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PROXIMATE AND SENSORY EVALUATION OF PAP FORTIFIED WITH MORINGA LEAF POWDER

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Abstract

Fortified pap was produced from the blends of Sorghum and moringa leaf powder. The sorghum were sorted, cleaned, soaked, steeped for 72 hrs at room temperature, washed, dried and milled into flour. The moringa leaves were sorted, washed, and dried under room temperature and were blended to obtain powder. The flours were blended into the following ratio, 100% Sorghum:0% moringa leaf powder (PS1), 98% Sorghum: 2% moringa Leaf Powder (PS2), 96% Sorghum: 4% moringa leaf powder (PS3), 94% Sorghum: 6% moringa leaf powder (PS4), 90% Sorghum: 10% moringa leaf Powder (PS5). The fortified pap samples were subjected to sensory evaluation and it was observed that sample PSI (100:0) followed by sample PS2 (98:2) were the most acceptable sample while the least was observed to be (PS5 (90: 10). From the sensory evaluation, the result showed that Sample PSI (100% Sorghum) had the best overall acceptability for the different formulation of the pap sample. The Control Sample (PS1) 100% sorghum, with Sample (PS2) 98% sorghum: 2% moringa leaf powder and (PS3), 96% sorghum: 4% moringa leaf powder were evaluated for their proximate composition and it was recorded that the moisture decreased significantly ($p \leq 0.05$) at 2% substitution of the moringa leaf powder from 8.26% to 7.23%, Carbohydrate from 80% to 79%, Ash from 0.80% to 0.60%, the protein content increased significantly, from 8.15% to 10.19%, fats from 2.42% to 2.69% and in fiber from 0.00% to 2.69%. This study shows that incorporation of moringa leaf powder to pap reduced the sensory acceptability and improved the proximate composition. Hence the consumption is recommended for infants and adults irrespective of its low sensory acceptability.

Keynote words: Moringa leaf powder, pap, sorghum, proximate composition.

INTRODUCTION

Pap is a traditional fermented starchy food item produced in Nigeria from maize, millet and sorghum (Adebola *et al*., 2017). Its colour depends on the cereal used. It is cream to glossy white from maize, light brown from sorghum and grey to greenish colour from millet. This food had undergone a desirable change due to the action of the invading microorganisms or their metabolic products (Patience, 2013).

During preparation of these fermented cereal foods, nutrients including protein and minerals are lost from the grains thereby affecting nutritional quality adversely (Aminigo and Akingbala, 2004). Such foods are often of poor protein qualities and have high paste properties. Efforts to improve the nutritional status of these staple have been based on fortification with legumes to provide the deficient amino acids (Osundahunsi *et al*, 2003). Various attempts that have been made towards nutrient restoration and fortification of Ogi include blending with fermented and unfermented legumes (Otunola *et al*., 2006).

Sorghum bicolor (L). Moench is the crop for grain for human and animal consumption. Sorghum is produced in areas that are too hot, a minimum average temperature of 25°C is necessary to ensure maximum grain production. The morphological characteristics of the culture make it one of the currently cultivated cereals that have the best drought tolerance. During the drought, it rolls its leaves to reduce water loss due to perspiration. If the drought continues, it becomes dormant instead of dying. The leaves are protected by a waxy cuticle to reduce evapo transpiration. Sorghum is the fifth most important cereal crop in the world after rice, wheat, corn and barley. It is the main cereal food for over 750 million people living in semi-arid tropical regions of Africa, Asia and Latin America.

Sorghum-ogi is prepared from sorghum grains (Sorghum bicolour (L)) through traditional processing technique. The traditional preparation of ogi involves soaking of sorghum in water (1 to 3 days), wet milling and sieving to remove bran, hulls and germs (Abioye and Aka, 2015). This processing method has been reported to result in the loss of proteins and minerals, thereby affecting the nutritional quality of the ogi adversely. However; this may be inadequate to meet the nutritional demands of growing infants (Ajanaku and Oluwole 2013).

