E-ISSN: 2706-8927
P-ISSN: 2706-8919
www.allstudyjournal.com
IJAAS 2023; 5(9): 33-36
Received: 27-07-2023
Accepted: 05-09-2023

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Proximate, functional and sensory properties of OGI" flour produced from maize-millet formulated blends

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DOI: https://doi.org/10.33545/27068919.2023.v5.i9a.1051

Abstract
'Ogi' were formulated from maize and millet and evaluated for proximate, functional and sensory properties. The different samples were combined in the ratio of 80:20, 65:35 and 50:50 (maize: millet) with 100% maize ogi serving as the control sample. The results of the proximate composition showed that 100% maize ogi had higher moisture (5.38%); protein (10.05%); fat (10.76%) and energy value (427.56kcal) and lower ash (n0.98%), fibre (0.20%) and carbohydrate (72.63%). The bulk density, water absorption capacity, oil absorption capacity and swelling capacity decreased from 0.67-0.63g/ml; 10.20-9.16mg/g; 11.99-10.1mg/g and 0.45-0.22% respectively as the level of millet increased in the blends. Sensory evaluation results showed that a significant difference exists between 100% maize ogi and the other samples as it was rated best in terms of all the sensory attributes assessed with values of 6.40 (colour); 6.10 (taste); 6.1 (aroma); 6.20 (consistency) and 6.30 (general acceptability). Sample produced from 80% maize and 20% ogi compared favourably with the control sample in terms of taste, consistency and general acceptability. This study has shown that ogi of good nutritional and sensory properties can be produced from the blends of maize and millet.

Keywords: Ogi, maize, millet, proximate and sensory

1. Introductions

'Ogi' is a fermented cereal-based porridge. It could be made from maize (*Zea mays*), millet (*Pennisetum glancum*), and sorghum (*Sorghum bicolor*). Its fermentation involves lactic acid bacteria, notably *Lactobacillus* sp., and various yeasts, including Saccharomyces cerivisiae (Odunfa and Adeyele, 2015) [18]. Ogi is a popular breakfast cereal product in West Africa with high acceptability, low cost, and shelf-life stability characteristics. It is widely consumed by infants, children, and adults in Nigeria (Oyewole, 2007) [28]. It could be prepared as liquid gruel and consumed solely or with supporting bean cakes, or it could be made into a stiff consistency (eko or agidi) and consumed with vegetable soups or bean cakes. Lactic acid bacteria convert the carbohydrates in the cereals during ogi production to organic acids, which contribute to the softness of the product and the characteristic flavor and sour taste (Banigo and Muller, 2012) [6].

Cereals are generally low in protein, particularly the essential amino acids lysine and tryptophan. These essential amino acids can be compensated for by fortifying cereal products with legumes, which are, on the other hand, high in lysine and tryptophan but low in methionine and cystine, which are high in cereals. This type of fortification of cereals with legumes has been documented by various authors (Nti and Plahar, 2005; Mbata *et al*., 2007; Oyarekua, 2011) [17, 16, 27].

'Ogi is traditionally prepared by steeping cereal (maize, sorghum, and millet) in cold water for three days (72 hours), followed by wet milling and wet sieving through muslin cloth. The filtrate is then allowed to sediment, the supernatant is discarded, and the sediment is the 'Ogi'. During the steeping and sieving of the maize paste, a lot of nutrients, including protein, vitamins, and minerals, are lost (Inyang and Idoko, 2006; Ajanaku *et al*., 2012) [13, 2]. The loss of these nutrients can be minimized by excluding the sieving stage.

Maize (*Zea mays*) is one of the major staple foods in many parts of Western and Central Africa, where it is consumed by no less than 50% of the entire population of the regions (Bolade *et al*., 2018) [7]. According to the International Institute of Tropical Agriculture (IITA), the annual global production output of maize is estimated at 785 million tons, and Africa contributes 6.5% of the total output (IITA, 2019) [9].

Nigeria is the top producer in Africa, with an average annual production volume of 8 million tons (IITA, 2019) [9]. Due to its high functionality, maize and its products are enjoying increasing applications in many food and non-food systems (Olaniran and Abiose, 2019) [21]. In West Africa, maize is subjected to different processing operations, and thus, many products are obtained (Okafor *et al*., 2018) [20]. Particularly, production of ogi, a popular complementary or breakfast product in Nigeria, Cameroun, and Benin, is achieved through submerged fermentation of maize grains (Ogunsakin *et al*., 2015) [19].

Maize, or corn, is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. More maize is produced annually than any other grain. About 50 species exist and consist of different colors, textures, and grain shapes and sizes. White, yellow, and red are the most common types. The white and yellow varieties are preferred by most people, depending on the region (Olaniran *et al*., 2019) [22].

This report is aimed at formulating blends of maize-millet ogi flour that would be nutritionally balanced and acceptable to consumers and determining the effect of the millet addition on the proximate, functional, and sensory properties of the ogi produced.

