

Chemical, Pasting and Sensory Properties of Whole Fermented Maize (*Ogi*) Fortified with Pigeon Pea Flour

S. B. Fasoyiro and K. A. Arowora

Abstract—Pigeon pea (*Cajanus cajan*) blanched for 20min was dehulled and milled into flour. The flour was incorporated into dried whole fermented maize (*Ogi*) at five levels. The resultant products were analyzed for chemical and pasting properties. The fortified *Ogi* samples were also assessed for sensory attributes: appearance, color, flavor, mouth feel and overall acceptability. The protein content in the whole *Ogi* fortified samples was in the range of 11.2-16.6% and crude fibre 3.22-3.46%. Fortified whole *Ogi* with pigeon pea at 30%, 40% and 50% of inclusion with pigeon pea flour has higher protein, crude fibre and ash content. Varying range of pasting quality was recorded for the blends, pasting temperature for fortified *Ogi* was in the range of 45.3-49.5°C and peak time 5.05-5.21°C. The sensory acceptability of the whole *Ogi* fortified blends prepared into gruel has higher acceptability for various qualities in comparison with the traditional *Ogi* gruel.

Keywords—Maize *Ogi*, pigeon pea, chemical, pasting, sensory properties.

I. INTRODUCTION

PIGEON pea (*Cajanus cajan*) is an important underutilized legume in Africa. It is also known as red gram, a crop that is well grown in tropic and semi-arid tropic region [1]. It is a rich source of protein and also vitamins especially calcium and iron [2]. Pigeon pea is extensively grown in south west Nigeria. In Nigeria, it is usually eaten in boiled form. Hard-to-cook phenomenon and limited information on alternative ways of utilization of the crop has limited the utilization of pigeon pea. Different methods have been reported in enhancing the utilization of legumes. These include soaking, dehulling, pressure cooking, germinating and fermenting [3], [4]. Different work has been reported on the physicochemical properties, functional and sensory properties of pigeon pea flours [5], [6]. Pigeon pea is an important crop that has the potential in addressing protein-energy malnutrition in Africa. Different researches have been attempted in improving the utilization of pigeon pea. Reference [7] reported on the utilization of rice starches and pigeon pea flour in making noodles. Maize (*Ogi*) is an important meal consumed in Nigeria made by soaking, fermenting, milling and shifting. It is however poor in nutritional quality. Fortification of the

whole fermented maize with pigeon pea flour will enhance the nutrients of the *Ogi*.

This study therefore assesses the chemical, pasting and sensory qualities of whole fermented maize made into *Ogi* fortified with pigeon pea flour.

II. MATERIALS AND METHODS

A. Blanched Pigeon Pea Flour Processing

Pale brown coloured pigeon pea seeds were obtained from the Institute of Agricultural Research and Training, Ibadan Nigeria. Five hundred grams of pigeon pea seeds were sorted to remove dirt. These were washed and boiled in tap water (1:3 w/v) for 20min. The seeds were dehulled by rubbing in between the palms. The dehulled seeds were drained and dried in a forced draft oven at 60°C for 8h. The seeds were later milled into flour using a hammer mill and sieved (1mm sieve). The milled flour was packaged in a polythene bag and stored in a cool dry place further processing.

B. Whole *Ogi* Processing

Maize variety (DMR-ESR-Y) was obtained from the Institute of Agricultural Research and Training, Ibadan. Five hundred grams of maize were sorted to remove dirt. The seeds were washed thoroughly and soaked with tap water (1:3 w/v) to 72h to allow the seeds to ferment. The fermented seeds were washed and milled with tap water (1:2 w/v). The slurry was allowed to settle and the wash water was decanted. The whole fermented *Ogi* was poured into one layer muslin cloth for 3h to further express the water content. This was dried in forced draft oven at 60°C for 8h to obtain dried whole *Ogi* (WMZ).

C. Whole Maize-Pigeon pea *Ogi* Processing

Blanched pigeon pea flour was incorporated into whole *Ogi* at five levels 10%, 20%, 30%, 40% and 50%. Sifted *Ogi* (WSZ) was prepared according to [8] and was used in comparing the products.

