Parameters	Sample A	Sample B	Sample C	Sample D
Taste	7.66±1.11	7.53±1.30	6.93±1.33	7.53±1.35
Appearance	7.40±1.04	7.53±0.1.24	7.26±1.16	7.33±0.07
Aroma	7.13±0.08	7.60±1.47	7.80±0.07	7.20±0.07
Colour	7.53±0.03	7.66±0.18	7.66±0.03	7.73±0.19
Texture	7.73±0.14	7.46±0.07	7.53±0.21	7.33±0.07
Acceptability	7.83±0.07	7.53±0.21	7.40±0.04	7.13±0.15

Values are mean± SD. Values with different superscripts on the same row are significantly different at $p<0.05$.

Conclusion

In this work, different samples Maize/Bambara ground nut fortified with Carrot flour blends were produced. Out of the four samples prepared, sample C was enhanced in terms of functional properties, nutritional value and sensory attributes. In conclusion therefore, Local snacks can be produced from Maize/Bambara ground nut fortified Carrot blend for snacks.

Recommendation

It is recommended that Local snacks produced from Maize/Bambara ground nut blend should be scaled up for local and commercial purposes to enable the utilization of the products. Further studies should be conducted on the vitamin content. Also, nutrition education and encouragement by the policy makers to adopt these blends using locally available raw materials could help in management of malnutrition related cases in Nigeria.

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