JABU Journal of Science and Technology (2016, Vol 2:4)

Proximate composition and heavy metal content of bread: A case study of Ikeji Arakeji and Ipetu Ijesa, Osun State, Nigeria

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Abstract

Consumers' acceptability of bread should be dependent on both its nutritive and safety values. In assessing these values, nine composite samples of bread were widely sampled over three months, (Feb. - April 2011, in two towns in Ori-Ade Local Government Area of Osun State. Standard methods were used to determine the proximate composition (moisture, ash, protein, crude fibre, fat and carbohydrate contents) of the samples and trace metals (Pb, Cr, Co, Cu and Zn) were analysed using Atomic Absorption Spectrophotometer. Results of proximate composition, in %, as ordered above occurred in the ranges 1.96-4.32, 0.22-0.51, 1.21-7.91, 1.96-2.52 and 57.06-74.92 while those of trace metals, in mg/kg, were not detected (n.d)-0.30, 0.32-1.49, n.d-0.06, 0.03-0.21, n.d-0.41 and n.d-0.01. Apart from crude fibre content which in all the samples had values similar to those found in wheat flour used in making bread, values for other proximate components were low. Similarly, values for Co, Ni and Zn in all the bread samples were lower than results of Khaniki *et al*., 2005, Naghipour *et al*., 2014, Onianwa *et al*., 2001 and Al-Kamil, 2011 while Pb, Cu and Zn were not detected in any sample from Ikeji Arakeji. All the bread samples could therefore be said to be safe for consumption but some lack essential nutrients for acceptability by consumers.

Keyw*ords:* *Bread, Proximate composition, Heavy metal*

INTRODUCTION

Bread is a common food in Nigerian. Its consumption cuts across people of different age, religion and status. A number of types exists and with varying composition depending on the source of raw materials and recipe for formulation. Bread has been described by Dewettinck *et al*. (2008) as a fermented confectionery produced mainly from wheat flour, water, yeast and salt by a series of processes involving mixing, kneading, proofing, shaping and baking. Other constituents are improvers and additives. As food, bread quality and safety are important. While the former deals with characteristics that appeal to sight, taste and nutritional value thus determining its acceptability to consumers, the latter concerns absence or acceptable levels of contaminants or other substances that make it injurious to consumers' health.

Generally, food is important for life's sustenance but unsafe food could be detrimental to health and pose a threat to life. Report by Deman (1990) states that human cells need forty-five chemical components and other elements called essential nutrients to be present in adequate healthy food. Aside oxygen and water, the remaining forty-three are grouped into the five main classes of carbohydrate, protein, fat, minerals and vitamins. A nutritive and well-balanced diet should be made of foods which supply all these essential nutrients.

Apart from the nutrients, trace elements, including heavy metals, are also important in nutrition either for their essential nature or toxicity. Mahindru

(2004) and Alegria *et al*. (1990) reported that copper, manganese, selenium, chromium, iron, zinc and molybdenum are examples of trace elements that are important in human diet. Excessive intake of zinc has been linked with copper deficiency (Bhutta, 2000) while lead exposure causes brain damage and this is more severe in young children. This work was therefore carried out to determine the nutritive and the safety values of bread produced and consumed in two towns, Ikeji Arakeji and Ipetu Ijesa, in Osun State indwelt by an ample number of Staff of Joseph Ayo Babalola University. These will be based on the trace metal composition of bread samples which has been done in a few other places and its proximate composition, one that is seldom found in literature.

MATERIALS AND METHODS

Sample collection

Ipetu Ijesa lies on latitude 7.467°, longitude 4.883° and has a higher land area and population than Ikeji Arakeji, a town on latitude 7.430°, longitude 4.948°. Both towns are in Oriade Local Government Area, Osun State, South-West Nigeria. Bread samples (1 to 6) were obtained randomly from markets, bus-stops, bread vendors and bakeries to form six composite samples from Ipetu Ijesa and three (7 to 9) from Ikeji Arakeji. These were kept in nylons and taken to the laboratory.

