Chemical, Functional and Sensory Properties of Ogi–Mango Mesocarp Flour

*Adefisola B. Adepeju, Ajibola M. Oyinloye, Ayooluwa O. Olugbuyi and Kunle O. Oni
Department of Food Science and Technology, Federal University, Oye-Ekiti, Nigeria
{adefisola.adepeju|ajibola.oyinloye|ayo.olugbuyi|kunle.oni}@fuoye.edu.ng

Received: 01-SEP-2023; Reviewed: 01-OCT-2023; Accepted: 15-NOV-2023
http://doi.org/10.46792/fuoyejet.v8i4.1098

ORIGINAL RESEARCH

Abstract- Ogi, a prepared gruel was produced from fermented maize paste fortified with mango mesocarp. Proximate composition of the Ogi-mango mesocarp flour blends were determined using the AOAC method; the functional properties were determined using conventional methods, while sensory evaluation of the samples was carried out using semi- trained panel consisting of ogi-pap consumers who are familiar with ogi-pap quality. The control (Sample A) was rated low. The proximate showed increase in total ash and crude fibre and reduced crude fat content. The energy values of the blends, which ranged from 356.99 to 364.70 and decreased significantly with increase in the percentage of mango mesocarp flour; however, values obtained indicated that the product remained a good source of energy for human consumption. The reduction in energy may be due to the reduction in the percentage of fermented maize flour, which is a good source of energy. The low moisture content observed in the study, implies that the blends would have a better keeping quality. The relatively high value in protein may be due to the fact that the maize grains were not wet milled and sieved after fermentation (Traditional method). However, there was decrease in crude fat and crude protein content of the blends as the substitution increases. The study also recorded reduction in viscosity as the mango mesocarp flour increased. The lower viscosity observed in the flour indicated that it could be used as a weaning food. Also, the hygroscopicity of the flour increased with mango mesocarp flour inclusion. Beta-carotene increased with increase in mango mesocarp inclusion. The sensory attributes increased significantly ($P \leq 0.05$) as the percentage of mango mesocarp flour increased. The blends with higher percentages of mango mesocarp flour were most preferred. The preference for the taste and flavour of the blends increased significantly ($P \leq 0.05$) with increase in percentage of mango mesocarp flavour. The problem of bulkiness and lack of some nutrients with ogi from maize is hereby addressed since the ogi fortified with mango mesocarp is less viscous with high nutrients. Thus, mango mesocarp could be utilized as recipe in ogi to improve nutrition of infants and children as well as adults.

Keywords- Chemical, Functional, Mango mesocarp, Pap, Ogi

1 Introduction

Ogi, (Pap, Koko, or Akamu) is a fermented cereal porridge and a popular weaning, breakfast, and convalescent food in Nigeria. It is generally made from Sorghum (*Sorghum bicolar, L. Moench*), Millet (*Pennisetum americanum*) or Guinea corn (*Sorghum spp*) grains in Northern Nigeria, where Sorghum is cultivated abundantly and more predominately from Maize (*Zea mays*) in the heavy rain belt of the south (Oyarekua and Adeyeye, 2009).

In both parts of the country, *Ogi* is traditionally produced only from the red," bird proof" variety of Sorghum because it is believed to be more nutritious, and is even added to Maize to enhance the nutritional value of the *Ogi* product. Both yellow and white varieties of Maize are processed to *Ogi* (Oyarekua and Adeyeye, 2009). *Ogi* is known to be of low nutrient density (Adepeju and Abiodun, 2011) and highly limited in some macro and micro nutrients necessary for the overall development of the body (Ukom *et al.*, 2019). Maize pap or koko has been implicated in the aetiology of protein-energy malnutrition in children during weaning period (Osungbaro, 2009). The protein content of Maize and Guinea corn is of poor quality, low in lysine and tryptophan (Kasshun *et al.*, 2004).

