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Assessment of Gross Chemical Composition, Antinutrients Factor, Vitamins and Mineral Level of Masa (Fermented Puff Batter) Produced From Pearl Millet and Local White Rice

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Abstract:

The gross assessment of masa (fermented puff battered) prepared from pearl millet and local white rice was investigated respectively. The chemical composition, ant nutrients factors, vitamins and mineral level of masa were determined using the standard analytical methods. On the average, the samples contained protein (4.7 -9.8g/100g), fat (3.4-3.5g/100g), fiber (2.3-2.7g/100g), carbohydrate (71.4-80.7g/100g), Ash (1.2-1.8g/100g). The energy ranged between 424 kcal/100g in rice masa to 436 kcal/100g in pearl millet masa. In pearl millet masa, phosphorus, iron, potassium, sodium and manganese were the most abundant minerals while zinc and magnesium were the least. Also, phosphorus, potassium, zinc and sodium were presented in abundant in rice masa while magnesium, iron and manganese were the least. The ant nutrients factor- phytate, phytic acid and tannin in the pearl millet mama were 16.0, 4.9 and 0.42mg/100g while in rice masa contained: 14.0, 3.8 and 0.98 mg/100g respectively. The vitamins- thiamine, niacin and riboflavin concentrations were relatively low in all the samples.

Keywords: Masa, Antinutrients factors, mineral level, pearl millet and local white rice

1. Introduction

Globally a nutrition transition is occurring, as shown by swift and widespread shifts in food consumption patterns towards the western diet and lifestyle. Accompanying this is an increased prevalence of diet-related-diseases. Developing countries are gradually experiencing a shift from the utilization of indigenous snacks in favour of pastries and western type of snacks especially amongst urban and peri-urban dwellers. In Nigeria, there exist a variety of indigenous snacks such as "Aadun", a maize-based snack, "Ojojo" made from water yam, "Kulikuli" from groundnuts, and "Masa", a muffin-like snack made from cereals, among several others. The consumption of these and other snacks dates back several decades in the country's history, especially among the low-income populace, thus contributing to the overall dietary nutrient intake (Aletor and Ojelabi, 2007). However, some indigenous snacks are deficient in one or more essential nutrient. There is therefore a need to improve their nutritional quality thus providing a nutritious and healthier alternative to western snacks which can be acceptable by the consumers.

Masa (waina) is a fermented puff battered rice, millet, maize or sorghum prepared in a frying pan with individual cuplike spaces. It resembles the Indian Idli in shape and dosa in taste. It is different from the maize masa used in Tortillas in Mexico and Central America. It is consumed in various forms by all age groups mostly in the Northern Nigeria and many other African countries (Mail, Burkina Faso, Niger, Chad and Gana). It is principal ingredient of a variety of cereal-based foods and is a good source of income for the housewives who prepare the traditional product for sale. Masa serves as snacks or as a breakfast meal cake, (Nkama 1993).

Protein-energy malnutrition has been identified as one of the most important problems in Africa. Attempts have been made to devise strategies for combating this nutritional problem. Nutritious foods of high protein and energy value based on cereal-legume combination have suggested. In Africa countries, traditional foods such as masa play a critical role in the nutrition of the population. Like other single-cereal-based foods, masa protein is deficient in the essential amino acid, lysine, threonine, and methionine. The masa contain about 80% of starch, with the mixture of amylase and amylopectin. However, masa is rich in B-complex vitamins; it has little quantity of vitamin A, D and C. Also it contains mineral like calcium, phosphorus and iron. It is a good source of protein, calories and vitamins, especially B-complex vitamins, compared to the raw unfermented ingredients. Taste of Masa depends upon the type and proportion of raw materials and the properties of batter.

Therefore, a combination of cereals and grain legumes in traditional preparations of masa will have improved nutritive value. Moreover, it is a way of increasing grain legume consumption in Africa, as is done in India for dosa and idli, (Nkama and Malleshi, 1998).

Nigerian cereal products have been successfully enriched using legumes, in particular, soybean. Soy-enriched maize pap ("soy-ogi") was developed by the Federal Institute of Industrial Research, Oshodi Nigeria (FIRO), and has established processed technologies for soy-ogi production for both infants and adults (Akanbi et al., 2010). Samuel and Otegbayo, (2006) also evaluated the chemical and sensory properties of "ogi" enriched with soybean and crayfish, showing that supplementation with legume and animal-based protein-rich foods increased the nutritive value of ogi. Nkama and Malleshi, (1998) had earlier pointed out that though masa is as popular as ogi (fermented cereal gruel), it receives very little attention Ayo et al., (2008). The work of Ayo et al., (2008) extended the knowledge frontier on masa; however, review of recent literature showed that there is room for more research on enrichment of masa.

The objective of this study was to evaluate the chemical composition, anti-nutrients, vitamin and mineral level of cereal-based masa.