Quality control

Chemicals used for the work were of analytical grade and the water was glass-distilled. The containers utilized were soaked in solution of dilute trioxonitrate (V) acid, washed and well rinsed. Blank determination was carried out and the results deducted from those of samples. Standard solutions of metals of interest were prepared with appropriate salts and employed in calibrating the AAS (PerkinElmer A Analyst 200 Atomic Absorption Spectrometer Version 3.0) used for analyzing trace metals.

Proximate analysis and trace metal determination

Determination of moisture content

A clean dry crucible was weighed and used to get 2 g sample to obtain a total weight (W1). This was placed in an oven, gradually heated to 105 °C and maintained at this temperature for 6 hours. It was thereafter cooled in a dessicator and weighed again. The process was repeated until a constant weight (W2) was obtained. Percentage moisture content was calculated using the formula: % moisture content = 100 (W1 – W2)/(W1) (Joslyn, 1970).

Determination of ash content

A crucible earlier washed and dried was weighed. Moisture-free sample (5 g) was then placed in it to obtain a total weight (W1). This was placed in a muffle furnace and heated at 550 °C for 3 hours to obtain the ash. The ashed sample was weighed (W2) after cooling in a dessicator. Percentage ash content was calculated as 100 (W1 – W2)/(W1) (Joslyn, 1970).

Determination of crude fibre

A sample (3 g) was weighed (W1) into an extraction apparatus. It was extracted three times using light petroleum ether by stirring, settling and decanting. The extracted sample was air-dried and transferred to a clean dry 100 cm^3 conical flask. A 0.1275 M sulphuric acid (80 cm^3) taken at room temperature and brought to its boiling point was added to the sample in the conical flask and heated for 30 minutes. The flask was rotated after every few minutes to remove particles from the side and mix the content. A plate was perforated and filter paper placed to cover the holes in it. The plate was fixed to a Buchner funnel and the mixture immediately poured into it. Adjustment was done to the funnel so that filtration was completed within 10 minutes. The insoluble matter was washed several times with boiling water until free from acid. It was transferred back to the conical flask and 0.313 M (80 cm^3) NaOH measured at

ordinary temperature and brought to boiling point was added and heated for 30 minutes. The mixture was was then allowed to stand for a minute and then filtered immediatelly. The insoluble material was transferred to the filter paper by means of boiling water and then washed with 1 % hydrochloric acid and again with boiling water until free from acid. It was thereafter washed twice with ethanol and thrice with ether. The insoluble material was then transferred to a dry and weighed crucible. It was repeatedly dried at 100 °C, cooled and weighed to a constant weight (W2). The crucible and its content were then placed on a heating mantle in a fume cupboard to burn off the organic matter. It was then transferred to a muffle furnace, heated at 550 °C for 3 hours, cooled and the ash content weighed as W3 (A.O.A.C., 1990).

Determination of crude fat

Sample (3 g) was weighed (W1) into a folded fat-free filter paper and a small cotton wool placed on it. This was properly tied with thread at both ends and weighed (W2). It was then placed in the extraction thimble and a small amount of cotton wool placed on top. The apparatus was connected after the addition of 300 cm^3 (60-80 °C) petroleum ether. Extraction was carried out for 3 hours using heating mantle with continuous flow of water in the condenser. The sample was thereafter removed, air-dried, placed in an oven and heated at 80 °C. Heating, cooling and weighing were carried out until a constant weight (W3) was obtained (A.O.A.C., 1990).

Determination of crude protein

Sample (0.15 g) was weighed and transferred into Kjeldahl digestion flask. Catalyst (0.8 g) and concentrated sulphuric acid (2 cm^3) were then added to the sample in the flask. The content of the flask was then heated on the heating mantle for 1 hour until the liquid became clear. The digest was cooled and made alkaline using 15 cm^3 of 40 % NaOH. This was then transferred to the distillation apparatus using minimum volume of water. The ammonia steam distilled into 2 % boric acid (10 cm^3) with 5 drops of methyl red indicator for 15 minutes. The distilled ammonia was then titrated with 0.02 M hydrochloric acid. The method was used to determine nitrogen and the value got was multiplied by 6.25 to obtain crude protein (Barenholz, 2002).

Determination of total carbohydrate

The crude carbohydrate content was determined by difference in 100 % and the sum of percentages of moisture, fat, crude fibre and protein.

