Physico-Chemical Properties Chemical Composition and Acceptability of Instant ‘Ogi’ from Blends of Fermented Maize, Conophor Nut and Melon Seeds

Oluwabukola Ojo D* and Ndigwe Enujiugha V

Federal University of Technology, Akure, School of Agriculture and Agricultural Technology, Department of Food Science and Technology, Akure, Ondo State, Nigeria

Abstract

‘Ogi’ is a popularly known fermented starch of staple cereals such as maize, sorghum and millet. Instant ‘ogi’ production arises from the need to meet the demand for ‘ogi’ among the urban populace in Nigeria and other developing countries. This study was carried out to evaluate the proximate, functional, pasting, mineral, anti-nutrient content and consumer acceptability of ‘ogi’ from blends of fermented maize, conophor nut and melon seed flours (90:5:5, 80:10:10, 70:15:15, 100:0:0). Pasting properties were determined by use of the rapid visco analyser. The mineral elements Ca, Mg, Fe, Zn, Cu, were determined by atomic absorption spectrophotometry while Na and K values were determined by flame photometry. Consumer acceptability of the instant ‘ogi’ was rated best at 5% supplementation level with conophor and melon seed flours (90:5:5) when compared with the control (100% fermented maize).

Keywords: Fermented maize; Instant ogi; Supplementation; Acceptability; Nutritional value

Introduction

‘Ogi’, a fermented maize gruel, is a popular breakfast cereal and infant weaning food in West Africa. Maize (Zea mays) also referred to as corn, is the most important cereal in the world after wheat and rice with regard to cultivation areas and total production Osagie and Eka [1]. Apart from being consumed by humans, it is also used to prepare animal feeds, and useful in the chemical industry. Maize can be cooked, roasted, fried, ground, pounded or crushed Abdulraharan, and Kolawole [2].

The conophor nut plant (Tetracarpidum conophorum) commonly called the African Walnut, is a perennial climbing shrub found in the moist forest zones of Sub-Saharan Africa. It is cultivated principally for the nuts, which are cooked and consumed as snacks, along with boiled corn [3]. Conophor nut commonly called ‘Ukpa’, ‘asala’, ‘awusa’ in some parts of southern Nigeria is one of the several high nutrient dense food with the presence of protein, fibre, carbohydrate and vitamins [4]. Conophor nut is a rich source of minerals such as calcium, magnesium, sodium, potassium, and phosphorus [5] A bitter after taste is usually observed upon drinking water immediately after eating conophor nut and this could be attributed to the presence of alkaloids and other anti-nutritional and toxic factors. Ripe conophor nuts are mostly consumed in the fresh or toasted form or used in cakes, desserts and confectionaries.

Melons are food crops with several varieties which serve as a major food source. Melon seeds are generally rich in oil and are a good source of protein. The seed contains about 44% oil and 32% protein [6]. It has both nutritional and cosmetic importance and is rich in vitamin C, riboflavin and carbohydrates. Melon seed is a good source of amino acids such as isoleucine and leucine [7]. It also contains palmitic, stearic, linoleic and oleic acids important in protecting the heart. It can serve as an important supplementary baby food, helping to prevent malnutrition. The objective of our study was to determine the effect of supplementing fermented maize flour at different levels with conophor nut and melon seed flours in the production of instant ‘ogi’.

Materials and Methods

Raw material source and collection

White maize (Zea mays), melon seed (Citrullus lanatus) and conophor nut (Tetracarpidum conophorum) were obtained from the local ‘Oba’ market in Akure, Ondo State, Nigeria.

Processing of fermented maize flour

The maize grains were cleaned and sorted by removing the pest-infested grains and discoloured ones. It was then steeped for 72 h at room temperature and the steep water was decanted while the fermented grain was washed with portable water and wet-milled. It was then wet-sieved and the slurry was allowed to ferment for 24 h. It was afterwards decanted, dried at 70°C for 4 h and milled using hammer mill. The fermented maize flour was then sieved to obtain a finer particle (630 µm mesh size) and packaged in air-tight containers prior to analysis. The production chart is presented in Figure 1.

Processing of melon seed flour

The melon seeds were sorted to remove the discoloured ones and then dried at 65°C for 6 h, milled with hammer mill and was defatted using n-hexane as the solvent for 6 h. The defatted melon was air dried and milled using hammer mill. The melon flour was then sieved to obtain a finer particle and packaged in air-tight containers prior to analysis. The production chart is shown in Figure 2.

