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Nutritive Composition and Sensory Properties of Ogi Fortified with Okra Seed Meal

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ABSTRACT: Maize ogi was fortified with defatted and roasted okra seed meals at substitution levels of 0,10 and 20%. Dry matter recovery levels during production of ogi, raw and roasted okra seed meals were 98.9, 97.3 and 94.7%, respectively. Okra –fortification of ogi at 20% level using defatted and roasted meals increased crude protein content by 122 and 106%, respectively. Ash content was increased by 2 – to 5 - fold due to the fortification. The fat content of samples fortified with 10 and 20% roasted okra seed meal were increased by 1.5 and 2.2%, respectively. Ogi supplemented with roasted okra seed meal had higher viscosities during heating and cooling cycles than samples fortified with the defatted meal. The former samples also had slightly higher sensory scores for colour and taste although all fortified samples were acceptable @JASEM

The development of high-protein foods of plant origin is essential in developing countries because of the shortage and high cost of animal protein. Consumption of such products plays a major role in combating malnutrition, which is a serious problem in these countries. Various plant protein sources may be combined to obtain products with improved protein quality (Rodríguez – Bürger *et al*, 1998).
Cereals are important sources of plant protein throughout the world (Dimler, 1971). Maize constitutes about 90% of the cereals consumed in southern Nigeria (Ekpenyong *et al*. 1977). The grain is often processed into a fermented product known as ogi, which can also be prepared from millet and sorghum, and is consumed in many parts of West Africa. In the traditional processing technique, the grain is steeped in water for 1-3 days, washed, wet-milled, sieved to remove bran and the sievate is allowed to settle to obtain ogi. During ogi manufacture, nutrients including protein and minerals are lost from the grain thereby affecting nutritional quality adversely. Akinrele and Bassir (1967) found that this cereal product was incapable of supporting the growth of rats. A number of studies have been carried out to improve the nutritive value of ogi. A reduction in protein loss was achieved by using an improved wet-milling technique (Banigo and Muller, 1972) while no nutrient losses occurred during production from high-lysine corn using an improved method (Banigo *et al,* 1974). The nutritive value of ogi was also improved by fortification with amino acids (Adeniji and Potter, 1978) and plant proteins (Akinrele and Edwards, 1971). Similarly, the protein content of maize meal was increased by combination with soy flour (Plahar and Leung, 1983), blends of roasted soybean and peanut meals (Aminigo and Ossai, 1999) and blends of cashewnut, African locust bean and sesame oil meals (Ekpenyong *et al* 1977).

Okra (*Abelmoschus esculentus L.*) is widely consumed as a fresh vegetable in both temperate and tropical countries. Although the seed pods are most often used (Camciuc *et al* (1981), the mature seed is known to have superior nutritional quality. Rubatzky and Yamaguchi (1997) reported that the seed is a rich source of protein and oil; contains cyclopropenoid fatty acids which cause some toxicity concerns and is used as a substitute for coffee in some countries. In an earlier study, Karakoltsides and Constantinides (1975) found that the Protein Efficiency Ratio (PER) of okra seed flour heated at 130°C for 3hr was not different from the nonheated flour, indicating the absence of anti-nutritional factors. According to these authors, the amino acid composition of okra seed protein is similar to that of soybean and the PER is higher than that of soybean. The high percentage of linoleic acid (42%) makes okra seed oil desirable and the amino acid pattern of the protein renders it an adequate supplement to legume or cereal based diets (Savello *et al* 1982). Recently, the seed has been utilized as a source of oil and protein in the United states of America (Jambhale and Nerkar, 1998). Although mature okra seed has a harsh flavour, it can be improved by processing. Okra cheese prepared from mature okra seed and bakery products in which wheat flour was substituted with okra seed meal at replacement levels of 25 – 100% had acceptable sensory properties (Martin and Ruberte, 1979).

Okra seed is a potential source of protein for the fortification of ogi. The objective of this study was therefore to improve the nutritive composition of ogi by fortification with okra seed meal and assess the sensory characteristics.