*Corresponding Author

Section D- MATERIAL/CHEMICAL ENGINEERING AND RELATED SCIENCES
Can be cited as:
Adepeju, A. B., Oyinloye, A. M., Olugbuyi, A. O., and Oni, O. K. (2023). Chemical, Functional and Sensory Properties of Ogi-Mango Mesocarp Flour, FUOYE Journal of Engineering and Technology (FUOYEJET), 8(4), 503-507. http://doi.org/10.46792/fuoyejet.v8i4.1098

Ogi with its wide acceptance could also be deficient in provitamin A due to the deficiency of this vitamin in the grains which form major raw materials for its production. This problem is most prevalent in developing countries particularly in the rural areas. World Health Organisation (WHO) estimated that vitamin A deficiency (VAD) existed in 61 countries and was likely to become a problem in at least 13 additional countries (WHO, 2002). In Nigeria, VAD affected 9.2 to 17.0% of children and 7.2 to 15.0% of mothers (UNICEF/FGN, 1994).

Vitamin A deficiency is more prevalent in the northern part than the southern part of Nigeria. Consequently, enriching the vitamin A content of any widely consumed local food that is readily available would help to reduce the prevalence of vitamin A deficiency in infants and mothers (Badifu *et al.*, 2000). The mesocarp of mango fruit is a good source of provitamin A with reported concentrations of 2400 mg/100 g (Veeranjaneya *et al.*, 2021). Maize supplemented vitamin (provitamin A) would reduce vitamin A deficiency. Therefore, the objective of this study was to produce *Ogi* flour blends as a carrier of provitamin A with improved nutrient content and consumer acceptability.

2 Materials and Methods

2.1 Sample Procurement

Yellow maize grains (*Zea mays*) and semi-ripe mango fruits (*Mangifera indica*) were purchased from Odo-oro market in Ikole Ekiti, Ekiti state, Nigeria.

2.2 Preparation of Mango Mesocarp Flour

Thirty kilogramme of moderately-ripe mango fruits (*Mangifera indica*) (local variety) were sorted, washed, peeled and the mesocarp manually sliced (2.00-2.50 mm thick). The slices of mango mesocarp were spread on a tray covered with a low-density polythene to avoid non-enzymatic browning and oven dried at 60 ^{0}C for 24 h. It was milled after cooling using hammer mill (UMB 25, A Stephan Sohne Hameln, Germany) and sieved to obtain mango mesocarp flour.

2.3 Preparation of Fermented Maize Flour

Two kilograms of maize grains were sorted, washed and steeped in tap water (1/3 w/v) and allowed to ferment for 72 h at room temperature (27± 2 ^{0}C). The grains were drained, washed and spread about 1 cm thick on a tray and oven-dried at 60 ^{0}C for 12 h. The grains were milled using hammer mill (UMB 25, A Stephan Sohne Hameln, Germany). The flour was sieved to obtain fermented maize flour.

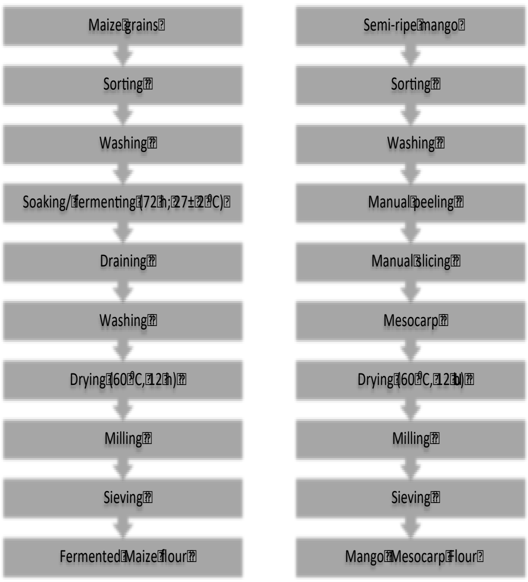

Fig. 1: Flowchart for production of fermented maize flour and mango mesocarp flour

2.4 Formulation of Composite Flour

Fermented maize and mango mesocarp flours were mixed together in a Kenwood mixer to obtain composite flour of varying proportions as shown in Table 1.

