Title: Chemical and sensory properties of sieved and unsieved fortified 'ogi'

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Abstract: Maize (*Zea mays*), yellow variety was processed into ogi. Two methods of processing were used to process the Ogi paste, Sieving and unsieving methods. The sieved ogi and the unsieved ogi were shared into four each. One part was fortified with soybean paste alone, 2nd part was fortified with soybean and spices (ginger and clove), the 3rd part was fortified with spices alone while the 4th part was left plain (unfortified). The ogi mixtures were dried and milled to powder. The proximate composition and mineral contents of the ogi samples were determined. The ogi samples were also evaluated organoleptionally. There was no significant difference $p<0.05$ in the moisture content of all the ogi samples fortified with soybean paste and spices. Crude protein ranged from 9.22% in the sieved plain Ogi to 14.56% in the unsieved soy ogi + spices. The fat contents of all the ogi samples were significantly different at $p<0.05$. Unsieved soy ogi sample contained the highest fibre (8.26%), fat 9.07%, but the least carbohyderate (58.17%). Unsieved soy ogi + spices also recorded the highest value for sodium (61.08 mg/100g), calcium (90.28mg/100g) and magnesium (152.32mg/100g). There was no significant difference $p<0.05$ in the iron (Fe) contents of all the spiced ogi samples. Sieved plain ogi recorded the least value for sodium (34.24mg/100g). All the ogi samples compared favourably well in terms of sensory quality. Fortification of plain ogi from maize with soybean and spices improved the nutrient composition and health benefits of ogi. Nutrients are better retained in the unsieved soy ogi samples.

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1. 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 1985). 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 1997). 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 flavor and sour taste (Banigo and Mutter 1972).

Cereals are generally low in protein particularly the essential amino acids; Lysine and tryptophan. These essential amino acids can be compensated for by fortifying cereals products with legumes which are on the other hand high in lysine and tryptophan but low in methionine and cystine which are high in cereals. This type of fortification of cereals with legumes have been documented by various authors (Nti and Plahar 1995; Sanni et al., 2001; Inyang and Idoko 2006; Mbata et al., 2007; Oyarekua 2011).

Soy-ogi is a cereal- soybean mixture processed into ogi paste. Soybean is an underutilized legume in West Africa which is of great importance due to its high protein content. Protein content in plain ogi is enhanced by its fortification with soybean paste (Akanbi et al., 2010).

'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 *et al.*, 2012). Loss of these nutrients can be minimized by excluding the sieving stage.

Spices are culinary/herbs which have aromatic or pungent flavor. They are dried seeds, fruit, root or vegetable substances used in preparation of soups to enhance the flavor of such food (Shakuntala and Shdaksharaswamy, 2008). Spices do not only excite taste, they are composed of high quality phytonutrients, essential oils, antioxidants, minerals and vitamins that are essential for overall health sustainance (Umesh,

2009). Ginger (*Zingiber officinale*) is a spice native of Asia. Ginger is valued for its wide array of medicinal uses. Ginger contains health benefiting oil such as gingerols and zingerone. Ginger is high in antioxidants which help in preventing cell damage caused by free radicals. Clove (*Syzygium aromaticum*) is a spice native of India. Clove has antioxidant, antiseptic, anti inflammatory and anti flatulent properties. It contains health benefit essential oil such as eugenol. It increases gastro intestinal secretion thus improving digestion of food and relieving constipation. Fortification of ogi with soybean have been reported by various workers but there is little information on quality of spiced ogi or soy ogi when sieved and when unsieved.

2. Material and Methods

Sources of Materials

Maize (*Zea mays*) yellow variety, soy bean seeds, ginger and clove were purchased at Apata market, Ibadan, Nigeria.