Processing of conophor nut flour

The conophor nuts were cleaned to remove debris and dirt and cooked at 100°C for 1 h. It was then shelled to obtain the kernels. The kernels were dried at 50°C for 8 h, milled with hammer mill and defatted using n-hexane as solvent for 6 h. The defatted conophor nut...
by subtracting the sum of the percentage weight of crude protein, crude fibre, ash, fat from 100 percent.

**Functional properties analysis**

For the determination of functional properties, the method of Onwuka [9] was used for the determination of Water/Oil absorption capacity. Bulk density and Swelling index were determined by the method described by Ukpabi and Ndimele. The rotating spindle method described in the Encyclopedia of Industrial Chemical Analysis E.I.C.A [10] was employed in viscosity determination.

pH was determined using a pH meter (Model: S90526, Fischer Scientific Ltd., Singapore). The method of Jitngarmkusol et al. [11] with some slight modifications was used for the determination of the foaming capacity and stability of the instant ‘ogi’ flour blends. Emulsion capacity was determined by the method of Yasumatsu et al. [12] Least gelation concentration (LGC) of the flour blends was determined using the modified method of Coffman and Garcia [13] Solubility index were determined as described by Takashi and Sieb [14] using a SPECTRA UK (Merlin 503) centrifuge. Reconstitution index were also determined as described by Banigo and Akpapunam [15].

**Pasting properties analysis**

The pasting properties of the samples were determined using a rapid visco–analyser (Model: NEWPORT SCIENTIFIC, NSW, Australia) as described by Adeyemi et al. [16] The peak, viscosity, trough, breakdown, final viscosity, set back, peak time and pasting temperature were read with the aid of Thermocline for Windows Software connected to a computer.

**Mineral elements analysis**

The mineral elements Ca, Mg, Fe, Zn, Cu, were determined using atomic absorption spectrophotometer (Model: PYE UNICAM SP9, Cambridge, UK). Flame photometer (JENWAY PFP7, Bibby Scientific Ltd, Staffordshire, U. K.) was also used to measure the values of Na and...
K in all the samples and Phosphorus (P) was determined as described by AOAC [8].

Anti-nutrients content analysis

For anti-nutrients content analysis, tannin content was determined by the method of Makkar and Goodchild [17] Oxalate content was determined by the method of Nwika et al. [18] and phytate content was determined by the method of Latta and Eskin [19].

Sensory evaluation

The instant ‘ogi’ was made into slurry by adding water till it formed a paste and boiled water was added to it and stirred continuously till it became viscous and formed a gruel. The products were evaluated for taste, appearance, aroma, and overall acceptability by a panel of ten members using a 9-point Hedonic scale. The rating of the samples ranged from 1 (dislike extremely) to 9 (Like extremely).

Statistical analysis

The data obtained were analyzed using a one-way Analysis of Variance and the means separated by Duncan New Multiple Range Tests (DMNRT) at 5% significance level (SPSS version 19 computer software) [20].

Results and Discussion

Proximate chemical composition of the instant ‘ogi’ flour blends

The proximate composition of instant ‘ogi’ from blends of fermented maize, conophor nut and melon seed flours is presented in Table 1. The increase in the protein value of the flour was due to the supplementation of the maize flour with melon seeds and conophor nuts. Low fat content of the flour coupled with the low moisture content of the flour blends is an indication that the samples will be stable during storage. According to Adeyemi and Beckey [24], the low moisture content of the samples would hinder the growth of micro-organism and increase the shelf life of the samples. Sample SPB had the highest crude fibre content. According to Norman and Joseph [22], fibre has an important role in providing roughage or bulk that aids in digestion, softens stool and lowers plasma cholesterol level in the body. Increased melon/conophor nut flour substitution gave progressively higher protein, crude fibre and ash contents of the samples while fat and carbohydrate contents were reduced. Crude protein, ash and crude fibre were significantly different in the four samples; however, there were no significant differences in the fat content of samples BPO and SPB.

Functional properties of the instant ‘ogi’ flour blends

According to Oyerekua and Adeyeeye [22] high water absorption capacity (WAC) is desirable for the improvement of mouth feel and viscosity reduction in food products. According to Afoakde and Sefa-Dedeh [23], WAC and OAC in the blended flour might be due to the thickness of interfacial bi-layer model of protein to protein interaction. Sample BPC had the lowest oil absorption capacity. The reduced value of OAC in Sample BPC might be due to collapse of the flour blend proteins thereby increasing the contact between protein molecules leading to coalescence and thus reduce stability of the samples. Bulk density is an important factor in food products handling, packaging, storage, processing and distribution. It is particularly useful in the specification of products derived from size reduction or drying processes.