2. Materials and Methods

2.1 Collection of Raw Materials

Maize and millet was bought from Oja Oba market in Owo Local government Area all in Ondo State.

2.2 Preparation of Ogi slurry

Maize and millet grains were sorted to remove dirt and unwanted parties after which was de-hulled, cleaned and soaked for 3 days. During soaking period, decantation was occur for 3 days to avoid foul smell, after soaking the sample was be wet milled using a mechanical blender into paste. Much water was added to the paste this allows it to settle down well, for an accurate result and a decanting was employed. The ogi was dried using a cabinet dryer at 55 °C for 72hours and it was then neatly placed (Adebayo and Aderiye, 2010) [1].

2.3 Formulation of Flour Blends

Maize and millet flour were grated to give four samples. Sample A consist of 100% maize ogi flour, Sample B 80% maize ogi flour with 20% millet flour, Sample C 65% maize ogi flour with 35% millet flour and Sample D consist of 50% maize ogi flour with 50% millet flour.

2.4 Proximate Analysis

Protein, fat, fibre, moisture and ash were determined by the method of analysis of the Association of Official Analytical Chemists (2005) [5] while carbohydrate was determined by difference. Energy contents were calculated using At-water factor.

2.5 Functional Properties of Flour Blends

2.5.1 Water absorption capacity determination

Water absorption capacity is an index of the amount of water retained within a food matrix under certain conditions (Ayinde *et al*., 2012) [4]. It usually refers to entrapped water but includes bound water and hydrodynamic water and depends upon the condition of determination. It was determined using the procedure of Sathe and Salunkhe (1982) [31] as modified by Adebowale *et al*., (2005) [3].

2.5.2 Oil Absorption Capacity Determination

Oil absorption capacity is an index of the amount of oil retained within a protein matrix under certain condition. It was determined using the method of Sathe and Salunkhe (1981) [32] as modified by Adebowale *et al*., 2005) [3].

2.5.3 Bulk density determination

The method of Sathe *et al*., (1982) [31] was used with slight modification.

2.5.4 Swelling index determination

The swelling index of the samples were determined by them method of Ukpabi and Ndimele (1990) [33].

3. Results

Table 1: Proximate composition of formulated blends of maize-millet ogi

	Maize: Millet			
	100:00	80:20	65:35	50:50
Moisture (%)	5.38	5.16	4.99	4.82
Ash (%)	0.98	1.00	1.01	1.03
Protein (%)	10.05	9.70	9.44	9.19
Fat (%)	10.76	9.26	8.14	7.01
Fibre (%)	0.20	0.61	0.92	1.24
Carbohydrate (%)	72.63	74.27	75.50	76.71
Energy (Kcal)	427.56	419.22	413.02	406.69

Table 2: Functional properties of formulated blends of maize-millet ogi flours

	Maize: Millet			
	100:00	80:20	65:35	50:50
Bulk density (g/ml)	0.67	0.65	0.64	0.63
Water absorption capacity (mg/g)	10.20	9.78	9.47	9.16
Oil absorption capacity (mg/g)	11.99	11.19	10.60	10.01
Swelling capacity (%)	0.45	0.38	0.30	0.22

Table 3: Mean Sensory scores of formulated blends of maize-millet ogi flours.

	Maize: millet			
	100:00	80:20	65:35	50:50
Colour	6.40 ± 0.699^{a}	4.80 ± 1.703^{b}	4.30 ± 1.229^{b}	4.20 ± 1.398^{b}
Taste	6.10 ± 0.994^{a}	5.00 ± 1.414^{ab}	4.90 ± 1.595^{ab}	4.40 ± 1.430^{b}
Aroma	6.10 ± 0.876^{a}	5.10 ± 1.449^{b}	4.60 ± 0.699^{b}	4.10 ± 1.197^{b}
Consistency	6.20 ± 0.919^{a}	5.20 ± 1.476^{ab}	4.70 ± 1.160^{b}	4.10 ± 1.287^{b}
General Acceptability	6.30 ± 0.823^{a}	5.50 ± 0.972^{ab}	5.10 ± 0.876^{b}	4.90 ± 0.876^{b}

Means with the same superscript along the row are not significantly different

4. Discussion

Table 1 presents the proximate composition of ogi flours produced from flour blends of maize and millet at different ratios. The moisture, protein, fat, and energy values ranged from 4.82-5.38%, 9.19-10.05%, 7.01-10.76%, and 406.69-427.56 kcal, respectively. These values showed that the ogi sample produced from 100% maize significantly contained the highest protein, fat, moisture, and energy values compared with other ogi samples. Ijarotimi *et al.* (2022) [11] reported the highest moisture and fat contents for white maize ogi.