D. Chemical Analysis of Samples

Samples and the controls were analyzed for crude protein, crude fat, fibre, ash and moisture content according to [9] methods. The crude protein content was determined by Kjeldahl method [9]. Approximately 2.0g of sample was digested with 25ml concentrated H₂SO₄ in a digester with 0.7g HgO and anhydrous Na₂SO₄. Frothing was reduced by adding

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small amount of paraffin. Boiling of the solution was allowed to continue until it became clear in 45min. The digest was cooled to $< 25^{\circ}\text{C}$ and 200ml of water was added prior to adding 25ml of sodium thiosulphate to precipitate Hg. Sodium hydroxide solution was added to make the reaction mixture become alkaline. The mixture was distilled such that the tip of the condenser was immersed in standard HCl. Standard sodium hydroxide solution was used in titrating the excess HCl in the distillate. The percent nitrogen was calculated according to [9]. Total protein was calculated by multiplying with a factor of 6.25 [9]. Ether extract content was determined by extracting 2g of sample added on Whatman No.1 filter paper in a funnel with five 20-ml portions of water prior to drying. The sample was further ether extracted and analyzed with for fat according to [9]. Crude fibre was determined by extracting 2 g of sample with petroleum ether in the presence of asbestors [9]. Crude fibre was calculated as the loss in weight on ignition expressed as the percentage of the weight of the initial sample.

Ash was determined by weighing approximately 4g of sample in a dish which was ashed in furnace at 550°C until grey ash resulted [9]. The content was allowed to cool to room temperature in a desiccators containing re-ignited CaO as drying agent and the dish and the content were weighed.

Moisture content was determined by drying 2g of sample in a weighed porcelain dish with lid in a hot air oven at 100°C until constant weight was obtained. The covered porcelain dish used had an opening for ventilation.

E. Pasting Properties

The pasting properties of the samples were determined using a Rapid viscoanalyzer (RVA) (Model 30, Newport Scientific Pty Ltd, Australia) at International Institute of Tropical Agriculture (IITA), Ibadan. Suspension of the flour (10%) was mixed in a cannister fitted into the rapid viscoanalyzer. The slurry was heated to $50-95^{\circ}\text{C}$ with holding time of 2min. This was followed by cooling to 50°C , holding for another 2min before reading the various values measured on a computer.

F. Sensory Evaluation

Whole *Ogi* samples (200g) each was mixed with 150ml of tap water. The sample was cooked for 2min in 1000ml of boiling water with continuous stirring. The samples were compared with sifted *Ogi*. Samples were coded and presented as random numbers to twenty panels of judges to test for desired attributes: appearance, colour, flavour, mouth-feel and overall acceptability. The panelists were provided with a mouth rinse in between each tasting. The attributes were scored using a nine-point Hedonics scale where nine equals like extremely and one equals dislike extremely [10].

G. Statistical Analysis

The data from the chemical analyses and sensory testing were subjected to analysis of variance (ANOVA) and means were separated by Duncan multiple range test [11].

TABLE I
CHEMICAL COMPOSITION OF WHOLE *Ogi* FORTIFIED WITH PIGEON PEA (DRY MATTER BASIS)

Samples	Protein (%)	Ether extract (%)	Crude Fibre (%)	Ash (%)	Moisture (%)
MZPG91	11.2 \pm 0.01 ^a	2.40 \pm 0.05 ^a	3.45 \pm 0.04 ^a	2.30 \pm 0.04 ^a	9.96 \pm 0.04
MZPG82	13.5 \pm 0.02 ^{bc}	3.70 \pm 0.03 ^a	3.22 \pm 0.04 ^a	2.70 \pm 0.02 ^{ab}	12.3 \pm 0.03 ^a
MZPG73	14.8 \pm 0.01 ^b	3.08 \pm 0.04 ^a	3.25 \pm 0.03 ^a	3.60 \pm 0.01 ^a	9.18 \pm 0.01 ^b
MZPG64	16.1 \pm 0.04 ^a	3.71 \pm 0.03 ^a	3.46 \pm 0.05 ^a	2.40 \pm 0.04 ^{ab}	12.9 \pm 0.04 ^a
MZPG55	16.6 \pm 0.02 ^a	3.04 \pm 0.03 ^a	3.25 \pm 0.07 ^a	3.00 \pm 0.04 ^a	10.5 \pm 0.04 ^b
WMZ	9.40 \pm 0.03 ^d	1.06 \pm 0.01 ^b	2.04 \pm 0.03 ^b	2.70 \pm 0.03 ^{ab}	9.84 \pm 0.05 ^b
WSZ	8.22 \pm 0.04 ^e	2.12 \pm 0.03 ^b	0.84 \pm 0.03 ^c	1.12 \pm 0.04 ^{bc}	11.4 \pm 0.02 ^c

Values are means of three replicates. Values in the same column not followed by the same letter are significantly different at 5% level of significance. Key: MZPG91-blend of whole *Ogi* with blanched pigeon flour ratio 9:1, MZPG82-blend of whole *Ogi* with blanched pigeon flour ratio 8:2, MZPG73-blend of whole *Ogi* with blanched pigeon flour ratio 7:3, MZPG64-blend of whole *Ogi* with blanched pigeon flour ratio 6:4, MZPG55-blend of whole *Ogi* with blanched pigeon flour ratio 5:5, WMZ-whole unsifted *Ogi*, WSZ-sifted *Ogi*