2.5 Proximate Analysis

Moisture, fat, protein (%N× 6.25), ash and crude fibre of the composite flour were carried out according to standard methods described by AOAC (2010); carbohydrate was determined by difference. Energy values were estimated from Atwater factors as reported by Adepeju and Abiodun, (2011).

2.6 Functional Properties

Loose and packed bulk densities were determined according to the modified method of Adebowale *et al.*, (2008). Ten grains of the samples were weighed into a measuring cylinder (100 ml) and the loose volume was noted for loose bulk density and then tapped for packed bulk density. Bulk density was expressed as mass per volume of the sample. The modified method of Adebowale *et al.*, (2005) was adapted for wettability. Wettability estimate was taken by measuring the wetting time (sec) of 1g of flour sample dropped from a height of 15 cm on the surface of 200 cm^3 distilled water contained in 250 cm^3 beaker at ambient temperature (27± 2 ^{0}C). The wetting time was regarded as the time required for all the flour to become wetted and penetrate the surface of the distil water.

Hygroscopicity was determined using the method described by Bhatty (1998). Five grams of the prepared samples were exposed to ambient conditions at average relative humidity at 75%. Hygroscopicity was expressed as the percentage weight gained by the sample after 48 h of exposure. The viscosity of the prepared samples of the flour (20% w/v) was determined using a Brookfield viscometer (Type LV-8 viscometers UK LTD) according to the method of Nnam and Baiyeri (2008). The viscosity was determined at room temperature using spindle No 2 at a speed of 12rpm. Readings were taken after 120 sec of revolution.

Dispersibility was determined according to the modified method of Kulkarni *et al.*, (1991). Ten grams of flour samples were weighed into 100 ml measuring cylinder. Distilled water was added up to 100 ml volume. The samples were vigorously stirred and allowed to settle for 3 h. The volume of settled particles was recorded. This was then subtracted from 100 to give a difference that is taken as the percentage dispersibility.

2.7 Chemical Analysis

The pH and titrable acidity of the composite flour samples were determined using the method described by Elkhalifa *et al.*, (2005), while Beta-carotene (provitamin A) of the composite flour was determined according to the method of AOAC (2010).

Table 1. Proportions (%) pf fermented maize mesocarp flour blend formulations

	Proportion (%)	
Blend	Fermented Maize Flour (FMF)	Mango Mesocarp Flour (MMF)
A	100	0
B	90	10
C	80	20
D	70	30
E	60	40

2.8 Sensory Evaluation

Sensory evaluation of the composite flour porridge was carried out using a 20-member semi-trained panellist including staff and students drawn from the Department of Food Science and Technology, Federal University Oye-Ekiti, Ekiti. A 9-point hedonic scale system (Meilgaard *et al.*, 2007) was used with the following individual scores: 1-Dislike extremely, 5-neither like nor dislike and 9- Like extremely. The composite flour sample was gelatinized, stirred, coded and presented for sensory analysis. The sensory attributes evaluated were appearance, taste. flavour and overall acceptability.

http://dx.doi.org/10.46792/fuoyejet.v8i4.1098 http://journal.engineering.fuoye.edu.ng/

2.9 Statistical Analysis

Data generated were subjected to appropriate statistical analysis (ANOVA) using a statistical package for the social sciences, SPSS (version 21). Mean separation was done using Duncan multiple range test and significance difference was accepted was accepted at 5% confidence level.