Processing of Plain 'Ogi'

A modified method of Odunfa and Adeleye (1985) was used. Maize (*Zea mays)* was sorted, one kilogram of the clean maize was soaked in 4 litres of water. The maize was steeped for 72hr at room temperature (30 ± 2 ^{o}C). Soaking water was decanted and the grains washed and wet milled using a mechanical blender (magic blender pentunjik penggunaam, Nikai, Japan) into paste. The paste was shared into two. One part was sieved using a muslin cloth and the other part was left unsieved. The unsieved part was also poured in muslin cloth to sediment but was not sieved through water. The sediments of the sieved paste and the unsieved paste were collected in clean plastic container with lid and kept on shelf for further treatment.

Processing of soy paste

Soybean (*Glycine max*) was sorted. Five hundred gram (500g) of the seeds were soaked in cold water for 6hr, the soaked seeds were wet milled into paste. Processing of spices

Method of Ziaur- Rehman *et al.,* (2000) was used to process ginger. Ginger 500g was washed manually with water, peeled with a sharp knife, washed again, sliced thinly (5mm thick) and dried in hot air area at 50^{o}C for 12hrs. The dried ginger was dry-milled into powder and kept in clean airtight container. Clove 300g was also washed and dried in hot air area at 50^{o}C for 8hrs. The dried cloves were ground into powder and kept in airtight container.

Fortification of the Ogi samples with soybean and spices

Plain sieved Ogi and plain unsieved ogi were shared into four parts each. One part was left plain, spices was added to one part, soybean was added to one part and soybean plus spices was added to the 4th part. Mixing of the samples was as follows: 250g of Ogi paste + 50g of Soybean paste + 2.5g of each of the two powdered spices (Ginger and clove totaling 5g) ie ratio 50:10:1 of ogi paste to soypaste to spices. Soy paste and spices were added to sieve ogi after sieving.

The ogi samples were coded as follows:

Sample code	Name SP
AZ	Sieved soy ogi + spices
RR	Unsieved soy ogi + spices
AV	Sieved plain ogi + spices
AQ	Unsieved plain + spices
AW	Sieved soy ogi
R	Unsieved soy ogi
AR	Sieved ogi (plain)
	Unsieved plain ogi

The ogi mixtures were dried in hot air oven at 50^{o}C for 24 hour, milled into powder and kept in air tight container at room temperature (30 ± 2^{o}C).

Proximate and Mineral composition

Proximate composition of the ogi samples was determined using the standard method of AOAC (1995). Percent Nitrogen was converted to crude protein by multiplying with a factor of 6.25. Carbohydrate was calculated by difference. Mineral content of the ogi samples were determined using the digestion method of AOAC. (1995). Atomic absorption spectrophotometry was used.

Sensory Evaluation

The Eight ogi samples were prepared into gruel/palp (semi solid porridge) and were presented to ten semi trained panel of Judges who are familiar with ogi palp as breakfast cereal food. The Judges were presented with water for mouth rinsing after each tasting and they were asked to score the samples for colour, appearance, flavor, texture, taste and overall acceptability using 9 point hedonic scale where 9 = like extremely, 5 = like moderately and 1 = dislike extremely (Iwe, 2002).

Statistical Analysis

Data obtained were analysed using descriptive and inferential statistics. Analysis of Variance (SPSS version 16) was used and means were separated by Duncan multiple range test.

3. Result

The result of the proximate composition of ogi samples is presented in Table 1. There was no significant difference ($p < 0.05$) in the moisture content of sieved and unsieved plain ogi. There was also no significant difference in the moisture content of all the fortified ogi samples with soy paste and spices. Sieved plain soy ogi (R) recorded the highest moisture content (8.29%). There was no significant difference ($p < 0.05$)

