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PROXIMATE ANALYSIS AND POTASSIUM BROMATE CONCENTRATIONS OF SELECTED BREAD SOLD WITHIN LOKOJA METROPOLIS, NIGERIA

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ABSTRACT

This study assessed the proximate composition and potassium bromate concentration of twenty selected bread samples sold in Lokoja metropolis, Kogi State, Nigeria. The samples were randomly obtained from open markets, bus stops, tea sellers, bread vendors and eateries. The percentage of moisture, crude fibre, crude protein, fat, ash and carbohydrate in the twenty bread samples were analyzed. Qualitative and quantitative assessments of potassium bromate in the bread samples were carried out. Results showed that all the six proximate parameters analyzed showed significant difference among the twenty samples ranging from 24.30 ± 0.30 to 34.40 ± 1.00 %, 3.00 ± 0.20 to 13.20 ± 0.03 %, 2.00 ± 1.00 to 24.00 ± 2.00 %, 1.70 ± 0.30 to 8.90 ± 0.20 %, 4.90 ± 0.10 to 15.20 ± 0.20 % and 30.20 ± 0.20 to 49.30 ± 0.20% for moisture, ash, crude fibre, fat, protein, protein and carbohydrate respectively. Only the ash and crude fibre contents of the twenty bread samples were above the permissible level recommended by Standard Organization of Nigeria (SON). Results of quantitative evaluation of potassium bromate ranged from 0.018 ± 0.001 to 3.107 ± 0.002 µg/g. Also, the qualitative and quantitative results for the twenty bread samples correlated very well with only 15.00 % of the samples containing potassium bromate within the safe limits recommended by SON and National Agency for Food, Drug Administration and Control (NAFDAC). It is recommended that routine checks should be carried out by regulatory authorities in order to ensure that bakers always comply with rules and regulations guiding bread production in Nigeria.

Keywords: Proximate, Qualitative, Quantitative, Potassium bromate, Lokoja

INTRODUCTION

Bread is a baked staple food made from wheat flour that is widely consumed among all socio-economic groups in Nigeria (Alli *et al*., 2013; Eke *et al*., 2013). According to Adebayo-Oyetoro *et al.* (2016) bread has become the second most widely consumed non-indigenous food after rice in Nigeria. They further reported that bread is consumed in homes, restaurants, construction sites, factories and hotels in developed and developing world. It is relatively expensive, being made from imported wheat that is not cultivated in the tropics for climatic reasons (Edema *et al*., 2005). Bread has always been one of the most popular and appealing food products due to its superior nutritional, sensorial, textural characteristics, ready to eat convenience as well as cost competitiveness (Tiimub, 2013). Ibidapo *et al*. (2019) stated that bread is an excellent source of important nutrients believed to provide

humans with essential element for centuries in many regions of the world. Bread supplies a significant portion of the nutrients required for growth, maintenance of health and well-being (Okafor *et al*., 2012; Tiimub 2013). It is a cereal product that is naturally low in protein and nutritionally not a balanced diet because it is low in lysine which is an essential amino acid (Nwanekezi, 2013). Bread usually contains several ingredients that would help improve its quality. Some of the basic identified ingredients, apart from flour are table salt, sugars, flavors and at least a flour improver such as potassium bromate (Emeje *et al*., 2010).

According to Emeje *et al*. (2010), the addition of potassium bromate to flour during bread production has been a common practice among flour miller and bakers throughout the world because it is cheap and probably the most efficient oxidizing agent. It acts as a slow oxidizing agent throughout the fermentation proofing and baking process affecting the structure and the rheological properties of the dough (Adebayo-Oyetoro *et al.*, 2016). The overall effect is to make bread rise in the oven, increase loaf volume and texture (Alli *et al*., 2013). As a result, many bakers use potassium bromate as an additive to assist in the raising process and to produce a texture in the finished product that is appealing to the public (Emeje *et al*., 2010). Ahmad *et al*. (2016) reported that oral doses of 185 - 385 mg/kg body weight of potassium bromate lead to irreversible renal damage and deafness, while lower doses lead to gastrointestinal disturbances and abdominal pain in humans. Potassium bromate according to Ekpo *et al*. (2008) is mutagenic and has shown the potential to cause cancer in laboratory animal studies. According to Airaodion *et al*. (2019a) the addition of potassium bromate to flour meant for baking was banned in Nigeria by NAFDAC in 2003 and its use above the permissible level infringes on the drug and related products registration decree 20 of 1990 and NAFDAC Decree 15 of 1993 sub-section 8.