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MATERIALS AND METHODS

Maize seed variety EV 8422SR was obtained from the International Institute of Tropical Agriculture, Ibadan. Okra seed variety 47 – 4 was collected from the National Institute of Horticultural Research, Ibadan.

A modification of the method described by Akingbala *et al*. (1981) was used for ogi manufacture. The flow chart for the process is shown in Fig 1. Maize grain (500g) was soaked in distilled water for 48hr (in triplicate). The grain was milled in a Waring commercial blender at medium speed for 7 min. The slurry was passed through U.S.A standard testing sieve No. 80 (W.S. Tyler Inc., Ohio, U.S.A.) and the suspension obtained was left to stand for 1 hr for the ogi to settle. The supernatant was decanted and the ogi collected. Ogi and bran were dried at 60°C for 48hr in a forced air oven (size two Hotbox Oven, Gallenkamp, UK) to obtain dried forms, as described by Akingbala *et al* (2002) and crushed manually. Ogi powder was supplemented with okra seed meal at replacement levels of 0, 10 and 20% (db) and mixed in a mixer (Model KM300, Kenwood, UK).

Raw okra seed was milled in an attrition mill (Cemotec 1090, Tecator, Sweden) and sieved through U.S.A standard sieves No.8 and 16 successively to obtain two fractions; one mainly kernels and the other mainly hulls. Two hundred gramme raw okra seed was also dry-roasted in the forced air oven at 130°C for 60 min (pre-determined roasting condition) to improve flavour. The roasted seed was milled coarsely in the attrition mill and the hulls were manually separated from the kernel. The samples were each milled in a laboratory hammer mill (Glen Mills Ltd, Switzerland) fitted with a 0.5mm screen. The raw okra seed kernel fraction yielded two meal samples; meal 1 passed through the screen and meal 2 was retained by the screen. Okra seed meal 1 had finer texture and was defatted using petroleum ether in a soxlet extractor. Samples were extracted for 16hr at a condensation rate of 2-3 drops/s, and the fat was dried at 100^{o}C for 30min before weighing. Weight and moisture content of ogi, bran and okra seed samples were determined and yields calculated (db). All yields were determined in triplicate. Soluble solids in steep and wash water were determined by drying 5ml aliquots of each sample at 130°C to constant weight in a forced air oven (Akingbala *et a*l, 1981). Moisture, ash, crude protein, crude fibre and ether extract were determined by standard AOAC methods (AOAC, 1990).

Pasting properties of ogi samples were determined using the method of Mazurs *et al* (1957). Ogi slurry (9% db) was heated in a Brabender viscoamylograph (Brabender Duisburg, West Germany). The slurry was heated from 25 to 95°C at the rate of 1.5°C/min with the viscometer bowl rotating at 15 r.p.m. The paste was held at 95°C for 30 min, then cooled to 50°C at 1.5°C/min, and held at 50°C for 30 min. Eight percent slurries (db) prepared from ogi powder and non-dried ogi (market sample) were boiled until cooked and sweetened with 2% (w/v) sucrose. 14 panelists familiar with the fermented product assessed the samples for aroma, colour, taste, texture and general acceptability. The 9 – point hedonic scale was used with I representing dislike extremely and 9 like extremely (Snedecor,1956).

The data obtained in this study were analysed using Statistical Analysis System computer program and means of data were compared using Duncan multiple Range Test (SAS, 1982).

RESULTS AND DISCUSSION

The yield of maize ogi was 64.6% and the total dry matter recovery from maize grain was 98.9% (Table 1). Higher mean yields of maize ogi (Banigo and Muller, 1972) and Sorghum ogi (Akingbala *et al* 1981), which ranged from 68 - 83% have been reported. The lower yield obtained in this study may be attributed to differences in processing conditions such as the utilization of a shorter steeping period and a sieve with smaller openings.

