PROXIMATE COMPOSITION AND SENSORY QUALITIES OF AMARANTH-*OGI* FROM GRAIN AMARANTH (*AMARANTHUS HYBRIDUS*)

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Abstract
Grain amaranth (Amaranthus hybridus) is an emerging pseudo-cereal with great potentials as a ready source of nutrients for the growth and development of children. However, it has not been adequately utilised in the Nigerian food industry. Amaranth-ogi was developed from grain Amaranth which was fermented for 24, 48 and 72 h. The proximate analysis of the raw grain amaranth, Amaranth-ogi and ogi produced from maize was carried out using AOAC standards. Consumer acceptability and sensory quality with overall acceptability of the products were assessed using 10 semi-trained panellists. The raw grain Amaranth contained percentage moisture (10.24); crude protein (16.86), crude fibre (2.50), fat (5.77), ash (2.90) and carbohydrate (61.77) which reduced significantly (p<0.05) with increased fermentation time when Amaranth-ogi was produced. Amaranth-ogi samples possessed percentage crude protein ranging from 10.73 – 14.68; crude fibre (1.92 - 2.62); fat (2.88 – 4.22); ash (1.11- 2.12. However, an increase in the percentage carbohydrate content was observed with increase in fermentation time from 66.52 – 71.00. Maize-ogi possessed percentage moisture (12.48); crude protein (6.57); crude fibre (1.33); crude fat (3.93); ash (0.82) and carbohydrate (74.87). Amaranth–ogi samples possessed significantly higher (double) percentage crude protein (10.73 – 14.68) and ash (1.11 – 2.12) than Maize-ogi (6.57, 0.82), respectively (p<0.05), with increased fermentation time. Amaranth-ogi was successfully produced from the grain amaranth, with enriched nutritive values. Amaranth-ogi that was fermented for 48 h was mostly preferred by the sensory evaluation panellists. Amaranth-ogi samples that were fermented for 48 h and 72 h had better overall acceptability than maize-ogi.

Keywords: Grain Amaranth, amaranth-ogi, pseudo-cereals, fermentation, food security, malnutrition, Amaranthus hybridus.

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1. INTRODUCTION

Amaranth is an herbaceous, erect, annual plant belonging to the Amaranthaceae family (Cai et al., 2004). Recent worldwide food research programmes are exploiting its low anti-nutritive content, very small starch granules, higher vitamins content (especially, folic acid), higher protein content and better protein quality, higher mineral (magnesium, potassium, manganese, phosphorus, copper, iron, calcium and zinc) content when compared to cereals (Bressani, 1994 and Gamel et al., 2006).

Amaranth is a multi-purpose crop with high nutritional quality grains and leafy vegetables for food and animal feed (Grobelnik-Mlakar, 2009). It is a pseudo-cereal regarded as a good source of protein and non-saturated fatty acids. There is gradual increase in interest in amaranth recently due to its high nutritional values (Hauptli, 1977). The plant is resistant to drought, and can be produced in a short time with high yield. The grain has high nutritional value (Andrasofszky et al., 1998). The nutritional composition of amaranth has been described to be excellent, with protein content higher than cereals species with a better quantity. The lipid or fat content is higher compared to most cereal species.

Malnutrition afflicts more people today in the developing countries and the staple cereals (wheat, corn, sorghum, rice, millets, oats, barley, and triticale) are not nutritionally sufficient to combat it. Infants and pre-school children are the most vulnerable to the health and nutrition disorders. There is therefore an imminent need to introduce some other food crops into commercial and production systems. The availability of affordable and nutritious alternative grains such as amaranth grain, a pseudo-cereal, could alleviate poverty and nutrition insecurity in the developing nations, like Nigeria, particularly among children and women of child bearing age (Oshundahunsi and Aworh, 2003).

Ogi (a lactic acid-fermented porridge) is a popular semi-solid staple food of tropical West African nations. Ogi is traditionally made from maize, millet or sorghum, sold as a wet cake, wrapped in leaves or transparent polythene packs. It is either boiled into a thin porridge, "pap", or a thick porridge, "eko" or "agidi", before consumption. It is mostly consumed in most homes as a popular weaning food by infants, standard breakfast by children and adults and a convenient meal for nursing mothers and the convalescents in Nigeria (Ashaye et al., (2000); Faber et al., (2001); Teniola and Odunfa, (2002); Omemu, (2011)). In south western Nigeria, the wet ogi cake is reconstituted in about 80 - 85% water and administered to people with diarrhoea to reduce the frequency of stooling (Aderiye and Laleye, (2004). Ashaye et al., (2000) reported that ogi is poor in protein and essential nutrients because during processing, some of the protein, most of the ash and nearly all the crude fibre are lost in the steeping and wash water.