in the ash content of sieved soy ogi + spices (SP) and unsieved plain ogi + spices (AV). The highest ash content was recorded by unsieved soy ogi + spices (AZ) (2.12%). Sieved plain ogi recorded the least ash content (0.83%). The low ash content in the plain ogi is similar to the report of ash content of plain ogi from sorghum (Akanbi et al., 2010). Crude protein content of the ogi samples ranged from 9.22% in the plain ogi (R) to 14.56% in the unsieved soy ogi + spices (AZ). There was no significant difference ($p < 0.05$) in the protein content of sieved soy ogi (AQ) and unsieved plain ogi + spice (AV). Crude fibre content of the ogi samples ranged from 3.39% in the sieved plain ogi (R) to 8.26% in the unsieved soy ogi + spices. Sieved plain ogi (R) was significantly low ($p < 0.05$) in fibre content compared to all the other ogi samples. There was no significant difference ($p < 0.05$) in the fibre content of all the unsieved ogi samples irrespective of whether or not soybean paste or spices was added.All the ogi samples were significantly different at $p < 0.05$ in their fat (ether extract) content. Unsieved soy ogi + spices (AZ) recorded the highest fat content (9.07%). This may be due to the fact that soybean and spices are good sources of oil. Carbohydrate content in the ogi samples ranged from 58.17% in the unsieved soy ogi + spices (AZ) to 72.35% in the sieved plain ogi (R). There was no significant difference ($p < 0.05$) in the carbohydrate content of sieved soy ogi + spices (SP) and sieved plain ogi + spices ((RR).

Result of the mineral content in the ogi samples is presented in Table 2. Unsieved soy og + spices (AZ) recorded the highest mineral content in all the minerals evaluated (Na, Ca, Mg, Zn and Fe). AZ was significantly high ($p < 0.05$) in magnesium (Mg) (152.32 mg/100g) and calcium (Ca) (90.28 mg/100g) respectively when compared with all the other ogi samples. This is in line with the ash content in this same sample (AZ) which shows that addition of spices, soybean paste and unsieving method used for this sample improved its mineral content. Likewise all the unsieved ogi samples fortified with spices also recorded high values for minerals. Sieved plain ogi (R) recorded significantly ($p < 0.05$) lower value of mineral content.

Result of sensory evaluation of the ogi samples is shown in Table 3. All the ogi samples were significantly different ($p < 0.05$) in terms of colour. Colour of sieved plain ogi (R) was most preferred. Similarly all the ogi samples were significantly different in terms of appearance. Sieved plain ogi (R) was most preferred in terms of appearance. There was no significant difference ($p < 0.05$) in the flavor of sieved soy ogi (AQ) and unsieved soy ogi (AW). Sieved plain ogi + spices (RR) was the most preferred in terms of flavor. There was no significant difference in the taste of unsieved soy ogi + spices (AZ) and unsieved plain ogi + spices (AV). All the ogi samples were accepted in terms of taste but sieved soy ogi + spices (SP) was most preferred. All the ogi samples were significantly different ($p<0.05$) in terms of texture but sieved plain ogi (R) was most preferred. This is expected due to the fortification of the plain ogi with soy paste and spices which have their own textural characteristics. There was no significant difference ($p < 0.05$) in the overall acceptability of sieved soy ogi + spices (SP) and sieved plain ogi + spices (RR) and sieved soy ogi (AQ). There was also no significant difference ($p < 0.05$) in the overall acceptability of unsieved plain ogi (AR), unsieved plain ogi + spices (AV), unsieved soy ogi + spices (AZ) and unsieved soy ogi (AW). Sieved soy ogi + spices was most preferred in terms of overall acceptability.