Table 1: Mean yield of ogi, bran and okra seed samples

Sample	Yield (%)
Ogi	44.6
Bran	29.1
Water Solubles	5.2
Total	98.9
Okra seed meal 1	20.2
Okra seed meal 2	31.6
Okra seed hulls	45.5
Total	97.3
Roasted okra seed meal	45.8
Roasted okra seed hulls	48.9
Total	94.7

Values are means of 3 replicates

The yield of okra seed kernel fraction obtained by sifting finely ground raw seed (51.8%) was slightly higher than that from manual separation of kernel from coarsely ground, roasted seed (45.8%). The latter method was more effective in separating kernel and hulls but was more tedious. The kernel fraction obtained by sifting was partly retained in the hammer mill screen in the course of milling, due to the resilient nature of okra seed hulls present in the fraction. Martin and Ruberte (1979) found that okra seed kernel breaks into small particles on grinding while the resilient hulls remain more coarse. The portion that passed through the screen had smaller particle size and a lighter colour than the retained portion, which contained more of the hulls. On the other hand, the manually separated roasted kernel fraction passed through the hammer mill screen indicating a lower level of okra seed hulls.

The proximate composition of maize, ogi and okra seed samples is shown in Table 2. Non-supplemented ogi had lower crude protein, crude fibre, ether extract and ash contents than raw maize. The proximate composition of okra seed and ogi obtained in this study was comparable to values reported by Savello *et al* (1982) and Muller (1970), respectively. Both dehulling and defatting of okra seed caused increases in protein and ash contents. The protein content of the raw hull fraction was twice the amount found in the roasted hulls thereby indicating that manual separation of kernel and hulls was more effective in reducing protein loss.

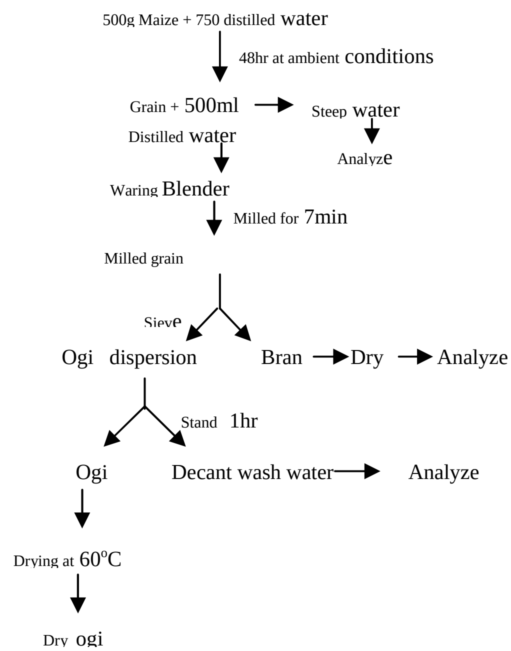

Fig 1 : Flowchart for the preparation of ogi
(Adapted from Akingbala *et al*.,

Table 2: Mean Proximate Composition* of maize, ogi and okra seed samples

Sample	Moisture (%)	Crude Protein (%)	Ether Extract (%)	Ash (%)	Crude Fibre (%)	Total Carbohydrate (%)**
Raw Maize	12.7 ± 0.16^{b}	10.5 ± 0.26^{j}	4.80 ± 0.02^{ef}	1.04 ± 0.01^{fg}	2.10 ± 0.06^{h}	81.6
Ogi (market sample)	10.3 ± 0.21^{cd}	5.47 ± 0.38^{l}	2.56 ± 0.11^{i}	0.04 ± 0.24^{i}	0.600 ± 0.23^{i}	91.3
Ogi (non-supplemented)	9.50 ± 0.01^{d}	8.12 ± 0.39^{k}	3.30 ± 0.09^{gh}	0.400 ± 0.06^{h}	0.510 ± 0.15^{i}	87.7
+ 10% OSM1[a]	8.32 ± 0.13^{e}	13.5 ± 0.23^{h}	3.20 ± 0.10^{h}	1.21 ± 0.10^{f}	0.600 ± 0.20^{i}	81.5
+ 20% OSM1	8.60 ± 0.44^{de}	18.0 ± 0.45^{f}	3.15 ± 0.25^{h}	2.07 ± 0.07^{e}	0.640 ± 0.10^{i}	76.1
+ 10% ROSM[b]	8.90 ± 0.21^{de}	11.5 ± 55^{ij}	5.07 ± 0.10^{e}	0.850 ± 0.21^{g}	0.530 ± 0.19^{i}	82.1
+ 20% ROSM	8.71 ± 0.17^{de}	16.7 ± 0.19^{g}	7.20 ± 0.18^{d}	1.26 ± 0.76^{f}	0.550 ± 0.08^{i}	74.3
Bran	11.1 ± 0.44^{c}	11.9 ± 0.24^{i}	3.70 ± 0.14^{g}	1.14 ± 0.25^{f}	7.20 ± 0.21^{g}	76.1
Water solubles	94.8 ± 6.04^{a}	25.7 ± 0.36^{d}	ND***	ND	ND	ND
Raw Okra Seed	7.70 ± 0.15^{ef}	21.0 ± 0.04^{e}	16.0 ± 0.18^{b}	5.10 ± 0.36^{c}	29.6 ± 0.08^{c}	28.3
Okra seed meal	10.4 ± 0.48^{cd}	35.3 ± 0.32^{b}	9.80 ± 0.07^{c}	5.22 ± 0.52	21.6 ± 0.09^{d}	28.1
Okra seed meal 1 (defatted)	6.80 ± 0.34^{f}	$49.50.43^{a}$	0.860 ± 0.03	7.83 ± 0.45^{a}	19.6 ± 0.60^{e}	22.2