Moringa oleifera is referred to as the miracle plant or the tree of life due to its medicinal and nutritional value. It is native to India, Pakistan, Bangladesh and Afghanistan (Abioye and Aka 2015). It is a tree plant with many uses; the leaves can be eaten fresh, cooked or stored as dry powder for many months without refrigeration without any loss of nutritional value. Moringa leaves have an immense nutritional value. It contains minerals, vitamins and amino acids and it has been used to alleviate malnutrition problems especially among infants and nursing mothers (Anjorin *et al*., 2010).

Due to the undesirable effects of traditional processing on the nutrient content of sorghum-ogi, several researchers have worked on improvement of the nutritional quality of sorghum-ogi. There have been reports about quality improvement of sorghum ogi (Anjorin *et al*., 2010). Moringa leaves have been reported to increase the nutritional value of ogi prepared from other grains, such as maize and yellow maize (Abioye and Aka, 2015). This work therefore aimed to investigate the effects of moringa leaf powder supplementation on the proximate and sensory properties of sorghum-ogi.

MATERIAL AND METHODS

Sources of Materials

Sorghum and moringa leaves were purchased at Eke Oko market, Orumba North Local Government Area in Anambra State, Nigeria.

METHOD

Processing Of Plain 'Ogi'

A modified method of Odunfa and Adeleye (2005) was used. Sorghum was sorted; One kilogram of sorghum was soaked in 4 litres of clean water separately. The cereals were steeped for 72hrs at room temperature (30^{o}C). Soaking water was decanted and the grain washed. Oven dried and dry milled using a mechanical blender and the sieved (0.25mm) to obtain flour (dry pap).

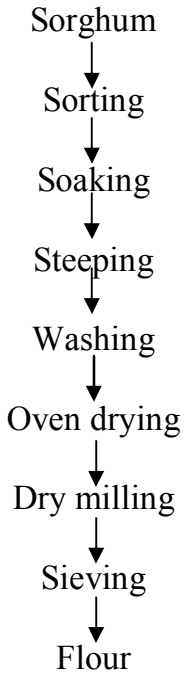

Fig 1: Flowchart for production of plain 'ogi' sorghum
Source: Odunfa and Adeleye (2005)

Production of moringa leaf powder

The moringa leaves (2kg) were sorted to remove the spoilt ones then washed and dried under room temperature. The moringa leaves were blended using an electric blender. The resultant powder was sieved to obtain powder.

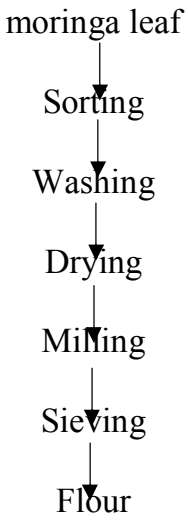

Fig 2: Flowchart for production of moringa leaf flour

Formulation of Ogi Sample with Sorghum and Moringa

Table 1: Formulation of pap with moringa leaf powder

SAMPLES	Sorghum	Moringa leaf
Pap	powder	
A	100	0
B	98	2
C	96	4
D	94	6
E	92	8
F	90	10

Sensory Evaluation

Samples were subjected to sensory evaluation using twenty panelists randomly selected students from Food Tech Dept. The samples were coded and presented to the panelists using white glass cups. Water was provided for mouth wash in between evaluations.

Panelists rated the products for their colour, aroma, taste, mouth feel and overall acceptability using a 9 point Hedonic scale (Ihekoronye and Ngoddy, 2005).

Proximate Analysis

Determination of moisture content

Two grams (2g) of the sample of the flour was placed in the crucible and heated at 105˚ C until a constant weight was attained. The moisture content of sample was calculated as loss in weight of the original sample and expressed as percentage moisture content.

Determination of crude protein

The crude protein was determined by the Kjeldahl method with slight modification. The determination of crude protein involved three steps namely; digestion, distillation and titration.

Digestion: One g of ground sample was weighed into a digestion flask. Reagent blank and high purity lysine HCL was included as check of correctness of digestion parameters.