2. Materials and Methods

2.1. Materials

Raw rice (*Oryza sativa* L.), pearl millet (*Pennisetum americanum*) and other ingredients—vegetable oil, sugar, salt, skim milk powder (optional) and active dried baker's yeast (*Saccharomyces cerevisiae*), Kanwa or trona (sodium sesquicarbonate) were purchased from a local market in Bauchi metropolis, Bauchi state, Nigeria.

2.2. Preparation of Samples

2.2.1. Trona (Kanwa Water)

Preliminary results showed that 5% kanwa concentration was optimum for masa preparation. A 5% kanwa water solution was prepared by dissolving 20 g of the salt in 400 ml of water. The resultant mixture was filtered through Whatman No. 4 filter paper to remove suspended material. A 20-ml aliquot of this solution was used for 250 g masa batter in all preparations. This quantity of kanwa water was always adjusted based on the quantity of the batter to be cooked.

2.3. Preparation of Rice Batter

4- cups of raw milled rice was cleaned to remove foreign matter, and then, the rice was divided into two portions, one part was parboiled for 2-3 minute and the other portions were soaked in water at room temperature for 30 –minutes. Both were drained, mixed and wet milled to produce smooth batter paste. Then, half cup of sugar was mixed with one tablespoon of skim milk and one teaspoon of active dry yeast was added to the paste. The batter was transferred into large bowl, covers and allowed to ferment for 8-12hours. Then, 20 ml of trona was mixed with one teaspoon of salt for neutralization and mixed together. Frying pan was heated over a medium heat and a few drop of vegetable oil was wiped on individual cuplike spaces. 3-4 tablespoons of the batter paste were poured on each space and flipped over after 3-4minutes, until the batters were properly toasted. The same procedure was repeated for pearl millet.

Figure 1: Flow Chart for the Production of Rice and Pearl Millet Masa

2.4. Determination of Proximate Composition of Samples

The proximate composition was determined following the standard method of the Association of Official Analytical Chemists (AOAC, 2005). Different samples were analyzed in triplicate and the results were reported as a means.

Total carbohydrate content was calculated by difference. The energy value was estimated (kcal/100g) following the method as describe by Ekanayake et al.(1999).

2.5. Determination of Mineral Contents

Analysis of potassium content of the samples was carried out using flame photometry, while phosphorus was determined by the phosphovanadomolybdate (yellow) method (AOAC, 2005). The other elemental content (Na, Mg, Fe, Zn and Mn) were determined, after wet digestion of sample ash with an Atomic Absorption Spectrophotometer (AAS, Hitachi Z6100, Tokyo Japan). All the determinations were carried out in triplicates.

2.6. Determination of Vitamin Contents

Thiamine (vitamin B1) and riboflavin (vitamin B2) were determined by using spectrophotometric method (AOAC, 2005). Niacin content (vitamin B3) was determined by high performance liquid chromatography (HPLC) according to the method of Ward and Trenerry (1997).

2.7. Determination of Anti-Nutrient Contents

Phytate content of each sample was determined according to the method described by Maga (1982). Quantitative estimation of tannins was carried out using the modified vanillin-HCl method according to Price et al. (1978). The phytic acid content was determined according to the method of Wheeler and Ferrel (1971).

3. Result and Discussion

3.1. Proximate Composition

The proximate composition of masa samples were given in Table 1. The crude protein of the masa samples ranged between 4.7 and 9.8 g/100g. The result obtained showed that pearl millet masa had significantly higher protein content compare to rice masa. Meanwhile, the recorded protein content of pearl millet masa is comparable to value of 9.6 g/100g as reported by Nkama and Nagappa, (1998).

The fat content of the masa samples varied significantly and values ranged between 3.4g/100g in rice masa and 3.5g/100g in pearl millet. The higher fat content of pearl millet masa was compared with Samuel et al (2015). Moreover, flipping of the masa on cuplike pot with oil during processing contributed to the high fat content. The crude fiber was marked higher in rice masa and ranged between 2.7g/100g and 2.3g/100g in millet masa. There is a causal relationship between the absent of fibre in the diet and the incidence of a wide range of diseases in man. Consumption of vegetable fibre has been shown to reduce serum cholesterol level, risk of coronary heart diseases, colon, breast cancer and hypertension; enhance glucose tolerance and increase insulin sensitivity (Hassan and Umar, 2004). The Ash content of masa samples ranged between 1.2 to 1.8 g/100g with pearl millet maze having the highest value. The significantly high ash content in millet masa sample could be attributed to inherent anti nutrients in the cereals. The total carbohydrate content was found to be significantly higher in pearl millet masa than rice masa. Therefore, the calorific value was however higher in millet masa.

The significantly higher value of energy of 436g/100g of pearl millet masa is readily accounted for higher protein in the sample as it contains about twice the fat content.