Roasted okra seed meal	10.0 ± 0.20^{d}	30.3±0.61^{c}	30.7±6.12^{a}	6.30±0.70^{b}	9.47±0.06^{f}	23.2
Raw okra seed hulls	2.2±0.18^{b}	10.6±0.21^{j}	4.40±0.26^{f}	4.52±0.22^{d}	43.8±0.14^{b}	36.7
Roasted Okra seed hulls	11.0±0.23^{c}	5.32±0.37^{l}	0.00±0.01^{k}	4.49±0.35^{d}	45.9±0.08^{a}	44.3

* Values are means of 3 replicates. Where letters following means within a column differ, such means differ significantly (P< 0.05)
** Determined by proximate composition difference, *** Not determined: [a] Okra seed meal 1 (defatted); [b] Roasted okra seed meal

The most significant effects of fortification were on protein, fat and ash contents. Substitution of ogi with 20% defatted okra seed meal and roasted meal increased protein content by 122 and 106%, respectively. These levels of increment are higher than the level reported for roasted maize meal substituted with roasted peanut meal at 30% level, and similar to the increase obtained for the soy-fortified sample at the same substitution level (Aminigo and Ossai, 1999). Whereas fat content was reduced slightly by fortification with the defatted meal, it was increased by as much as 53.6 and 118% at the 10 and 20% levels of replacement with roasted meal. The increase in ash content ranged from 2- to 5- fold while crude fibre was slightly increased but carbohydrate content was significantly reduced by fortification as expected. These changes in nutrient levels of ogi may be attributed to the relatively higher protein, fat and ash contents of okra seed meal as compared to non-supplemented maize ogi.

Table 3: Pasting Properties of blends of ogi and okra seed meal

Sample	Pasting temperature °C	Peak Pasting viscosity (v_p) BU	Viscosity at 95°C BU	Viscosity after 30 min at 95°C (v_r) BU	Viscosity at 50°C holding BU	Starch stability (vp- v_r) BU
Ogi	70.0	780	780	600	940	180
+10% OSM1[a]	72.0	580	570	450	505	130
+20%OSM1	70.0	400	400	280	340	120
+ 10%ROSM[b]	69.5	750	750	540	890	210
+ 20% ROSM	72.0	680	680	465	790	215