The moisture content decreased as the level of substitution with millet ogi increased in the blends from 5.38 to 4.82%, but was observed to be within the recommended value of less than 10.00% for food products (NIS, 2004) [29]. Studies have shown that moisture in food products can facilitate microorganism growth, which may cause spoilage and low food quality (Oyarekua, 2012) [27]. Ash content is an indication of the level of mineral elements present in diets (Onwuka, 2005) [23]. There was a slight increase in the ash content of samples produced in this study, from 0.98 to 1.03%, probably due to the addition effect. A similar trend of increment was observed in the fiber content of the ogi samples, from 0.20 to 1.24%, as the level of millet increased in the blends. Crude fiber helps prevent heart diseases, diabetes, colon cancer, and so on (Oppong *et al*., 2015) [24]. The addition of millet increased the fiber content of maize-millet ogi blends, and this may be because of the high fiber content of millet, which had a greater effect on the maize.

The percent protein content of the ogi samples was observed to be higher in 100% maize ogi compared with the other blends, which had lower protein contents, as a decrease in the protein content was observed as the level of millet increased in the blends. Moreover, the protein content (9.19-10.05%) obtained in this study is comparatively higher than the 2.15-8.02% reported for ogi produced from acha ogi enriched with hydrolyzed soy peptides (Hleba, 2020) [8]. This implies that the ogi samples produced in this study may be useful in the management of protein-energy malnutrition (Ijarotimi *et al*., 2021) [10]. There was a significant reduction in the fat content from 10.76 to 7.01%, and this may be due to the fact that millet contained a lower fat content compared to maize (James *et al*., 2015) [14].

The carbohydrate content increased as the level of millets increased in the blends, from 72.63 to 76.71%. This increase may be due to the decrease in moisture, protein, and fat contents of the flour, as carbohydrate is always obtained by difference (Onwuka, 2005) [23]. However, a decrease in the energy value of the ogi flours from 427.56 to 406.69 kcal was observed with an increase in the level of millet. This decrease may be due to a decrease in fat and protein content, which form the basis for the calculation of energy values in foods. The energy values obtained in this study were found to be higher than the recommended value (344 kcal) as reported by NIS (2004) [29]. This may imply that these samples can provide the recommended daily intake of energy.

The functional properties of the various ogi blends are shown in Table 2. The bulk density values ranged from 0.63 to 0.67 g/ml. A decrease in the bulk density was observed as the level of millet increased in the blends, with 100% maize ogi having the highest value (0.67 g/ml). Diets of lower density are required for infants for easy swallowing, thereby preventing chocking or suffocation (Ikujenlola *et al*., 2013) [12]. A similar trend of reduction was observed in the water and oil absorption capacities of the ogi samples, from 10.20 to 9.16 mg/g and 11.99 to 10.01 mg/g, respectively. Water and oil absorption capacities of food proteins depend on intrinsic factors like amino acid composition, protein conformation, and surface polarity or hydrophobicity (Onwuka, 2005) [23]. The values of water absorption capacity reported in this study were lower, and studies have revealed that low water absorption capacity is desirable in complementary diets for making thinner gruels with high calorific density per unit volume (WHO, 2003) [30]. This will enhance the intake of nutrients (Kanu *et al*., 2009) [15].

The swelling capacity of the ogi samples also decreased as the level of millet increased in the blends from 0.45 to 0.22%. Fu (2008) [34] reported that an increase in water absorption capacity increases swelling capacity, leading to improved solubility. This explains why 100% maize ogi with the highest water absorption capacity (10.20 mg/g) also had the highest swelling capacity of 0.45%.

Sensory mean scores of ogi produced from blends of maize and millet flours are shown in Table 3. The results showed that all the sensory attributes (color, tatse, aroma, consistency, and general acceptability) assessed in this study were negatively affected by substitution with millet at different levels of substitution as they decreased from 6.40 to 4.20; 6.10 to 4.40; 6.10 to 4.10; 6.20 to 4.10; and 6.30 to 4.90, respectively. The 100% maize ogi was ranked highest in all the attributes and differs significantly from the samples blended with millet.

However, the samples blended with millet with ratios of 80:10, 65:35, and 50:50 were not significantly different in all the attributes assessed. It was also observed that the 80:10 (maize-millet) ogi sample compared favorably with the 100% maize ogi in terms of taste, consistency, and general acceptability.

5. Conclusion

The study evaluated the proximate, functional, and sensory properties of ogi samples produced from blends of maize and millet in the ratios of 100:00, 80:20, 65:35, and 50:50, respectively. The increased addition of millet decreased the moisture, protein, fat, and energy values with a corresponding increase in the ash, fiber, and carbohydrate contents. Moreover, all the selected functional properties assessed in this study (bulk density, water absorption capacity, oil absorption capacity, and swelling capacity) decreased in value as the level of millet increased in the ogi blends. However, ogi flour made from 100% maize had better functional properties.

The sensory evaluation results showed that the consumers preferred ogi made from 100% maize flour to those blended with millet, as all the sensory attributes (color, tatse, aroma, consistency, and general acceptability) assessed decreased as the level of substitution with millet increased in the blends. Ogi produced from 100% maize was significantly different from all the other blended ogi samples, which were not significantly different among themselves. This implies that maize may be a better grain for ogi production.

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