Table 1: Proximate composition of ogi samples (% dry weight basis)

Sample	Moisture	Ash	Crude protein	Crude fibre	Ether extract	Carbohydrate
SP	7.80 ± 0.04^{a}	1.16 ± 0.07^{a}	12.33 ± 0.35^{a}	6.09 ± 0.03^{b}	8.98 ± 0.24^{a}	63.19 ± 0.55^{a}
AZ	7.82 ± 0.07^{a}	2.12 ± 0.06^{b}	14.56 ± 0.50^{b}	8.26 ± 0.06^{a}	9.07 ± 0.15^{b}	58.17 ± 0.7^{b}
RR	8.07 ± 0.03^{a}	1.09 ± 0.06^{c}	10.23 ± 0.26^{c}	5.15 ± 0.12^{b}	6.56 ± 0.20^{c}	68.89 ± 0.75^{a}
AV	7.94 ± 0.10^{a}	1.43 ± 0.10^{a}	12.13 ± 0.60^{d}	6.84 ± 0.08^{a}	8.13 ± 0.62^{d}	63.53 ± 0.38^{c}
AQ	8.09 ± 0.25^{a}	1.22 ± 0.50^{bc}	11.41 ± 0.55^{d}	5.83 ± 0.16^{b}	4.20 ± 0.33^{ab}	66.25 ± 0.45^{bc}
AW	7.96 ± 0.15^{a}	1.66 ± 0.10^{ab}	13.04 ± 0.55^{bd}	8.1 ± 0.08^{a}	7.90 ± 0.35^{ac}	61.26 ± 0.80^{ab}
R	8.29 ± 0.04^{b}	0.83 ± 0.15^{ac}	9.22 ± 0.33^{bc}	3.39 ± 0.07^{b}	5.80 ± 0.26^{bc}	72.35 ± 1.1^{d}
AR	8.26 ± 0.16^{b}	1.13 ± 0.06^{bc}	11.45 ± 0.16^{ab}	6.24 ± 0.03^{a}	6.14 ± 0.50^{cd}	66.77 ± 0.85^{b}

Values are means of triplicates. Each value with the same superscript in the same column are not significantly different at $p < 0.05$.

Table 2: Mineral composition of ogi samples (mg/100g dry weight basis)

Sample	Na	Ca	Mg	Zn	Fe
SP	44.80 ± 1.24^{a}	44.16 ± 2.25^{a}	86.92 ± 1.35^{a}	17.36 ± 0.85^{a}	18.85 ± 0.84^{a}
AZ	61.08 ± 1.27^{b}	90.28 ± 1.09^{b}	152.32 ± 2.50^{b}	20.84 ± 0.66^{b}	23.08 ± 1.15^{a}
RR	45.66 ± 0.73^{a}	59.84 ± 1.26^{c}	89.04 ± 1.56^{c}	12.64 ± 1.12^{c}	19.60 ± 1.20^{a}
AV	43.88 ± 2.01^{a}	68.44 ± 0.90^{d}	144.56 ± 0.60^{e}	15.60 ± 1.09^{b}	23.76 ± 0.68^{a}

AQ	55.52 ± 0.65[a]	51.44 ±0.50[c]	78.88 ± 0.75[d]	11.16 ± 0.86 [d]	18.32 ±1.33[b]
AW	48.32 ± 1.15[a]	61.16 ±0.70[d]	136.04 ±0.55[ac]	21.04 ± 0.88[b]	20.52 ±0.35[c]
R	34.24 ± 1.20[c]	35.96 ±0.96[e]	76.56 ± 1.33[bc]	09.96 ± 1.22[ab]	17.44 ± 0.26[d]
AR	45.68± 0.86[a]	59.84 ±1.07[d]	99.04 ±0.80[e]	12.60 ± 0.63[c]	19.60 ±0.62[ab]

Values are means of triplicates. Each value with the same superscript in the same column are not significantly different at p< 0.05.