15 g potassium sulfate, 0.04 g anhydrous copper sulfate, 0.5 to 1.0 g alundum granules, 16.7 g K_2SO_4, 0.01 g anhydrous copper sulfate, 0.6 g TiO_2 and 0.3 g pumice was added. Then 20 mL sulfuric acid was added. The flask was placed on preheated burner (adjusted to bring 250 mL water at 25^{o}C to rolling boil in 5 minutes) and the mixture was heated until white fumes clear bulb of flask was seen, swirled gently, and heating continued for 90 min for copper catalyst. The mixture was then cooled and cautiously 250 mL of distilled water was added to room temperature.

Distillation: A mixture of 15 mL of hydrochloric acid and 70 mL of water (HCL) was accurately measured to form acid standard solution then added to the titration flask. For reagent blank, 1 mL of acid and approximately 85 mL water was added followed by three to four drops of methyl red indicator solution. In addition, two to three drops of tributyl citrate, an antifoam agent was added to digestion flask to reduce foaming. This was then followed by addition of another 0.5 to 1.0 g alundum granule. Slowly down side of flask, sufficient 45% sodium hydroxide solution (approximately 80 mL) was added to make mixture strongly alkali. The flask was connected to distillation apparatus and distilled until at least 150 mL distillate was collected in titrating flask.

Titration: Excess acid was titrated with standard 0.1M sodium hydroxide solution to orange endpoint (color changed from red to orange to yellow) and volume was recorded to nearest 0.01 mL (NaOH). The reagent blank (B) was titrated similarly.

Calculations was done as follows:

%N (DM basis) = ((HCL x N HCL) - (BK x N NaOH) - (NaOH x N NaOH))/1.4007 x W x Lab DM/100

Where DM – dry matter; V NaOH = mL standard NaOH needed to titrate sample; HCL = mL standard HCL pipetted into titrating flask for sample; N NaOH = Normality of NaOH; N HCL = Normality of HCL; V BK = mL standard NaOH needed to titrate 1 mL standard HCL minus B; B = mL standard NaOH needed to titrate reagent blank carried through method and distilled into 1 mL standard HCL; 1.4007 = milli equivalent weight of nitrogen x 100; W = sample weight in grams.

Calculation for crude protein (CP):

Crude Protein (Dry Matter (DM) basis) = % N (DM basis) X F; where F = 6.25.

Determination of crude lipid

This estimation was performed using the Soxhlet extraction method. 10 g of the powdery form of each plant sample was weighed and wrapped with a filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser. 200 ml of n – hexane was used to extract the lipid.

Determination of crude fibre

Five grammes (5g) of the powdery form of each flour and 200 ml of 1.25 % H_2SO_4 was heated for 30 min and filtered with a buchner funnel. The residue was washed with distilled water until it was acid free. 200 ml of 1.25% NaOH was used to boil the residue 30 minutes; it was filtered and was washed several times with distilled water until it was alkaline free. It was then rinsed once with 10% HCL and twice with ethanol. Finally it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105^{o}C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550^{o}C for 90 minutes to obtain the weight of the ash.

Determination of ash content

The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. 2g of the pulverized samples was placed in a crucible and ignited in a muffle furnace at 550^{o}C for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash.

Determination of carbohydrate

The carbohydrate content was determined by subtracting the summed up percentage compositions of moisture, protein, lipid, fibre, and ash contents from 100

RESULTS AND DISCUSSION

Table 2: Results of the sensory evaluation of Pap from sorghum and moringa leaf powder blend