Bulk densities of the samples were similar to that reported by Adeyemi and Beckey [24]. The bulk densities ranged from 0.66-0.90 g/ml with sample POS having the highest value which indicate that its packaging would be economical. Plaami [25] reported that higher bulk density is desirable, since it helps to reduce the paste thickness which is an important factor in convalescent and child feeding. Viscosity ranged from 0.61-0.70 DPa with samples SPB and BPC having the highest value. pH is important in determining the acid factor which is an indicator of the rate of conversion of starch to dextrin. The pH value ranged from 5.70-6.60. The foaming capacity ranged from 1.38%-10.00% with BPO having the highest value. The increase in foaming capacity with melon and conophor nut supplementation might be due to soluble proteins and higher emulsion capacity; this might make it a better flavor retainer and enhance mouth feel [26]. It has also been reported that foam capacity is related to the rate of decrease of the surface tension of the air/water interface caused by absorption of protein molecules [27]. The foaming stability of the flour increased with increment in the supplementation level of the flour though sample SPB had the highest value. Sample BPC had the highest value for least gelation capacity. The emulsion capacity ranged from 50.20%-78.15%, with sample BPO having the highest value. High level of least gelation capacity means less thickening capacity of food; the contents ranged from 6.0%-18.0%. Reconstitution index ranged from 3.61-5.05 ml/g with Sample POS (control) having the highest value. The functional properties of the instant ‘ogi’ flour blends are shown in Table 2.

Pasting characteristics of the instant ‘ogi’ flour blends

Table 3 shows the results of the pasting characteristics of the instant ‘ogi’ flour blends. The pasting properties of the samples BPO, SPB, BPC and control (POS) were significantly different (p < 0.05). Peak viscosity of the instant ‘ogi’ samples ranged from 133.51-213.83 RVU, the values were observed to reduce with increase in supplementation levels. Final viscosity is a measure of stability of the cooked sample [28]. The final viscosity ranged from 145.67-243.59 RVU with BPO having the highest value; this implies that highly viscous paste can be formed during cooking. The setback value is a measure of retrogradation the cooked sample and it ranged from 60.17-108.58 RVU with BPO having the highest value. Pasting temperature is also a measure of the temperature at which flour viscosity begins to rise during cooking, it provides information on the cost of energy required to cook the instant ‘ogi’ [24]. The pasting temperature of the instant ‘ogi’ ranged from 83.65°C to 94.75°C with BPC having the highest value. The pasting time ranged from 5.36-5.85 sec, with POS having the highest value.

Mineral content of the instant ‘ogi’ flour blends

Table 4 shows the mineral contents of the instant ‘ogi’ flour blends.

| Samples   | BPO  | SPB  | BPC  | POS  |
|-----------|------|------|------|------|
| Moisture  | 4.73 ± 1.09a | 4.73 ± 1.09a | 4.73 ± 1.09a | 4.73 ± 1.09a |
| Ash       | 9.01 ± 0.72a | 1.80 ± 0.00a | 2.44 ± 0.00a | 2.98 ± 0.00a |
| Crude fibre | 5.94 ± 0.87b | 1.14 ± 0.12b | 3.96 ± 0.01b | 3.96 ± 0.01b |
| Fat       | 5.55 ± 1.11b | 0.44 ± 0.12b | 5.20 ± 0.28b | 5.20 ± 0.28b |
| Carbohydrate | 5.94 ± 0.87b | 1.14 ± 0.12b | 3.96 ± 0.01b | 3.96 ± 0.01b |

Values are means ± standard deviation of triplicate determinations.

