PHYSICOCHEMICAL AND SENSORY PROPERTIES OF FORMULATED BLENDS OF MAIZE-MILLET "OGI" FLOUR

***Omosuli S.V., Oloye, D.A., Ibrahim T.A., and Agbaje R.B.**
Department of Food Science and Technology; Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria
*Corresponding e-mail: adetayo992@gmail.com

Abstract
'Ogi' is formulated from maize and millet and evaluated for proximate, functional and sensory properties. 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, Sensory

1.0 Introduction

'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). 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). It could be prepared as liquid gruel and consumed sole or with supporting bean cakes or it could be made into stiff consistency ('eko' or 'agidi') and consumed with vegetable soups or bean cakes. Lactic acid bacteria converts the carbohydrates in the cereals during ogi production to organic acids, which contribute to softness in the product and the characsteristic flavour and sour taste (Banigo and Muller, 2012).

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 cysteine, which are high in cereals. This type of fortification of cereals with legumes has been documented by various authors (Nti and Plahar, 2005; Mbata, Ikenebomeh and Alanemen, 2009; Oyarekua, 2011).

'Ogi', traditionally, is prepared by steeping cereal (maize, sorghum, millet) in cold water for three days (72hrs), followed by wet milling and wet sieving through muslin cloth. The filtrate is then allowed to sediment, supernatant is discarded and the sediment is the 'Ogi'. During steeping and sieving of the maize paste, a lot of nutrients including protein, vitamins, minerals are lost (Inyang and Idoko, 2006; Ajanaku, Edobor and Nwiyi, 2012). 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, Anota and Bolade, 2018). According to International Institute of Tropical Agriculture (IITA), annual global production output of maize is estimated at 785 million tons and Africa contributes 6.5% of the total output (IITA, 2019). Nigeria is the top producer in Africa, with an average annual production volume of 8 million tons (IITA, 2019). Due to its high functionality, maize and its products are enjoying increasing applications in many food and non-food systems (Olaniran and Abiose, 2019). In West Africa, maize is subjected to different processing operations and, thus, many products are obtained (Okafor, Omemu, Obadina, Bankole

and Adeyeye, 2018). Particularly, production of ogi, a popular complementary/breakfast product in Nigeria, Cameroun and Benin is achieved through submerged fermentation of maize grains (Ogunsakin, Banwo, Ogunremi and Sanni, 2015).

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 colours, 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 and Abiose, 2019).

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

2.0 Materials and Methods

2.1 Collection of Raw Materials

Maize and millet were bought from 'Oja Oba' (market) in Owo Local government Area, Ondo State.

2.2 Preparation of Ogi Slurry

Maize and millet grains were sorted to remove dirt and unwanted particles after which was de-hulled, cleaned and soaked for 3 days. During soaking period, decantation occurred for 3 days to avoid foul smell. After soaking, the sample was wet milled, using a mechanical blender into paste. Much water was added to the paste. This allowed 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).

2.3 Formulation of Flour Blends

Maize and millet flour were grated to give four samples. Sample A consists 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) while carbohydrate was determined by difference. Energy contents were calculated, using At-water factor.

2.5 Functional Properties of Flour Blends

Water absorption capacity determination

Water absorption capacity is an index of the amount of water retained within a food matrix under certain conditions (Ayinde, Bolaji, Abdulsalam and Osidipe, 2012). 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) as modified by Adebowale, Sanni and Awonorin, (2005).

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) as modified by Adebowale *et al*. (2005).

Bulk Density Determination

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

Swelling Index Determination

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

3.0 Results and Discussion

The results obtained from the study are presented in Tables 1- 3.

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

Table 1 presents the proximate composition of ogi flour produced from flour blends of maize and millet at different ratios. The moisture, protein, fat and energy value ranged from 4.82 – 5.38%, 9.19 – 10.05%; 7.01 – 10.76% and 406.69 – 427.56kcal, respectively. These values showed that ogi sample produced from 100% maize significantly contained the highest protein, fat, moisture and energy value compared with other ogi samples. Ijarotimi, Oluwajuyitan, Olugbuyi and Makanjuola (2022) 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 – 4.82%, but was observed to be within the recommended value of less than 10.00% for food products (NIS, 2004). Studies have shown that moisture in food products can facilitate microorganisms growth, which may cause spoilage and low food quality (Oyarekua, 2012). Ash content is an indication of the level of mineral elements present in diets (Onwuka, 2005). There was a slight increase in the ash content of samples produced in this study from 0.98 – 1.03%, probably due to addition effect. A similar trend of increment was observed in the fibre content of the ogi samples from 0.20 – 1.24%, as the level of millet increased in the blends. Crude fibre helps to prevent heart diseases, diabetes, colon cancer and so on (Oppong, Eric, Samuel, Eric and Patrick, 2015). Addition of millet, increased the fibre content of maize-millet ogi blends; and this may be because of the high fibre contents of millet which had a greater effect on the maize.