Sample codes	Colour	Taste	Texture	Aroma	Consistency	Overall Accept.
PS1	$8.50^{a}\pm0.53$	$8.60^{a}\pm0.97$	$7.30^{a}\pm0.95$	$8.20^{a}\pm0.92$	$7.83^{a}\pm1.55$	$8.08^{a}\pm0.58$
PS2	$7.70^{a}\pm^{b}0.67$	$7.70^{a}\pm0.67$	$7.30^{a}\pm1.42$	$7.50^{a}\pm1.35$	$6.60^{a}\pm1.84$	$7.36^{a}\pm0.75$
PS3	$6.50^{b}\pm2.07$	$7.60^{a}\pm1.25$	$6.60^{a}\pm1.17$	$6.40^{ab}\pm2.76$	$6.60^{a}\pm2.91$	$6.77^{ab}\pm2.04$
PS4	$4.70^{c}\pm1.95$	$5.50^{b}\pm2.01$	$4.30^{b}\pm2.45$	$5.20^{bc}\pm2.44$	$3.90^{b}\pm2.42$	$5.32^{bc}\pm2.50$
PS5	$3.70^{c}\pm1.70$	$5.60^{b}\pm2.32$	$4.40^{b}\pm2.07$	$4.10^{c}\pm2.23$	$4.20^{b}\pm1.55$	$4.41^{c}\pm1.41$

Mean values in the same column with the same superscripts are not significantly different ($p>0.05$)

Table 3: Results of the proximate composition of Pap from sorghum and moringa leaf powder blend

Sample	Moisture%	Protein%	Fat%	Fibre%	Ash%	Carbhydrate%
PS1	$8.26^{a}\pm0.36$	$8.15^{c}\pm0.32$	$2.42^{a}\pm0.23$	$0.00^{b}\pm0.00$	$0.80^{a}\pm0.00$	$80.39^{a}\pm0.29$
PS2	$8.19^{a}\pm0.28$	$9.00^{b}\pm0.16$	$2.62^{a}\pm0.05$	$0.07^{a}\pm0.03$	$0.70^{b}\pm0.00$	$79.45^{b}\pm0.03$
PS3	$7.23^{b}\pm0.17$	$10.19^{a}\pm0.24$	$2.69^{a}\pm0.12$	$0.08^{a}\pm0.03$	$0.60^{c}\pm0.00$	$79.18^{b}\pm0.46$

Values are means ± standard deviation from triplicate determination. Values with the same superscript in the same column are not significantly ($p>0.05$) different, while values with different superscripts in the same column are significantly ($p<0.05$) different.

Key:

PS1- 100% sorghum : 0% moringa leaf powder
PS2- 98% sorghum : 2% moringa leaf powder
PS3- 96% sorghum : 4% moringa leaf powder
PS4- 94% sorghum : 6% moringa leaf powder
PS5- 90% sorghum: 10% moringa leaf powder

Discussion

The results of the sensory evaluation and proximate composition of the pap (Akamu) enriched with moringa leaf powder were shown in Table 2 and 3 respectively.

Sensory

There were significant differences in all the sensory attributes of the fortified pap.The mean scores for colour ranged from 3.70 obtained for sample PS5 (90% sorghum :10% moringa leaf powder) to 8.50 obtained for sample PS1 (100% sorghum). The range for colour showed that increasing addition of moringa leaf powder led to decrease in colour acceptability, this agrees with the report of Abioye and Aka (2015) who recorded a drop in colour acceptability from 8.40 to 5.50 with increasing moringa in moringa fortified yellow maize-ogi, also Ijarotimi (2022) reported an increase in colour acceptability with increasing moringa leaf flour inclusion in complementary food made from maize, melon seed and *Moringa oleifera* leaf powder.

Panelists' preference for taste ranged from 5.50 obtained from sample PS4 (94% sorghum :6% moringa leaf powder) to 8.60 obtained from sample PS1 (100% sorghum). Comparing the blends to the control, the blends were less preferred to the control. Statistical analysis however indicated significant ($p<0.05$) difference between the control and the 94% sorghum: 6% moringa leaf powder and 90% sorghum :10% moringa leaf powder blends in terms of taste with the taste acceptability dropping with increasing moringa inclusion. This drop in taste acceptability with increasing moringa inclusion agreed with the findings of Abioye and Aka (2015) who also reported a consistent drop in taste from 8.10 to 5.20 and 7.20 to 5.70 respectively with increasing moringa leaf powder addition in maize-moringa leaf pap. The possible high antinutrient factors present in moringa may have affected the taste of the pap.