3 Results and Discussion

3.1 Effect of Mango Mesocarp Addition on the Proximate Composition and Energy Values of Fermented Maize Flour Blends

Results of proximate composition of flour blends are presented in Table 2. There was no significant ($p \geq 0.05$) difference in moisture and protein content of some of the blends. Low moisture content signifies better keeping quality. The relatively high value in protein may be due to the fact that the maize grains were not wet milled and sieved after fermentation (Traditional method). This would definitely result in increased protein intake for consumers since most of the grain protein would still be present in the *ogi* (except for what is leached during steeping and in the wash water). However, there was significant ($P \leq 0.05$) decrease in crude fat and crude protein content of the blends as the substitution increases. The slight variation in carbohydrate content may be due to alterations in other nutrient components (protein, fat, ash, fibre and moisture) (Adegunwa *et al*., 2014).

Table 2. Proximate composition and energy values of Ogi-mango mesocarp flour blends

Blends	Moisture Content (%)	Crude Fat (%)	Crude Protein (%)	Total Ash (%)	Crude Fibre (%)	Total Carbohydrate (%)	Energy Value (Kcal/100g)
A	8.23 ± 0.03^{a}	4.65 ± 0.04^{a}	13.77 ± 0.00^{a}	2.44 ± 0.14^{b}	2.40 ± 0.10^{c}	68.53 ± 0.04^{b}	371.05 ± 0.03^{a}
B	8.28 ± 0.02^{a}	3.42 ± 0.00^{b}	13.69 ± 0.00^{a}	2.42 ± 0.14^{b}	2.40 ± 0.10^{c}	69.79 ± 0.01^{b}	364.70 ± 0.01^{b}
C	8.35 ± 0.04^{a}	3.21 ± 0.00^{c}	12.68 ± 0.24^{b}	$2.53 \pm 0.14^{a,b}$	2.40 ± 0.10^{c}	70.83 ± 0.03^{a}	$362.93 \pm 0.03^{b,c}$
D	8.36 ± 0.04^{a}	3.18 ± 0.04^{c}	12.42 ± 0.00^{b}	$2.50 \pm 0.14^{a,b}$	2.96 ± 0.10^{b}	69.51 ± 0.00^{b}	$359.74 \pm 0.01^{c,d}$
E	8.40 ± 0.02^{a}	3.11 ± 0.03^{c}	12.43 ± 0.02^{b}	2.75 ± 0.00^{a}	3.49 ± 0.10^{a}	69.82 ± 0.03^{b}	356.99 ± 0.03^{e}

Values are mean standard deviation of triplicate determinations. Means in the same column not followed by same superscript are significantly different ($P \geq 0.05$).
A = 100% FM: 0% MMF; B =90% FM: 10% MMF; C =80% FM: 20% MMF; D = 70% FM: 30% MMF; E = 60% FM: 40% MMF;
FM = Fermented Maize; MMF = Mango Mesocarp Flour

The total ash and crude-fibre content of the blends increased significantly ($P \leq 0.05$). This could be attributed to addition of mango mesocarp flour. Total ash value of 4.10% for mango mesocarp flour was reported by Chinma and Gernah (2007); while Noha *et al*. (2011) reported 1.75% as the total ash value for Sorghum flour. Therefore, increase in mango mesocarp flour is expected to increase the total ash content of the blends. It was also reported that fruit and vegetables are good sources of vitamins, minerals and crude fibre (Slavin and Lloyd, 2012). This would indicate that addition of mango mesocarp flour would increase total ash and crude fibre contents and reduce the crude fat content. The energy values of the blends decreased significantly ($P \leq 0.05$) with increase in the percentage of mango mesocarp flour; however, energy values were still sufficiently high enough. This may be due to the reduction in the percentage of fermented maize flour which is generally known as a good source of energy.