III. RESULTS AND DISCUSSION

The chemical constituents of whole *Ogi* maize fortified with different levels of pigeon pea flour is shown in Table I. The samples were compared with those of whole *Ogi* and sifted *Ogi*. The crude protein content in the fortified maize samples was in the range of 11.2-16.6%. The protein content of the whole *Ogi* (WMZ) and the sifted maize were significantly lower than those of the fortified samples at $p < 0.05$. Whole *Ogi* has significantly higher ($P < 0.05$) protein content than the sifted *Ogi*. The protein content of the fortified samples compares with protein content of 10-15% recommendation for the population nutrient intake [12]. The protein content of MZPG64 (16.1%) and MZPG55 (16.65) compares with the minimum protein requirement (less than or equals to 16%) for weaning diets [13]. Fortification of whole *Ogi* with pigeon pea flour increased also the crude fibre. Similar trend observed with the protein content was also observed with the crude fibre contents of the samples. Ether extract, ash and moisture contents of the fortified flours were in the range of 2.40-3.17%, 2.30-3.60% and 9.18-12.9% respectively. The pasting properties of the samples are shown in Table II. Pasting temperature marks the gelatinization or initial increase in viscosity. The pasting temperature of the blends was in the range of $45.3-49.5^{\circ}\text{C}$. The set back is the viscosity at the cooling end. The fortified blends MZPG73, MZPG64, and MZPG55 had lower set back in the range of 32.4 to 37.1. Varying trough and peak viscosities were recorded for the samples. The peak time for fortified samples was in the range 5.05 -5.21min.

TABLE II
PASTING PROPERTIES OF WHOLE *Ogi* FORTIFIED WITH PIGEON PEA (DRY MATTER BASIS)

Samples	Peak	Trough	Break down	Final Viscosity	Set back	Peak time (mins)	Pasting Temperature (°C)
MZPG91	98.5 ^b	68.3 ^d	24.4 ^b	114.7 ^d	46.3 ^b	5.01 ^a	49.4 ^a
MZPG82	92.8 ^b	78.4 ^c	25.1 ^b	126.1 ^c	52.7 ^a	5.10 ^{ab}	49.5 ^a
MZPG73	80.8 ^c	64.3 ^e	16.4 ^c	101.4 ^e	37.1 ^c	5.05 ^a	45.8 ^b
MZPG64	69.1 ^d	55.4 ^f	13.7 ^c	89.5 ^f	34.1 ^c	5.05 ^a	49.0 ^a
MZPG55	64.6 ^d	50.3 ^f	12.1 ^c	87.2 ^f	32.4 ^c	5.21 ^{ab}	45.3 ^b
MWZ	129.3 ^a	80.6 ^b	48.7 ^a	136.3 ^{ab}	55.7 ^a	4.89 ^b	49.0 ^a
MSZ	129.3 ^a	94.5 ^a	42.8 ^a	141.3 ^a	46.8 ^b	4.12 ^c	49.4 ^a

Values are means of three replicates. Values in the same column not followed by the same letter are significantly different at 5% level of significance. Key: MZPG91-blend of whole *Ogi* with blanched pigeon flour ratio 9:1, MZPG82-blend of whole *Ogi* with blanched pigeon flour ratio 8:2, MZPG73-blend of whole *Ogi* with blanched pigeon flour ratio 7:3, MZPG64-blend of whole *Ogi* with blanched pigeon flour ratio 6:4, MZPG55-blend of whole *Ogi* with blanched pigeon flour ratio 5:5, WMZ-whole unsifted *Ogi*, WSZ-sifted *Ogi*

Table III shows the sensory properties of the samples. Whole *Ogi* gruel as in traditional form of consuming *Ogi* had the highest acceptability for all the attributes tested in terms of appearance, colour, flavour and overall acceptability. The fortified samples MZPG at 10%, 20 % and 30 % levels were not significantly different $p < 0.05$ from whole maize *Ogi*.