[a] Okra seed meal 1 (defatted), [b] Roasted okra seed meal

Table 4: Sensory Characteristics of porridges prepared from ogi samples

Sample	Aroma	Colour	Taste	Texture	General Acceptability
Ogi (Market sample)	7.30^{a} ± 1.7	7.90^{a} ±1.1	7.60^{a} ± 1.5	8.00^{a} ± 1.0	8.22^{a} ± 0.78
Ogi	6.60 ^{a} ±1.4	6.60^{ab}±2.0	6.80^{ab} ±3.2	7.60^{a} ± 2.2	6.89^{ab} ± 1.3
+ 10% OSM1[a] (defatted)	6.40^{a} ± 2.6	6.00^{b} ± 1.4	5.80^{ab} ± 1.2	5.80^{b} ± 1.4	6.56^{ab} ± 1.5
+ 20% OSM1	5.70^{a} ± 3.3	5.00^{b} ±3.0	5.10^{b} ± 3.2	4.90^{b} ± 3.1	5.11^{b} ± 3.4
Ogi (market sample)[c]	6.60^{a} ± 1.4	7.57^{a} ± 1.4	7.15^{a} ± 0.85	7.64^{a} ± 1.4	7.31^{a} ± 1.7
Ogi	6.78^{a} ± 1.2	8.14^{a} ± 0.86	5.85^{ab} ± 1.8	7.29^{a} ± 1.7	7.54^{a} ±1.5
+ 10% ROSM[b]	6.93^{a} ± 2.1	6.43^{b} ± 1.6	6.23^{ab} ± 3.1	6.14^{ab} ± 1.9	6.23^{ab} ± 2.8
+ 20% ROSM	6.64^{a} ± 2.4	6.29^{b} ±1.7	6.08^{ab} ± 1.9	5.93^{ab} ± 3.1	6.00^{ab} ± 3.0

[a] Okra seed meal 1 (defatted);[b] Roasted okra seed meal [c]Sample dried at 60ºC for 48hr.

The pasting temperatures of starches in the ogi samples ranged from 69.5 – 72.0°C (Table 3). This narrow temperature range indicates that fortification had minimal effect on the initial pasting temperature of ogi. Fortification with okra seed meal reduced the defatted meal, although all samples had good stability. The lower viscosities of samples fortified with the defatted meal as compared to the hand-

. The sensory characteristics of ogi samples are shown in Table 4. A comparison of porridges prepared from ogi fortified with defatted okra seed meal and control (non-supplemented) samples showed that fresh ogi (market sample) was most

viscosity during the heating and cooling cycles but samples fortified with the roasted meal had higher viscosities than the other fortified samples. This indicates that fortification with the roasted meal would result in better porridges than with

picked meal may be attributed to the relatively high level of hulls which are resilient during cooking

preferred by panelists for all parameters assessed. Scores for this sample were however not significantly different from those for non-supplemented laboratory prepared ogi, for each parameter. Fortified samples differed significantly from fresh ogi in terms of colour, taste, texture and general acceptability; and also from non-supplemented laboratory ogi in terms of texture. The higher the substitution level, the lower the preference scores for ogi fortified with defatted okra seed meal. The lower scores obtained for colour can be explained by the brown colouration of okra-fortified ogi and the presence of black hull particles. A better method of dehulling could improve the acceptability of this potential protein source. Differences in scores for fresh ogi and the fortified samples were most pronounced for texture and general acceptability. Lower texture ratings may be attributed to the lower viscosities of fortified porridges as revealed by the pasting properties. Although okra contains mucilaginous substances, these do not possess the swelling and gelling characteristics of a starch suspension subjected to a defined heating, holding and cooling program as provided by the Brabender Amylograph. The sugar components of okra mucilage resemble those of pectic substances (Jambhale and Nerkar, 1998) instead of starch. Also, the presence of hull particles in fortified ogi samples imparted a slightly gritty texture unlike the smooth mouth-feel associated with the typical product.

Among the porridges prepared from ogi fortified with roasted okra seed and the control samples, non-supplemented laboratory prepared ogi was most preferred in terms of aroma, colour and general acceptability while the dried market sample was rated highest for taste and texture. Fortification with roasted okra seed meal improved the taste of ogi; a change which may be attributed to the nutty flavour of roasted okra seed. With the exception of colour, the sensory scores for ogi fortified with roasted okra seed meal, and control samples did not differ significantly.

Okra-fortified ogi was generally acceptable at 10 and 20% substitution levels. Whereas, samples fortified with roasted okra seed meal had better pasting and sensory characteristics, those fortified with the raw defatted meal had higher crude protein and ash content at each substitution level. Thus, okra seed meal is a suitable supplement for ogi and the roasted meal is preferable to the raw defatted meal.

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