Determination of trace metals

Sample (5 g) oven-dried at 60 °C was weighed into a dry clean crucible. This sample was ignited in a muffle furnace at 500 °C for 6-8 hours to obtain a greyish white ash. It was cooled on an asbestos sheet and 5 cm^3 of 1 N HNO_3 added to it. To obtain a more perfect greyish white ash, it was evaporated to dryness by heating on a hot plate at 400 °C for 15 minutes. This ash was cooled on an asbestos sheet, 10 cm^3 of 1 N HCl was added and the content was filtered into 50 cm^3 volumetric flask. A solution (10 cm^3 portion) of 0.1 N HCl was used to wash the crucible and the filter paper three times to make up to volume with 0.1 N HCl. The filtrate was stored for trace metals [lead (Pb), chromium (Cr), cobalt (Co), copper (Cu) and zinc (Zn)] determination using Atomic Absorption Spectrophotometer (A.O.A.C., 1990).

RESULTS AND DISCUSSION

Table 1 shows results of proximate composition of the bread samples. Percentage moisture content was generally low in all the bread samples as it ranged from 1.96 to 4.32 %. Moisture content of a food substance is an essential factor in the determination of its nutritive value and is an index of its stability and quality. It can also influence its packaging and shelf life. Bread sample 1 therefore had the lowest shelf life and greatest tendency to spoil while sample 9 had the highest shelf life and lowest

vulnerability to spoilage. The bread samples also had low ash content ranging from 0.22 to 0.51 %, with that of sample 9 being the least. It is important to note that ash content gives an idea of the amount of mineral elements present in a sample.

Table 1: Proximate composition of bread (%)

Bread	Moisture	Ash	Fat	Crude Fibre	Protein	Carbohydrate
1	4.32±1.23	0.34±0.26	10.91±1.08	7.91±4.23	2.40±0.52	74.13±2.06
2	2.77±1.24	0.26±0.16	14.94±0.55	7.75±0.62	2.52±0.82	71.76±1.18
3	3.36±1.54	0.42±0.16	16.02±1.89	3.20±1.16	2.08±0.17	74.92±2.19
4	3.19±1.22	0.24±0.11	15.45±1.73	5.23±1.33	1.97±0.04	73.93±1.64
5	2.64±0.41	0.39±0.16	16.11±1.63	4.79±0.62	2.26±0.46	73.81±2.38
6	2.26±0.44	0.26±0.10	19.76±0.90	4.11±0.93	2.13±0.50	71.49±0.82
7	2.17±1.34	0.51±0.21	37.61±0.55	1.21±0.41	2.27±0.64	57.06±0.91
8	2.49±1.16	0.51±0.20	31.49±4.78	4.62±1.44	2.45±0.61	58.44±4.64
9	1.96±2.50	0.22±0.10	31.21±2.04	2.63±0.47	1.96±0.35	62.02±0.95

Results are mean±standard deviation (n = 4)

Bread samples from Ikeji Arakeji (7, 8 and 9) had higher percentage fat contents and are therefore better sources of energy than those from Ipetu Ijesa (1 to 6). This is because fat is a high source of energy that is essential to growing animals, especially children. Dietary fibre is an important ingredient in food and has become popular in prevention and managemnt of diseases. Crude fibre consists chiefly of cellulose and other vegetable cell wall substances. Range of crude fibre obtained in the bread samples is 1.21 to 7.91 % and is within that (2 to 12 g/100 g) obtained by Rodriguez *et al*. (2006) for dietary fibre in wheat flour, a major ingredient in bread. Variation or modification of its composition and structure could be caused by food processing.

Similarly, in comparison with the range in wheat (8-15 %) obtained by Shewry (2009), protein content of all the bread samples are low and ranged from 1.96 to 2.52 %. The author also remarked that of the twenty amino acids commonly found in protein, ten of them are essential and can not be synthesized by animals. These must therefore be supplied through the diet and bread is an example of such. Furthermore, the same author reported that wheat (white flour) contains starch, a form of carbohydrate, in the range of 65 to 75 % and the range of values got in majority of the bread samples (57.06-74.92 %), except samples 7, 8 and 9 from Ikeji Arakeji, fall within this. Starch is a good source of energy and a fraction of it resists digestion in the small intestine, passing into the colon and gets fermented to short-chain fatty acids (notably butyrate). Topping (2007) has

observed that this may have health benefits including reduction of colo-rectal cancer.