TABLE III
SENSORY QUALITY OF WHOLE *Ogi* FORTIFIED WITH PIGEON PEA (DRY MATTER BASIS)

Samples	Appearance	Color	Flavour	Taste	Overall acceptability
MZPG91	6.9 ^b	6.8 ^b	6.5 ^b	6.5 ^b	6.9 ^b
MZPG82	6.6 ^b	6.5 ^b	6.8 ^b	6.7 ^b	6.8 ^b
MZPG73	6.2 ^{bc}	6.4 ^b	6.3 ^b	6.7 ^b	6.5 ^b
MZPG64	5.6 ^c	5.7 ^b	5.4 ^d	5.8 ^c	5.6 ^c
MZPG55	4.3 ^d	4.2 ^c	4.1 ^e	4.6 ^d	4.7 ^d
WMZ	6.3 ^b	6.7 ^b	6.1 ^c	6.1 ^b	6.1 ^b
WSZ	8.1 ^a	7.4 ^a	7.3 ^a	7.3 ^a	8.2 ^a

Values are means of three replicates. Values in the same column not followed by the same letter are significantly different at 5% level of significance. Key: MZPG91-blend of whole *Ogi* with blanched pigeon flour ratio 9:1, MZPG82-blend of whole *Ogi* with blanched pigeon flour ratio 8:2, MZPG73-blend of whole *Ogi* with blanched pigeon flour ratio 7:3, MZPG64-blend of whole *Ogi* with blanched pigeon flour ratio 6:4, MZPG55-blend of whole *Ogi* with blanched pigeon flour ratio 5:5, WMZ-whole unsifted *Ogi*, WSZ-sifted *Ogi*

IV.CONCLUSION

This study shows that *Ogi* (fermented cereal) as whole *Ogi* is nutritionally better than sifted *Ogi*. Also, sifted or whole *Ogi* is nutritionally improved by fortification with blanched pigeon pea flour. Improvement in protein and crude fibre quality of whole *Ogi* pigeon fortified gruel in comparison with traditional consumed *Ogi* will be useful in addressing protein energy malnutrition, hence better nutritional status of children especially when utilized as weaning diet. The increase in crude fibre of the fortified product is also essential in preventing gastrointestinal disorder such as constipation.

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REFERENCES

- [1] Singh, U. (1988). Anti-nutritional factors of pea and pigeon pea and their removal by processing. *Plants Foods in Human Nutrition* 38, 251-261.
- [2] Kaur, M., Sandhu, K.S. and Singh, N. (2007). Comparative study of the functional, thermal and pasting properties of flours from different field pea (*Pisum sativum* L.) and pigeon pea (*Cajanus cajan* L.) cultivars. *Food Chemistry* 104, 259-267.
- [3] Duhan, A., Khetarpaul, N. and Bishnoi, S. (2004). HCl-extractability of zinc and copper as affected by soaking, dehulling, cooking and germination of high yielding pigeon pea cultivars. *Journal of Food Composition and Analysis* 17, 597-604.
- [4] Fasoyiro, S.B., Ajibade, S.R., Saka, J.O. Ashaye, O.A., Obatolu, V.A., Farinde, E.O. and Afolabi, O.O. (2005). Physical characteristics and effects of processing methods on pigeon pea varieties (*Cajanus cajan*). *Journal of Food, Agriculture and Environment* 3, 59-61.
- [5] Corzo, O., and Fuentes, A. (2004). Moisture sorption isotherms and modeling of pre-cooked flours of pigeon pea (*Cajanus cajan* L. Mill sp) and lima bean (*Canavalia ensiformis*). *Journal of Food Engineering* 44, 3029-3032.
- [6] Fasoyiro, S.B., Akande, S.R., Arowora, K.A., Sodeko, O.O., Sulaiman, P.O., Olapade, C.O. and Odiri, C.E. (2010). Physico-chemical and sensory properties of pigeon pea (*Cajanus cajan*) flours. *African Journal of Food Science* 4, 120-126.
- [7] Yadav, B.S., Yadav, R.B. and Kumar, M. (2011). Suitability of pigeon pea and rice starch and their blends for noodle making. *Food Science and Technology* 44, 1415-1421.
- [8] Akingbala, J.O., Rooney, L.W. and Faubion, J.M. (1981). Physical, chemical and sensory evaluation of sorghum of different kernel characteristics. *Journal of Food Science* 46, 15-23.
- [9] AOAC (2000). Official Methods of Analysis. Association of Official Analytical Chemists. 17th edition, Washington DC.
- [10] Iwe, M.O. (2002). Handbook of Sensory Methods and Analysis. Rojoint Communication Services Limited, pp. 71-72, Enugu, Nigeria.
- [11] SAS (2003). SAS User's Guide. Statistical Analysis System Institute. Inc. Cary.
- [12] Joint WHO/FAO Consultation (2003). Diet, nutrition and prevention of chronic diseases. WHO Technical report series No. 916. World Health Organization, 2003.
- [13] FAO/WHO/UNU (1985). Energy and protein requirement. WHO Report of Joint Expert Consultation. Technical Report Series No.724. Geneva.