The range 4.30 obtained for sample PS4 (94% sorghum: 6% moringa leaf powder) to 7.30 obtained for samples PS1 (100% sorghum) and PS2 (98% sorghum : 2% moringa leaf powder) was obtained from the texture assessment of the pap samples. The results for texture showed significant ($p<0.05$) difference between the control and the sorghum and moringa leaf powder blend pap samples. The control sample (100% sorghum), 2%

and 4% substituted samples had consumer acceptable values while the values obtained for the 6% and 10% substitution of sorghum fell below the acceptability threshold (5.0) which suggests that increasing moringa leaf powder inclusion reduced the textural quality of the pap product to the point of rejection. Reduction in textural quality (7.60 to 5.70) was also reported by Abioye and Aka (2015) in moringa fortified yellow maize- ogi samples while Ijarotimi (2022) reported an improvement (5.9 to 6.8) in texture of complementary foods from maize, defatted white melon seed and moringa leaf powder with increasing moringa leaf powder addition.

For the products Aroma, significant ($p<0.05$) difference was observed between the 100% sorghum pap and the sorghum-moringa pap samples which ranged from 4.10 for sample PS5 (90% sorghum : 10% moringa leaf powder) to 8.20 obtained for sample PS1 (100% sorghum). Irrespective of the significant variation between the 100% sorghum pap and the sorghum-moringa blend samples, the flavor of the blend samples were accepted by the panelists up to 6% sorghum substitution with moringa, which agreed with the findings of Ijarotimi (2022) who reported a slight decrease (5.7 to 3.7) in texture of complementary foods from maize, defatted white melon seed and moringa leaf powder with moringa leaf powder addition.

The consistency showed that significant ($p>0.05$) difference was observed between the 100% sorghum pap and the sorghum-moringa pap samples which ranged from 4.10 obtained for sample PS5 (90% sorghum: 10% moringa leaf powder) to 8.20 obtained for sample PS1 (100% sorghum). There were insignificant variation between the 100% sorghum sample, PS2 (98% sorghum: 2% moringa leaf powder) and PS3 (96% sorghum : 4% moringa leaf powder) but varied significantly the consistency of the 6% and 10% substitution of sorghum were not accepted by the panelists.

The response for the overall acceptability showed significant ($p<0.05$) decrease in acceptability with the range 4.41 obtained for sample PS5 (90% sorghum :10% moringa leaf powder) to 8.08 obtained for PS1 (100% sorghum). This implies that, for overall acceptance, the increase in substitution of sorghum with moringa reduced the overall acceptability of the pap; which agreed with the findings of Abioye and Aka (2015).

However, the most accepted and highly rated samples which were samples PS1 (100% sorghum:0 moringa leaf powder), PS2 (98% sorghum : 2% moringa leaf powder) and PS3(96% sorghum : 4% moringa leaf powder) with respective overall acceptability scores of 8.08, 7.36 and 6.77 were selected for proximate analysis in order to determine the effects of the inclusion of moringa leaf powder on the nutritional composition of the pap.

Proximate

The proximate composition of the powdered ogi samples fortified with moringa leaf powder revealed an increase in the nutritional content. This is similar to the reports from studies in which ogi was supplemented with other substances such as okra seed meal, soybean (Aminigo and Akingbala, 2004; Adesokan *et al*., 2011). The moisture content varied significantly between 7.23% obtained for sample PS3 (96% sorghum: 4% moringa leaf powder) to 8.26% obtained for sample PS1 (100% sorghum). The lower moisture content could be as a result of lower moisture content of moringa as its increasing inclusion led to decrease in moisture content of the pap samples. Abioye *et al*. (2018) reported a slightly higher moisture value (8.67-9.03%) for moringa-maize pap while Verem *et al*.(2021) reported a comparable moisture value of 5% - 10% for wheat, soy and moringa leaf composite flours. The moisture content of any food is an index of its water activity and is used as a measure of stability and susceptibility to microbial contamination. Considering that the products have relatively low moisture content, this is an indication that the products would have good storage stability if properly packaged.