Table 3: Sensory evaluation of ogi samples

Sample	Colour	Appearance	Flavour	Texture	Taste	Overall acceptability
AZ	5.5 ± 0.8[a]	5.0 ± 0.10[a]	6.8 ± 0.5[a]	4.9 ± 01.5[a]	5.6 ± 0.08[a]	5.9 ± 1.8[a]
SP	7.3 ± 1.2[ab]	6.9 ± 0.4[d]	6.7 ± 0.5[a]	6.9 ± 0.13[b]	7.2 ± 0.10[c]	7.6 ± 1.2[b]
RR	5.0 ± 0.7[b]	5.3 ± 0.6[b]	6.9 ± 0.6[a]	6.4 ± 0.11[c]	6.1 ± 0.12[ab]	6.1 ± 0.8[b]
AV	5.1 ± 1.1[d]	5.1 ± 0.3[bc]	6.6 ± 0.03[a]	5.5 ± 0.13[d]	5.3 ± 0.08[a]	5.7 ± 1.2[a]
AQ	6.7 ± 0.9[cd]	6.5 ±0.2[ad]	6.1 ± 0.3[b]	5.8 ± 0.11[e]	5.6 ± 0.11[ab]	6.3 ± 0.8[b]
AW	7.0 ± 0.6[ac]	6.4 ± 0.2[ab]	6.1±0.56[b]	5.3 ± 0.15[ab]	6.0 ± 0.11[ac]	6.5 ± 1.0[a]
R	7.7 ± 1.1[bc]	7.1 ± 0.3[ab]	6.2 ±0.5[c]	7.3 ± 0.12a[c]	6.80 ± 0.12[c]	7.0 ± 0.9[c]
AR	6.9 ± 0.8[c]	6.2 ± 0.2[c]	6.1 ±0.6[c]	5.6 ± 0.9[bc]	5.7 ± 0.09[b]	6.7 ± 01.0[a]

Means of each attribute followed by the same superscript in the same column are not significantly different at p<.05.

4. Discussion

The study shows that fortification of ogi from maize (*Zea mays)* with soy bean (*Glycine max*) and spices Ginger (*Zingiber officinales*) and Clove (*Syzygium aromaticum*) improve significantly (p< 0.05) the nutrient (proximate and mineral) composition of the ogi samples. Soybean is well known for its high nutrient composition particularly protein. Soybean protein constitutes about 40% of the total solids and plays a very important role in the enrichment of cereal-based food products (Fukushima, 1999). It is also a rich source of fat, vitamins and minerals (Duke, 1981). Spices are very important both as food and as medicine. They are of high health benefit. Ginger and Clove contain high level of antioxidants which help in preventing cell damage caused by free radicals (Biomhoff, 2004). Ginger and clove also contain essential oils such as gingerol and euginol respectively. Addition of soybean and spices contribute immensely to the increase in the protein contents of the fortified ogi samples. The protein content range in the ogi samples is similar to the report of Oyarekua (2011) on millet and sorghum fermented with cowpea. The fat content of soybean and the oil content of the spices also improved the fat content of the fortified ogi samples.

Sieving was found to reduce the nutrient content of the ogi samples as some of these nutrients are lost with the sieving water. Unsieved soy ogi + spices contained the highest protein, fat, ash and crude fibre. It also contained the highest sodium, calcium and magnesium. This is expected because its inherent nutrients coupled with the nutrients supplied by spices and soybean are retained and not loss into sieving water as in the case of sieved ogi. High fibre content contained in the unsieved ogi samples will give the samples high digestibility quality which is of heath benefit to the consumers.

The study also shows that fortification of ogi from maize with soy bean and spices improves the sensory attributes of the ogi. The colour, flavor, texture and taste of ogi when fortified increased significantly (p< 0.05) as shown in sieved soy ogi + spices. However unsieving as a method of processing ogi reduced the acceptability of the ogi samples as most of the sensory attributes such as texture, appearance and taste were affected. The smooth texture and taste of sieved ogi samples were preferred but both the sieved and unsieved ogi samples were accepted.

The study indicates that Ogi processed from maize could be fortified with soybean and spices (ginger and clove) to improve the nutrients composition and health benefits of the ogi and that unsieving method for processing ogi gives ogi better quality nutritional wise by retaining the nutrients but the unsieving method of processing ogi results in low acceptability of the product in terms of sensory attributes.

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