Producing Ogi with Amaranth grain provided a traditional food item with improved nutritive values. Therefore this research work focused on the development of Amaranth Ogi from the Amaranth grain.

2. MATERIALS AND METHODS

Production of amaranth *ogi*

Fresh grain amaranth was obtained from National Institute of Horticultural Research and Training (NIHORT), Ibadan while chemical reagents of analytical grade were purchased at local stores in Akure and Ibadan.

Amaranth ogi was produced using the modified method of Omemu and Adeosun (2010) as presented in Figure 1. The grain amaranth was manually cleaned (to remove dirt and sand) and 500 g each, of the cleaned grains was weighed into three different transparent plastic containers. The samples were washed and steeped in 1 litre of water for 12, 24 and 36 h, respectively, to obtain three fermented samples (24AO, 48AO and 72AO). At the end of each fermentation period at 29 ± 2 °C, the samples were washed with water, wet-milled, and wet-sieved with a white muslin cloth to remove bran, hull and germ, left to sediment and further ferment for 12, 24 and 36 h, respectively after which the souring water was decanted. The starchy slurry (Amaranth ogi) was weighed, packaged sterilisable plastic containers, labelled as 24AO, 48AO and 72AO (Amaranth-Ogi fermented for 24, 48 and 72 h), respectively.

Fresh Grain Amaranth
↓
Cleaning
↓
Washing
↓
Steeping (Cold water; 12-36 h)
↓
Wet milling
↓
Wet-sieving
↓
Fermentation/Sedimentation (12-36 h)
↓
Decanting
↓
Packaged amaranth *ogi*

Fig. 1: Production of amaranth *ogi*.
Source: Omemu and Adeosun, 2010

Proximate Analyses

The proximate analyses such as ash, carbohydrate, crude fibre and fat contents were determined, using AOAC 2005 standard methods. The pH of each sample was determined using the method described by Adebayo *et al.*, (2009) and Nwachukwu *et al.*, (2010). The mole titration method (Pirie, 1975; Akoh, 1981) was used for the determination of protein and moisture content determination was based on loss on drying at an oven temperature of 105 ºC (AOAC, 2005; Akoh, 1981).

Sensory Evaluation

The consumer acceptability and sensory quality in terms of aroma, colour, taste, mouth feel and overall acceptability of the Amaranth-*ogi* was assessed and evaluated in comparison with the conventional Maize *ogi* using 10 panelists. The samples were served in clean bowls, presented randomly and one at a time to each panellist. A 9-point Hedonic scale was used in the scoring, with 1 being 'like extremely' and 9 being 'dislike extremely' ((1 = Like extremely, 2 = Like very much, 3 = Like moderately, 4 = Like slightly, 5 = Neither like nor dislike, 6 = Dislike slightly, 7 = Dislike moderately, 8 = Dislike very much, 9 = Dislike extremely). The mean scores were subjected to analysis of variance (ANOVA) at probability of 5% ($p\leq 0.05$) (Fapohunda and Adeware, 2012).

Statistical Analysis

The results obtained were subjected to statistical analysis using one-way analysis of variance (ANOVA) and the means were separated by using Duncan's New Multiple Range Test (DNMRT).

3. RESULTS AND DISCUSSION

Proximate Composition

The result of proximate analyses of raw grain amaranth, Amaranth-*ogi* fermented for 24 to 72 h and Maize-*ogi* fermented for 72 h, respectively, are shown in Table 1. From the table, percentage crude protein (16.86), crude fibre (2.50), fat (5.7), and ash (2.90) in raw grain amaranth (GA) decreased significantly ($p<0.05$) with increased fermentation time when processed into amaranth-*ogi*. The proximate composition of the Amaranth–*ogi* samples varied ($p<0.05$) with fermentation time. The percentage crude protein, crude fibre, fat and ash content reduced significantly ($p<0.05$) with increased fermentation time (24 – 72 h), ranging from 14.68 – 10.72, 2.62 – 1.92, 4.22 – 2.88 and 2.12 – 1.11, respectively. The reduction in the values might be due to loss of the nutrients which might have dissolved in the decanted steep water during the fermentation process. The increased percentage moisture content was not significant while the increased carbohydrate was ($p<0.05$), with increased fermentation time. Maize-ogi, on the other hand, possessed percentage moisture (12.48); crude protein (6.57); crude fibre (1.33); crude fat (3.93); ash (0.82) and carbohydrate (74.87). When compared with Maize-*ogi* fermented for 72 h, the proximate composition of Amaranth–*ogi* samples was significantly better ($p<0.05$). All the Amaranth–*ogi* content significantly higher percentage crude protein (10.73 – 14.68) and lower carbohydrate (66.52 – 71.01) than Maize-*ogi* (6.57, 74.87), respectively, with increased fermentation time, which could be exploited in treating protein-energy malnutrition (PEM) in children up to age 5 years old and serve as a means to contribute to food security in Africa.