The percent protein content of the ogi samples were 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 2.15 – 8.02% reported for ogi produced from acha ogi enriched with hydrolyzed soy peptides (Hleba, 2020). This implies that ogi samples produced in this study may be useful in the management of protein-energy malnutrition (Ijarotimi *et al.,* 2021). There was a significant reduction in the fat content from

10.76 – 7.01% and this may be due to the fact that millet contained a lower fat content, compared to maize (James *et al.,* 2015).

The carbohydrate content increased as the level of millets increased in the blends from 72.63 – 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). However, a decrease in energy value of the ogi flour from 427.56 – 406.69kcal was observed with increase in the level of millet. This may be due to the decrease in fat and protein content which forms the basis for the calculation of energy values in foods. The energy values obtained in this study were found to be higher that the recommended value (344kcal) as reported by NIS (2004). This may imply that these samples can provide the recommended daily intake of energy value.

The functional properties of the various ogi blends are shown in Table 2. The bulk density values ranged from 0.63 – 0.67g/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 (0.67g/ml). Diets of lower density are required for infants for easy swallow, thereby preventing chocking or suffocation (Ikujenlola, Oguntuase and Omosuli, 2013). A similar trend of reduction was observed in the water and oil absorption capacities of the ogi samples from 10.20 – 9.16mg/g and 11.99 – 10.01mg/g, respectively. Water and oil absorption capacities of food protein depend on the intrinsic factors like amino acid composition, protein conformation and surface polarity or hydrophobicity (Onwuka, 2005). 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). This will enhance more intake of nutrients (Kanu, Armel, Mueller, Sams, Deyton, McElroy and Kopsell, 2009).

The swelling capacity of the ogi samples also decreased as the level of millet increased in the blends from 0.45 – 0.22%. Fu (2008) reported that increase in water absorption capacity increases the swelling capacity leading to improved solubility. This explains why 100% maize ogi with the highest water absorption capacity (10.20mg/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 (colour, 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 – 4.20; 6.10 – 4.40; 6.10 – 4.10; 6.20 – 4.10 and 6.30 – 4.90, respectively. The 100% maize ogi was ranked highest in all the attributes and differs significantly with 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 favourably with the 100% maize ogi in terms of taste, consistency and general acceptability.

4.0 Conclusion

The study evaluated the proximate, functional and sensory properties of ogi samples produced from the blends of maize and millet in the ratios of 100:00; 80:20; 65:35 and 50:50 respectively. Increased addition of millet decreased the moisture, protein, fat and energy value with a corresponding increase in the ash, fibre 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 the ones blended with millet as all the sensory attributes (colour, 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.

References

Adebayo, C.O. & Aderiye, B.I. (2010): Antifungal activity of bacteriocins of lactic acid bacteria from some Nigerian fermented foods. *Research Journal of Microbiology*, 5, 1070-1082.

Ajanaku, K.O., Ajanaku, C.O., Edobor, O. & Nwiyi, O.C. (2012): Nutritive value of sorghum ogi fortified with groundnut seeds. *American Journal of Food Technology*; 7: 82 – 88.

Adebowale, A.A., Sanni, L.O. & Awonorin, S.O. (2005). Effect of texture modifiers on the physicochemical and sensory properties of dried fufu. *Food Sci. Tech.* Int. 11, 373–382.

Ayinde, F.A., Bolaji, O.T., Abdulsalaam, R.B. & Osidipe O. (2012). Functional properties and quality evaluation of kokoro blended with beniseed cake (*Sesame indicum*). *African Journal of Food Science,* 6(5): 117 – 123.

AOAC (2005), Official methods of analysis (18th Ed.). Association of Official Analytical Chemists, Washington, D. C., U.S.A.

Banigo, E.O.I. & Muller, R.G. (2012): Manufacture of 'ogi', a Nigerian fermented cereal porridge. Comparative evaluation of corn, sorghum and millet. *Cam. Inti. Food Sci. Technol*.; 5: 217.

Bolade, M.K., Anota, O.A. & Bolade, O.O. (2018): Effect of traditional and modified grain-soaking methods on physicochemical characteristics and consumers acceptability of sorghum ogi. *Afr J Food Sci*.; 12:28–37.

Hleba, I., Cistrova, M. & Glinushkin, A. (2020): Physicochemical, functional and sensory properties of acha-tamba based ogi enriched with hydrolysed soy peptides. *Journal of Microbial Biotechnology Food Science*, 9: 823-830.