Key: BPO = 70% fermented maize flour, 15% melon flour, 15% Conophor nut flour; SPB = 80% fermented maize flour, 10% melon flour, 10% conophor nut flour; BPC = 90% fermented maize flour, 5% Melon flour, 5% Conophor nut flour; POS = 100% fermented maize flour.
Seed flours
Values with different superscript in a row are significantly different (p < 0.05). Values are means ± standard deviation of triplicate determinations.

| Antinutrient  | BPO | SPB | BPC | POS |
|---------------|-----|-----|-----|-----|
| Ph (mg/100 g) | 6.60 ± 0.00a | 6.20 ± 0.00a | 5.70 ± 0.00a | 6.20 ± 0.00a |
| WAC (%) | 660.00 ± 0.70a | 680.00 ± 0.28b | 660.00 ± 0.56b | 665.00 ± 0.63b |
| OAC (%) | 830.00 ± 0.70a | 870.00 ± 0.21a | 800.00 ± 0.28b | 820.00 ± 0.20a |
| EC (%) | 78.15 ± 0.21a | 75.20 ± 0.28a | 75.20 ± 0.35a | 53.25 ± 0.47b |
| Viscosity (dPa) | 0.71 ± 0.01a | 0.70 ± 0.01a | 0.70 ± 0.01a | 0.61 ± 0.01b |
| RI (m/s) | 3.61 ± 0.02c | 3.62 ± 0.03c | 4.35 ± 0.07b | 5.05 ± 0.07a |
| BD (g/ml) | 0.86 ± 0.00d | 0.71 ± 0.00a | 0.76 ± 0.00a | 0.90 ± 0.00b |
| FC (%) | 10.00 ± 0.00c | 9.85 ± 0.03c | 4.28 ± 0.02b | 1.38 ± 0.01a |
| FS (%) | 4.28 ± 0.03b | 5.63 ± 0.02c | 1.42 ± 0.01a | 1.38 ± 0.01a |
| SI (v/v) | 3.61 ± 0.02c | 3.62 ± 0.03c | 4.35 ± 0.07b | 5.05 ± 0.07a |
| LGC (%) | 18.00 ± 0.00d | 14.00 ± 0.00a | 20.00 ± 0.00a | 6.00 ± 0.00b |

Table 2: Functional properties of instant 'ogi' from blends of fermented maize, conophor nut and melon flour and meal.

Sensory evaluation of gruel of instant 'ogi' from blends of fermented maize, conophor nut and melon seed flours
Table 6 shows the sensory evaluation results of the instant 'ogi' flour blends. Sensory evaluation was carried out by ten (10) untrained panelists and the parameters evaluated were taste, flavor, appearance and overall acceptability. Consumer evaluation of taste showed that blends. Calcium value decreased with increase in supplementation level but magnesium content increased. Magnesium is well known to be important in cellular energy production and enzyme activity, its value ranged from 106.06-126.03 mg/100 g. Iron (Fe) ranged from 9.87-11.70 mg/100 g with the sample BPC having the lowest value. The instant 'ogi' flour blends provides a good amount of iron that is needed in the production of haemoglobin which carries oxygen in the blood.

Anti-nutrient content of the instant 'ogi' flour blends
Table 5 shows the level of anti–nutrients in the instant 'ogi' flour blends. The phytate content of the ogi flour blends ranged from 5.25-5.96 mg/g. Phytate are known to form complexes with iron, zinc, calcium and magnesium making them less available and thus inadequate in food samples especially for children however, the phytate content of the ogi flour blends are far lower than the minimum amounts of phytic acid reported by Siddhuraju and Becker [29] to hinder the absorption of iron and zinc. Oxalates are also known to make complexes with calcium to form an insoluble calcium–oxalate salt. Siddhuraju and Becker [29] reported a safe normal range of 4-9 mg/100 g for oxalates. The oxalate content of the samples which range from 2.48 - 2.67 mg/100 g is quite lower than the reported value. Tannin content range from 4.65–5.85 mg/100 g. Tannins have been implicated in the interference of iron absorption; it usually forms insoluble complexes with proteins, thereby interfering with their bioavailability [30-32].
there were no significant differences between sample BPC and SPB. Sample BPC were also rated higher than SPB in terms of appearance and aroma. In terms of overall acceptability, Samples BPC and SPB compared favourably with the control (POS) and there were no significant differences between them.

**Conclusion**

The study has shown that fermented maize- conophor nut-melonogoni flour with improved nutrient s, pasting properties and sensory quality compared to the traditional fermented maize ‘ogi’ flour can be obtained up to 80:10:10 ratio. Conophor and melon seeds which are under-utilized are suitable for use in instant ‘ogi’ flour production. The production of instant ‘ogi’ from fermented maize- conophor nut-melon flour makes the local food product ‘ogi’ readily available for consumption, increases its variety, hence, consumer choice of ‘ogi’.

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