3.2 Effect of Mango Mesocarp Addition on Some Functional Properties of Fermented Maize Flour Blends

Table 3 showed the result of functional properties of composite flour of fermented maize and mango mesocarp flour. The addition of mango mesocarp flour had no significant effects ($P \geq 0.05$) on the bulk density of the flour blends. Similar values were reported by Jha *et al.* (2002) for both loose and packed bulk densities of instant Kheer mix (agglomerated rice and spray-dried buffalo milk). The bulk densities of 0.69 g/cm^3 for loose and packed bulk density respectively were reported. Bulk density gives indication of the relative volume of packaging material required. Generally, higher bulk density is desirable for the greater ease of dispensability and reduction of paste thickness which is an important factor in convalescent and child feeding (Sengev *et al.,* 2012).

Addition of mango mesocarp had no significant ($P \geq 0.05$) effect on the wettability of the flour blends. Jha *et al.*, (2002) reported higher values of wettability for instant kheer mix. The low values which ranged from 48.00 to 36.30 seconds may be due to fermentation of maize flour. Fermentation was reported to decrease the wetting time of Mucuna flour (Udensi and Okoronwo, 2006). This may also be as a result of differences in product composition. Generally, wettability provides a useful indication of the degree to which the dry flour is likely to possess instant characteristics. Hygroscopicity of the flour increased with mango mesocarp flour inclusion. This may be ascribed to the presence of more hydrophilic carbohydrate from reducing sugars in the mango mesocarp flour. The viscosities of the flour blends decreased significantly ($P \leq 0.05$) as the mango mesocarp flour increased. The decrease in viscosity may be ascribed to the reduction of fermented maize flour which consequently reduced the starch content of the blends. The lower viscosity indicates that the flour could find application as a weaning food and higher flour concentrations would be required to produce gel and improve on the nutrient density of the food (Irene *et al.*,2013).

3.3 Effect of Mango Mesocarp Flour on Some Chemical Properties of Fermented Maize Flour Blends

Results of some chemical properties of the flour blends are presented in Table 4. There was no significant difference ($P \geq 0.05$) among the blends in terms of Titratable Acidity (TTA) and pH. The low pH (acid) of the blends may be partly due to fermentation and the organic acids present in the mango mesocarp flour. The low pH is

http://dx.doi.org/10.46792/fuoyejet.v8i4.1098 http://journal.engineering.fuoye.edu.ng/

an indication that the blend would be less susceptible to microbial attack. It has been reported that fermented foods with low pH have some antimicrobial activities (Dimidi *et al.*, 2019). There was no significant ($P \geq 0.05$) increase in TTA with increase in mango mesocarp flour.

Table 3. Functional properties of composite flour made from fermented maize and mango mesocarp

Blend	Bulk Density (g/cm^3) Loose	Packed	Wettability (Sec)	Hygroscopicity (%)	Dispersibilty (%)	Viscosity (cP, 12rPm)
A	0.68±0.15ᵃ	0.89±0.03ᵃ	48.00±0.01ᵃ	6.35±0.02ᵈ	74.44±0.05ᵃ	1450.00±0.01ᵃ
B	0.69±0.11ᵃ	0.86±0.01ᵃ	45.50±0.02ᵇ	6.70±0.04ᵈ	74.26±0.02ᵃ	1401.44±0.03ᵇ
C	0.69±0.20ᵃ	0.84±0.02ᵃ	42.40±0.20ᶜ	8.95±0.05ᶜ	73.69±0.00ᵃ	1160.70±0.00ᶜ
D	0.67±0.01ᵃ	0.83±0.01ᵃ	40.50±0.11ᵈ	9.11±0.11ᵇ	73.26±0.20ᵃ	1100.98±0.02ᵈ
E	0.69±0.02ᵃ	0.81±0.03ᵃ	36.30±0.30ᵉ	10.10±0.01ᵃ	72.10±0.05ᵃ	1094.37±0.20ᵉ

Values are mean standard deviation of triplicate determinations. Means in the same column not followed by same superscript are significantly different ($P \geq 0.05$).
A = 100% FM: 0% MMF; B =90% FM: 10% MMF; C =80% FM: 20% MMF; D = 70% FM: 30% MMF; E = 60% FM: 40% MMF;
FM = Fermented Maize; MMF = Mango Mesocarp Flour