Nutrient	Rice	Pearl Millet
Protein	4.7 ± 0.20	9.8 ± 0.24
Fat	3.4 ± 0.20	3.5 ± 0.14
Fibre	2.7 ± 0.10	2.3 ± 0.16
Ash	1.2 ± 0.20	1.8 ± 0.22
Carbohydrate	71.4 ± 0.20	80.7 ± 0.18
Energy (kcal/100g)	424 ± 0.20	436 ± 0.22

Table 1: Proximate Composition of Masa Produced from White Local Rice and Pearl Millet (G/100g Dry Weight)

3.2. Mineral Composition

The mineral compositions of masa samples are given in Table 2. The concentration of phosphorus and magnesium were significantly ($p \leq 0.05$) higher in rice masa while pearl millet masa had significantly higher Iron, Sodium, Zinc and Manganese concentration. The potassium concentration of pear millet was relatively high which was in agreement with earlier studies of Olafe and Sanni (1988) that potassium is an abundant mineral in Nigeria agricultural products. It plays a major role in maintaining fluid and electrolyte balance and cell integrity.

Iron and calcium are often added to food for improvement of its nutritional value (Camire et al, 1990). Mineral such as iron (Fe), copper (Cu), magnesium (Mg) and calcium (Ca) act as catalyst for enzymes during normal metabolic processes, while Fe is essential for prevention of anemia and Ca, for bone health. Although zinc and iron were present in small quantity in the rice sample, only trace amounts are required for metabolic activities. Meanwhile, lower

concentrations of some mineral elements are observed in rice masa may be as a result of the high amounts of anti nutrients in the cereals which adversely affect mineral bioavailability.

Parameter	Rice	Pearl millet
P	81.7± 0.04	24.3± 0.02
Mg	9.13± 0.26	7.7± 0.22
Fe	7.2± 0.20	92.0± 0.14
Na	12.10± 0.12	26.0± 0.12
Zn	15.0± 0.20	17.0± 0.22
Mn	6.0± 0.24	20.0± 0.20
K	28.0± 0.20	36.0± 0.22

Table 2: Mineral Composition of Masa Produced from White Local Rice and Pearl Millet (Mg/100g Dry Weight)

3.3. Anti Nutritional Factors

The anti-nutritional concentration of masa samples is presented in Table 3: The phytate value recorded for pearl millet (16.0 mg/100g) was significantly higher than rice masa. Similarly, pearl millet masa had significantly higher concentration of phytic acid (4.9 mg/100g) than rice masa (3.8mg/100g). The tannin content of pearl millet masa and rice masa were 0.98 and 0.42mg/100g, respectively. These values suggest that the reddish coloration of pearl millet is high in tannin genotype while white rice is low in tannin genotype. These values are higher compared with 0.29 and 0.09% reported by Khalil and Sawaya (1984) for white-reddish and white sorghum, respectively. The high content of phytate is of nutritional significance because phytate phosphorus is unavailable to humans but it also complexes with other essentials dietary minerals such as calcium, zinc, iron, and magnesium to make biologically unavailable for absorption (Lasztity and Lasztity, 1990; Reddy et al., 1982). The higher concentration of ant nutrients noted in pearl millet explained the fact that millet contains high quantities which adversely affect mineral bioavailability.

Parameter	Rice	Pearl millet
Phytate	14.0± 0.30	16.0 ± 0.20
Phytic acid	3.8± 0.16	4.9± 0.22
Tannin	0.98± 0.10	0.42 ± 0.20

Table 3: Anti-Nutrient Composition Masa (Mg/100g Dry Weight)

3.4. Vitamin Composition

The vitamin concentration of masa samples are given in Table 4. Thiamine content of pearl millet masa was 0.24 mg/100g which was significantly higher than that of rice masa 0.20mg/100g, while the recommended daily intake for <1yr infant to>65yrs adult, ranges from 0.2 to1.0mg (Belitz et al., 2009). Niacin ranged between 1.72 to2.80mg/100g. The values were within the recommended daily intake of 2 to 18mg for infants <1yr old and adults (Belitz et al., 2009). The riboflavin content of masa ranged between 0.04 to 0.15mg/100g. Vitamins are organic components in food that are needed in very small amounts for growth and for maintaining good health (Freeland and Briggs, 1980). They have diverse biochemical functions. Niacin is needed for carbohydrate and protein metabolism and active in preventing the disease, pellagra while deficiency of thiamine in the diet is the cause of the disease, beriberi. However, it is imperative to note that deficiency of riboflavin does not in any specific and identifiable disease (Paul and Pearson, 2005).

Parameter	Rice	Pearl millet
Thiamine	0.20± 0.01	0.24± 0.03
Niacin	2.80± 0.02	1.72± 0.03
Riboflavin	0.04 ± 0.01	0.15± 0.02

Table 4: Vitamin Composition of Masa (Mg/100g Dry Weight)

4. Conclusion

The present study has provided information on proximate composition, minerals content, anti-nutrient and vitamin composition of masa prepared from white local rice and pearl millet. Rice masa compare well with pearl millet commonly consumed in North Nigeria. Despite these qualities, the awareness in this project work showcases an eye opener and promoting of the fully use of pearl millet at household level to achieve cheap balance diet and food security.

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