The concentrations of trace metals in bread samples in the current work are shown in Table 2 and those for comparison in Table 3. Lead was not detected in any bread sample from Ikeji Arakeji as well as samples 5 and 6 from Ipetu Ijesa while the values found in other samples from Ipetu Ijesa were lower than the range reported by Khaniki *et al*. (2005) and Magomya *et al.* (2013) except sample 2 as well as much lower than maximum concentration

Table 2: Concentration of trace metals in bread (mg/kg)

Metal	Bread sample								
	1	2	3	4	5	6	7	8	9
Pb	0.07	0.30	0.11	0.22	n.d.	n.d.	n.d.	n.d.	n.d.
Cr	0.47	0.32	0.32	0.52	0.38	0.34	1.49	0.97	0.79
Co	0.05	0.06	0.002	0.05	0.02	0.01	n.d.	0.01	0.002
Ni	0.03	0.12	0.05	0.06	0.11	0.09	0.21	0.17	0.04
Cu	0.41	0.23	0.08	0.08	n.d.	0.01	n.d.	n.d.	n.d.
Zn	n.d.	n.d.	n.d.	0.01	n.d.	0.004	n.d.	n.d.	n.d.

n.d. = Not detected

Table 3: Concentration of trace metals for comparison (mg/kg)

Metal	Similar work on bread	Maximum permitted[f]	Maximum level[g]
Pb	0.27-0.52 (Iran)[a] 0.34-3.13 (Nigeria)[c] 0.004-0.006 (Basra City)[e]	6 (in any solid food)	0.2 (in cereal grains)
Cr	0.70-2.80[b]	1 (in cereals)	-
Co	0.20-1.80[b]	-	-
Ni	0.43-2.28[a]	-	-
Cu	0.13-0.66 (Nigeria)[c]	-	0.5
Zn	2.93 (Nigeria)[d] 2.96-4.61 (Basra City)[e] 7.2 (USA)[e], 8.2 (Egypt)[e] 13-93 (Romania)[e]	-	0.3-1

[a](Khaniki *et al*., 2005); [b](Naghipour *et al*., 2014); [c](Magomya *et al.*, 2013); [d] (Onianwa *et al*., 2001), [e](Al-Kamil, 2011); [f](Choi, 2011) and [g](FAO/WHO, 2011) permitted in any solid food (6 mg/kg) stipulated by Choii (2011). However, all the values detected were higher than those reported by Al-Kamin (2011).

Copper and Zinc were also not detected in any bread sample from Ikeji Arakeji as well as sample 5 from Ipetu Ijesa. Besides, samples 1, 2 and 3 did not reflect trace of Zinc. These two, Copper and Zinc, are trace elements essential in food and their non-detection in these sample is detrimental to the consumers and depreciates their nutritive value. All levels of Copper detected are lower than the maximum allowable but only those in samples 1 and 2 fall within the range reported by Magomya *et al.* (2013). As for Zinc, levels in the only two samples where detected (from Ipetu Ijesa) are lower to those from similar works.

Chromium and Nickel were detected in all the samples and Cobalt was also detected in all except sample 7, again from Ikeji Arakeji. Cobalt is an integral component of vitamin B 12, a co-factor for two enzymes [methionine synthase and methylmalonyl coenzyme A (CoA) mutase] and thus an essential nutrient for non-ruminant animals and humans. All levels of Cobalt and Nickel detected were lower than those reported for similar works and the same holds for Chromiun except those found in bread samples 7, 8 and 9 (also from Ikeji Arakeji) that exist in the range reported by Naghipour *et al*. (2014).

CONCLUSION

From the ongoing, all the bread samples where trace elements were detected had concentrations or levels within the maximum allowable limits with some below and others within the ranges reported in similar works. Their proximate analysis as regards some components were however low and some essential trace metals were not detected. The bread samples could therefore be said to be safe for human consumption but defective in nutritive standard.

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