Beta-carotene was not detected in the control (100% fermented maize flour) but increased significantly ($P \leq 0.05$) from 94.56 to 140.16 μg/100g as the percentage of mango flour increased. This could be attributed to the rich content of βeta-carotene in mango mesocarp flour. Rodrigulz-Amaya (2003) and Provesi *et al.*, (2011) also reported that mango fruits are rich sources of vitamin C and provitamin A (β-carotene).

Table 4. Chemical properties of flour blends made from mango mesocarp and fermented maize

Blend	pH	TTA (% lactic acid)	β- carotene (μg/ 100g)
A	3.49 ± 0.06ᵃ	0.02 ± 0.01ᵃ	ND
B	3.29 ± 0.01ᵃ	0.02 ± 0.06ᵃ	94.56 ± 0.07ᵈ
C	3.40 ± 0.16ᵃ	0.02 ± 0.07ᵃ	115.71 ± 0.04ᶜ
D	3.26 ± 0.13ᵃ	0.02 ± 0.06ᵃ	123.42 ± 0.05ᵇ
E	3.15 ± 0.07ᵃ	0.03 ± 0.06ᵃ	140.16 ± 0.06ᵃ

Values are mean standard deviation of triplicate determinations. Means in the same column not followed by same superscript are significantly different ($P \geq 0.05$).
A = 100% FM: 0% MMF; B =90% FM: 10% MMF; C =80% FM: 20% MMF; D = 70% FM: 30% MMF; E = 60% FM: 40% MMF;
FM = Fermented Maize; MMF = Mango Mesocarp Flour

3.4 Effect of Mango Mesocarp Flour on the Sensory Attributes of Reconstituted Fermented Maize

The sensory properties of the reconstituted fermented maize mango mesocarp flour samples are presented in Table 5. The control (Sample A) was rated low. In all, the attributes increased significantly ($P \leq 0.05$) as the percentage of mango mesocarp flour increased. The blends with higher percentages of mango mesocarp flour were most preferred. The increase in preference for appearance may be ascribed to the impact of the yellow colour of βeta-carotene present in mango mesocarp flour.

This implies that incorporation of mango mesocarp flour could improve the sensory attributes of fermented maize flour. Badifu *et al*. (2005) reported that supplementing wheat bread with mango mesocarp flour made an improvement in its sensory attributes. Sengev *et al*., (2010) also reported that supplementing sorghum flour with mango mesocarp flour improved the sensory attributes of instant Kunnun-zaki. The preference for the taste and flavour of the blends increased significantly ($P \leq 0.05$) with increase in percentage of mango mesocarp flavor. The increase in preference may be attributed to the sugar and flavor components of mango fruits respectively. The general acceptability followed a similar pattern with the scoring for appearance, taste and flavour.

Table 5. Sensory attributes of reconstituted composite flour made from mango mesocarp and fermented maize

Blend	Appearance	Taste	Flavor	Overall Acceptability
A	4.2ᵉ	4.0ᵉ	4.3ᵉ	4.5ᵉ
B	5.6ᵈ	5.3ᵈ	5.4ᵈ	5.4ᵈ
C	6.2ᶜ	5.8ᶜ	6.5ᶜ	7.0ᶜ
D	7.3ᵇ	6.4ᵇ	7.2ᵇ	7.5ᵇ
E	8.5ᵃ	7.5ᵃ	8.2ᵃ	8.3ᵃ

Values are mean standard deviation of triplicate determinations. Means in the same column not followed by same superscript are significantly different ($P \geq 0.05$).
A = 100% FM: 0% MMF; B =90% FM: 10% MMF; C =80% FM: 20% MMF; D = 70% FM: 30% MMF; E = 60% FM: 40% MMF;
FM = Fermented Maize; MMF = Mango Mesocarp Flour