The significantly higher percentage ash content in Amaranth–ogi ($p<0.05$) implies higher mineral content which could also be exploited to combat vitamin and mineral deficiencies in both children and adults in Africa.

Table 1: Proximate composition of raw grain amaranth, a*maranth-ogi*, and maize *ogi*

	Moisture %	Crude Protein %	Crude fibre %	Fat %	Ash %	Carbohydrate %
GA	10.2400^{a}	16.8633^{e}	2.5000^{c}	5.7667^{d}	2.9033^{e}	61.7700^{a}
24AO	11.7600^{a}	14.6833^{d}	2.6167^{c}	4.2233^{c}	2.1167^{d}	66.5233^{b}
48AO	12.4800^{a}	12.8300^{c}	2.1167^{b}	3.4667^{b}	1.6767^{c}	67.2533^{b}
72AO	12.9367^{a}	10.7267^{b}	1.9167^{b}	2.8500^{a}	1.1133^{b}	71.0067^{c}
MO	12.4833^{a}	6.5667^{a}	1.3333^{a}	3.9333^{b}	0.8167^{a}	74.8667^{d}

Mean values followed by different subscripts within columns are significantly different by New Duncan's multiple range tests ($p< 0.05$; n = 10).

Key:
GA = Grain amaranth,
24AO = Amaranth-*ogi* fermented for 24 h,
48AO = Amaranth-*ogi* fermented for 48 h,
72AO = Amaranth-*ogi* fermented for 72 h,
MO = Maize-*ogi* fermented for 72 h.

Table 2 Sensory Qualities of *ogi* samples

Sensory attribute /sample	Aroma	Colour	Mouth feel	Taste	Overall acceptability
24AO	7.7±0.2^c	7.4±0.2^c	7.3±0.6^c	7.4±0.3^c	7.6±0.3^c
48AO	1.5±0.2^a	1.5±0.2^a	1.2±0.1a	1.5±0.5^a	1.5±0.3^a
72AO	2.0±0.3^a	1.9±0.3^a	2.1±0.2^a	1.9±0.2^a	2.0±0.2^a
MO	3.8±0.3^b	3.9±0.3^b	4.1±0.3^b	3.9±0.3^b	3.9±0.2^b

Values are mean sensory scores by panelists ± standard deviation.
Mean values followed by different subscripts within columns are significantly different by New Duncan's multiple range tests ($p< 0.05$; $n = 10$).
Key:
24AO = Amaranth-*ogi* fermented for 24 h,
48AO = Amaranth-*ogi* fermented for 48 h,
72AO = Amaranth-*ogi* fermented for 72 h,
MO = Maize-*ogi* fermented for 72 h.

Sensory evaluation results as shown in Table 2 indicated that Amaranth-*ogi* that was fermented for 48 h was the most acceptable to the sensory evaluation panellists, particularly mouth feel (1.2), while the least acceptable was Amaranth *ogi* that was fermented for 24 h Amaranth-*ogi* which was fermented for 72 h was acceptable next to that which was fermented for 48 h and was even more acceptable than Maize-*ogi* which was also fermented for 72 h. Maize-*ogi* recorded higher scores for all the parameters examined than Amaranth-*ogi* which was fermented for 24 h. All the parameters examined for sensory evaluation of all the samples of Amaranth *ogi* were significantly different ($p<0.05$). Amaranth-*ogi* that was fermented for 48 h had the best mean sensory scores (1.2 - 1.5) for all the parameters examined which depicted like extremely and like very much on the 9-point-hedonic scale. The mean sensory scores (3.8 – 4.1) for all the examined parameters in 24AO indicated that the sample was liked slightly and might be due to the short fermentation time which might not have encouraged the development of the aroma and taste components desired by the panellists. The longer fermentation time exploited in MO could also explain the reason why the sample was better scored for all the examined parameters than in 24AO.

4. CONCLUSION

Grain Amaranth has been established to possess the potentials for production of ogi with higher nutritive values and preferred overall acceptability at 48 h fermentation, as compared to the usual practice of 72 h with maize.
It has been established in this study that Amaranth-ogi contained twice as much protein and ash as in Maize-ogi. hence, the possibility of increasing the usefulness of grain Amaranth as a new crop and a novel ingredient to fight Protein Energy Malnutrition (PEM), vitamin and mineral deficiencies, thereby, contributing to food security, at household and industrial levels.
Further study is therefore recommended to evaluate the quality and quantity of the micronutrients (vitamin and mineral) composition of Amaranth-ogi. Utilisation of grain Amaranth for various food products and its integration into the food systems at all levels will be worthwhile.

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5. REFERENCES

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