The ash content gives an indication of the mineral composition preserved in the food materials (Nnamani *et al*., 2009). The ash content (0.80%) was significantly higher in sample PS1 (100% sorghum) than the rest of the samples while the least value (0.60%) was obtained for the sample PS3 (96% sorghum :4% moringa leaf powder). It was observed that increasing addition of moringa led to decrease in ash content. This disagreed with the findings of Abioye *et al*. (2018) who reported a rather increase in ash (3.17 - 5.17%) and (1.70 - 3.30%) with increase inclusion of moringa for moringa-maize pap and moringa-yellow maize pap respectively. Higher ash content indicates a higher

mineral content which implies that individual feeding on the flour of sorghum will not be mineral deficient.

The fat content was again significantly higher in sample PS3 (96% sorghum: 4% moringa leaf powder) (2.69%) while the least was obtained for sample PS1 (100% sorghum pap) with the value (4.42%). However, the fat contents obtained are lower than the recommended 10% FAO for breakfast food formulation. Abioye *et al.* (2018) reported a slightly similar fat value (2.53%) and (3.56 %) in moringa-maize pap and moringa-yellow maize pap. This low fat content is an advantage for people suffering from obesity and also implies that the storage life of the dry pap may increase due to their low fat. Dietary fats function in the increase of palatability of food by absorbing and retaining flavours (Antia *et al*., 2006). A diet providing 1-2 % of its calories of energy as fat is said to be sufficient to human beings. Excess consumption of fatty foods has been implicated in certain cardiovascular disorders such as atherosclerosis, cancer, and aging (Antia *et al*., 2006). Therefore, these flour blends for diets will not pose any risk of the above diseases in man.

The fiber content of the blends ranged from 0.00 obtained for the control sample PS1 (100% sorghum pap) to 0.08% PS3 (96% sorghum: 4% moringa leaf powder). Abioye and Aka (2015) reported a much higher value (2.33 - 3.57%) which similarly increased with inclusion of moringa leaf powder. Fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body. Fibre is an indigestible component of plant material that helps in improving roughage and bulk as well as contributes to a healthy condition of the intestine (Potter and Hotchkiss, 2005). Fibre increases stool bulk and decreases the time that waste materials spend on in the gastro intestinal track.

The protein content was highest (10.19%) in sample PS3 (96% sorghum: 4% moringa leaf powder) while the least value (8.15%) was obtained for sample PS1 (100% sorghum). The values were lower compared to the findings of Folake and Bolanle (2006) who reported 14.16% protein content for ogi. Abioye and Aka (2015) also reported a higher value range of (9.23- 18.00%) of protein for moringa-yellow maize pap. Proteins are required for the structure, function, and regulation of the body's tissues and organs,

therefore the increased protein composition of moringa-sorghum pap samples showed that the product is healthy.

Results from SP1 (100% sorghum pap) shows the carbohydrate content was highest (80.39%) while the least value (79.18%) was obtained for sample SP3 (94% sorghum :4% moringa leaf powder) this was similar to the report of (Bhatt *et al*., 2003) who stated that finger millet ogi have 72 to 79.5% carbohydrate. Carbohydrate content contributes energy value of food formulations. The high carbohydrate in these blends make them ideal for all age groups most especially infants since they require energy for their rapid growth.

Conclusion and Recommendation

This work has shown that there is improvement in the proximate composition of pap through blending of sorghum pap with moringa leaf powder as it offers higher percentages of fibre, protein and fats. The increase in moringa inclusion also reduced the carbohydrate value of the moringa fortified pap.

Considering the insignificant drop in sensory qualities of the pap with 2% inclusion of moringa leaf powder in sample PS2 (98% sorghum: 2% moringa leaf powder), the sample is therefore recommended for commercialization. The study revealed an improvement in proximate composition with addition of moringa leaf powder therefore it's also recommended that moringa leaf powder should be introduced in breakfast and complementary food products to provide additional nutrients to the consumers.

Further studies on mineral properties of the products is also recommended, which will help to also ascertain the effect of moringa addition on other aspects of sorghum pap products.

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