4 Conclusion

This work has explored a new utilization potential for mango mesocarp in maize *ogi*. It has also indicated that the βeta-carotene (Provitamin A) contents of unfortified maize *ogi* can be improved by fortification with mango mesocarp flour. Also, the inclusion of the mango mesocarp flour can reduce the viscosity of the reconstituted flour blends. Similarly, the higher the inclusion level, the better it meets the βeta-carotene requirements. Based on consumer acceptability, mango mesocarp flour blends *ogi* at all levels of inclusion were significantly preferred because of the apparent impacts of mango mesocarp flour on taste and colour. This study concluded that inclusion of mango mesocarp flour resulted in more acceptable *Ogi.*

References

Adebowale, A.A., Sanni, L.O. and Awonorin, S.O. (2005). Effect of Texture Modifiers on the Physicochemical and Sensory Properties of Dried Fufu. *Food Science Technology Int*ernational, 11(5): 373-382

Adebowale, A.A., Sanni, L.O and Oladapo F.O. (2008). Chemical, Functional and Sensory Properties of Instant yam breadfruit Flour. *Nigerian Food* Journal, 26(1):2-12

Adegunwa, M.O., Adebowale, A.A, Bakare, H.A and Ovie, S.G. (2014). Compositional Characteristics and Functional Properties

http://dx.doi.org/10.46792/fuoyejet.v8i4.1098 http://journal.engineering.fuoye.edu.ng/

of Instant Plantain Breadfruit Flour. *International Journal of Food Research*,1:1-7.

Adepeju, A.B and Abiodun, O.A. (2011). Effect of protein rich foods mixtures on the quality of formulated weaning food diet. *International Research Journal of Biochemistry and Bioinformatics.* 1(5): 114-118.

AOAC (2010). Official methods of Analysis chemistry. Association of official and Analytical chemists, Gaithersburg.

Badifu, G.I.O., Ilochi, J.C., Dutse, J.V. and Akpapunam, M.A. (2000). Use of mango mesocarp flour to enrich the provitamin A content of a complementary food blend of maize and soya bean flours for porridge. *Food and Nutrition Bulletin*, vol 21, no 3.

Badifu, G.I.O, Chima, C.E, Ajayi, Y.I. and Ogori, A.F. (2005). Influence of mango mesocarp flour supplement to micronutrient, physical and organoleptic quality of wheat-based bread. *Nigeria Food Journal*, 23: 59-68.

Bhatty, R.S. (1998). Physicochemical and functional properties of hull-less berley fractions. *Cereal Chem*istry, 63(1):31-35.

Chinma, C.E. and Gernah, D.I. (2007). Physicochemical and sensory properties of cookies produced from cassava/ soybean/mango composite flours. *Journal of Food Technol*ogy, 5(3): 256-260.

Dimidi, E.,C, S.R., Rossi, M. and Whelan, K.(2019). Fermented Foods. Definitions and Characteristics, Impact on the Gut Microbiota and Effects on Gastrointestinal Health and Disease. *Nutrients.* 11(8): 1806.

Elkhalifa, A.O., Schifflier, B. and Berrhardt, R. (2005). Effect of Fermentation on the Functional Properties of Sorghum Flour. *Food Chemistry*, 92:1-5.

Irene, S.T. de Carvallo, Yvonne Granfieldt, Ann- Charlotte Eliasson, Petr Dejmek (2013). Predictability of the Consistency of Porridges Using Mixture of Different Flours. *Food and Nutrition Sciences*, 4(9) 10-14

Jha, A, Ashoki, A.P and Singh, R.R. (2002). Physicochemical properties of instant kheer mix. *Journal of Diary Science & Technol*ogy, 82:501-513.