IITA (International Institute of Tropical Agriculture) (2019). Maize

Ijarotimi, O.S., Adesanya, I.H. & Oluwajuyitan, T.D. (2021): Nutritional, antioxidant, angiotensin-converting enzyme and carbohydrate-hydrolyzing enzyme inhibitory activites of underutilized leafy vegetable: African wild lettuce (*lactuca taraxacifolia wild*). *Clin Phytosci.*, 7(47): 1 – 15.

Ijarotimi, O.S., Oluwajuyitan, T.D., Olugbuyi, A.O. & Makanjuola, S.B. (2022): Comparative study on nutrient composition, functional property and glycaemic index of ogi in healthy rats prepared from selected cereal grains. *Journal of Future Foods*, 2(4): 380 – 387.

Ikujenlola, A.V., Oguntuase, S.O. & Omosuli, S.V. (2013): The Physicochemical properties of a complementary food from malted quality protein maize (*Zea mays l.)* and defatted fluted pumpkin flour (*Telfaria occidentalis Hook. F*). *Food and Public Health*, 3(6): 323 – 325.

Inyang, C.U. & Idoko, C.A. (2006): Assessment of the quality of ogi made from malted millet. *African Journal of Biotechnology*; 5(22): 2334-2337.

James, S., Oloyede, O.O., Ocheme, O.B., Chimma, C.E. & Agbaje, A.Y. (2015): Proximate, anti-nutrient and sensory properties of ogi, a millet based gruel supplemented with treated African oil bean (*Pentaclethra macrophylla Benth*) seed flour. *African Journal of Food Science*, 9(3): 136 – 141.

Kanu, D.A. Armel, G.R. Mueller, T.C. Sams, C.C. Deyton, D.E., McElroy, J.S. & Kopsell, D.E. (2009). Increase in nutritional important sweet corn kernel carotenoids following mesotrione and atrazine applications. *Journal of Agricultural and Food Chemistry*, 57, 6362-6368.

Mbata, T.I., Ikenebomeh, M.J. & Alanemen, J.C. (2009): Studies on the microbiological, nutrient composition and anti nutritional contents of fermented maize flour fortified with Bambara groundnut (Vigna subterranean L.). *African Journal of Food Sci*.; 3(6): 165 – 171.

Nti, C.A. & Plahar, W.A. (2005): Chemical and biological characteristics of a West African weaning food supplemented with cowpea (Vigna unguiculata). *Plant Foods Human Nutr.;* 48: 45 – 54.

Odunfa, S.A. & Adeyele, S. (2015): Microbiological changes during the traditional fermentation of ogi baba, a West Africa fermented sorghum gruel. *Journal of Cereal Sci*.; 3: 173 – 180.

Ogunsakin, O.A., Banwo, K., Ogunremi, O.R. & Sanni, A.I. (2015): Microbiological and physicochemical properties of sourdough bread from sorghum flour. *Int Food Res J*., 22:2610–2618.

Okafor, U.I., Omemu, A.M., Obadina, A.O., Bankole, M.O. & Adeyeye, S.A.O. (2018): Nutritional composition and antinutritional properties of maize ogi cofermented with pigeon pea. *Food Sci Nutr*.; 6:424–439.

Olaniran, A.F., & Abiose, S.H. (2019): Proximate and antioxidant activities of bio-preserved ogi flour with garlic and ginger. *F1000Research*.1936:7.

Olaniran, A.F., Abiose, S.H. & Gbadamosi, S.O. (2019): Quality attributes and acceptability of ogi flour biofortified with garlic and ginger. *J Health Sci*.; 7:101–109.

Onwuka, G.I. (2005): *Food analysis and Instrumentation: Theory and Practice*, Lagos: Naphtali Publishers.

Oppong, D., Eric, A., Samuel, O.K., Eric, B., & Patrick, S. (2015): Proximate Composition and Some Functional Properties of Soft Wheat Flour. *Int'l J. of Innovative Research in Sci, Engineering and Technol*. 4 (2): 753 – 758.

Osungbaro, A., Adriana, C.C.A., Teixeira, J.A. & Paiva, P.M.G. (2000): Isolation of a seed coagulant *Moringa oleifera* lectin. *Process Biochem,* 44: 504-508.

Oyanekua, V.F. (2013): Proximate composition and sensory properties of moringa fortified yellow maize-ogi. *Journal of Nutrition and Food Sciences*, 12: 1 – 4.

Oyarekua, M.A. (2011): Evaluation of nutritional and microbiological status of co fermented cereals/cowpea 'Ogi'. *Agricultural and Biological Journal of North America*; 2(1):61 – 73.

Oyewole, O.B. (2007): Lactic acids fermented foods in Africa and health benefits. Food Control; 8: 615 – 619.

Nigerian Industrial Standard (NIS) (2004): Standard for edible cassava flour. Pp 12 – 34.

WHO (2003): Diet, Nutrition and the prevention of chronic diseases. Report of a WHO Study group: Geneva: WHO Technical Report Series. Pp. 797.