Kassahum Bantte and Prasanna B.M. (2004). Analysis of Grain Protein, Tryptophan and Lysine contents of Quality Protein Maize (QPM) Lines. *Ethiopia Journal of Health Sciences*, 14(1):31-41.

Kulkarni, K.D., Kwkarni, D.N. and Ingle, U.M. (1991). Sorghum malt-based weaning food formulations: Preparation, functional properties and nutririve value, *Food Nutrition Bulletin*, 13(4):322-327.

Meilgaard, M.C., Civille, G.V. and Carr, B.T. (2007). Sensory Evaluation Techniques, 4th Ed. C.R.C.

Noha, A.M., Isam, A., Mohammed, A. and Elfadil, E.B. (2011). Nutritional evaluation of sorghum flour (Sorghum bicolar L. Moench) during the processing of Injera. *World Academy of Science Engineering and Technology*, 25:72-76.

Nnam, N. M. and Baiyeri, G. T. (2008). Evaluation of the nutrient and sensory properties of multimixes and porridges made from maize, soybean and plantain for use as complementary food. *Journal of Ecology of Food and Nutrition*, 47: pp 64-76.

Osungbaro, T.O. (2009). Physical and nutritive properties of fermented cereal foods. *African Journal of Food Science*, 3(2):023-027.

Oyarekua, M.A. and Adeyeye, E.I. (2009). Comparative Evaluation of the Nutritional Quality, Functional Properties and amino Acid Profile of Co-Fermented Maize/Cowpea and Sorghum/ Cowpea Ogi as infant Complementary Food. *Asian Journal of Clinical Nutrition*, 1:31-39

Provesi, J.G., Dias, C.O., Amante, E. R. (2011). Changes in carotenoids during processing and storage of pumpkin puree. *Food Chemistry*, 128:195-202.

Rodriguez-Amaya, D.B. (2003). Food carotenoids: analysis, composition and alterations during storage and processing of foods. *Forum Nutrition*, 56: 35-37.

Sengev, I.A., Ingbia, E.K. and Gernah, D.I. (2010). Sensory and storage properties of instant kunun-zaki. A non-alcoholic fermented sorghum beverage supplemented with mango mesocarp flour. *Nigerian Food Journal*, 28(2):336-348.

Sengev I.A., Akpapunam, M.A. and Ingbian E.K. (2012). Physicochemical and Sensory Properties of Instant Kunun-zaki Flour Blends from Sorghum and Mango Mesocarp Flours. *Nigerian Food Journal*, 30(2):8-16.

Slavin, J.L. and Lloyd B. (2012). Health Benefits of Fruits and Vegetables. *Advances in Nutrition.*, 3(4): 506-516

Udensi, E. A. and Okoronkwo, K.A. (2006). Effect of fermentation and germentation on the Physico-chemical properties of mucuna chochin chinensis protein isolates. *African Journal of Biotechnology*, 5 (10): 896-900.

Ukom, A.N., Adiegwu, E.C., Ojimelukwe, P.C., and Okwunodulu, I.N. (2019). Quality and sensory acceptability of yellow maize ogi porridge enriched with orange-fleshed sweet potato and African yam bean seed flours for infants. *Scientific African*, volume 6, https://doi.org/10.1016/j.sciaf.2019.e00194.

UNICEF/FGN (1994). The Nutritional status of women and children in Nigeria. Report of UNICEF country office, Lagos, Nigeria.

Veeranjaneya, R.L., Young-jung, W., Weibing, Y. and Mallikarjuna, K. (2021). Nutritional Composition and Bioactive compounds in Three Different Parts of Mango Fruit. *International Journal of Environmental Research and Public Health*. 18(2): 741.

World Health Organisation (2002). Global prevalence of Vitamin A Deficiency: "Micronutrient Deficiency Information System" WHO/NUT. 95(3):1-2.

http://dx.doi.org/10.46792/fuoyejet.v8i4.1098 http://journal.engineering.fuoye.edu.ng/