In Nigeria, efforts have been made to assess the nutritional composition and potassium bromate quantity of bread sold in Uyo, Akwa Ibom State (Ekpo *et al.*, 2008), Eastern part of Nigeria (Emeje *et al.*, 2010), Gwagwalada in Federal Capital Territory (Alli *et al.*, 2013), Benue and Nasarawa States (Eke *et al.*, 2013), Zaria in Kaduna State (Magomya *et al.*, 2013), Asaba in Delta State (Kelle, 2017), Port Harcourt metropolis in Rivers State (Naze *et al.*, 2018), Gombi in Adamawa State (Alexander *et al.*, 2019), Ogbomoso metropolis in Oyo state (Airaodion *et al.*, 2019a), Ibadan metroplolis in Oyo State (Airaodion *et al.*, 2019b), Jalingo metropolis in Taraba State (Magomya *et al.*, 2020) and Port Harcourt metropolis in Rivers State (Wordu and Akusu, 2020). There is paucity of information on the nutritional composition and potassium bromate level of bread sold in Lokoja metropolis, North Central, Nigeria.

Lokoja town is the capital of Kogi State in Nigeria located in the North-Central part of Nigeria with over 195, 261 people at 2006 census (Olorunfemi *et al.*, 2016). Lokoja lies at the confluence of the River Niger and River Benue. According to Austine and Egwu (2018) Lokoja is the only state capital in Nigeria where tens of thousands of people from over 19 States of the federation travel through every day to the Northern States and Abuja, and people from the Northern States cross to South-South,

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South-East or South-West for different engagements. The town therefore remains the favourites of travelers, endeared for its stop-over joints that have now coloured the landscape of the city. During the stop-over several travelers buy bread as a ready to eat food as they progress in the journey while some other buy bread to give to families and friends. This therefore suggests that breads sold in Lokoja are widely consumed by large population in Nigeria. It is therefore imperative to assess the nutritional composition and potassium bromate concentration of the breads sold in Lokoja metropolis. The aim of this study is to determine the nutritional composition and quantity of potassium bromate in selected brands of bread sold in Lokoja, Kogi State, Nigeria

MATERIALS AND METHODS

Sample Collection

Twenty bread samples were randomly purchased from hawkers at open markets/bus stops, tea sellers, bread vendors and eateries in Lokoja Metropolis, Kogi State, Nigeria as shown in Table 1.

Table 1: Sources and codes ascribed to the bread samples considered for the study

S/N	Sample codes	Source
1.	A	Hawker at bus stop/open market
2.	B	Hawker at bus stop/open market
3.	C	Hawker at bus stop/open market
4.	D	Hawker at bus stop/open market
5.	E	Hawker at bus stop/open market
6.	F	Tea seller
7.	G	Tea seller
8.	H	Tea seller
9.	I	Tea seller
10.	J	Tea seller
11.	K	Bread Vendor
12.	L	Bread Vendor
13.	M	Bread Vendor
14.	N	Bread Vendor
15.	O	Bread Vendor
16.	P	Eatery
17.	Q	Eatery
18.	R	Eatery
19	S	Eatery
20.	T	Eatery

Proximate Analysis

The twenty bread samples were analyzed for moisture, carbohydrate, crude protein, crude fat, crude ash, and crude fibre contents. The proximate composition of the twenty bread samples were analyzed according to the procedure outlined by Association of Official Analytical Chemists (1990)

The moisture content was determined by heating 2 g of each fresh sample to a constant weight in a crucible placed in an oven maintained at 105 °C. The dry matter was used in the determination of the other parameters. Crude protein (% total nitrogen × 6.25) was determined by the Kjeldahl method, using 2 g samples; crude fat was obtained by exhaustively extracting 5 g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40-60°C) as the extractant. Ash was determined by the incineration of 10.0 g samples placed in a muffle furnace maintained at 550 °C for 5 hrs. Crude fibre was obtained by digesting 2 g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550 °C for 5 hrs. The carbohydrate contents of the samples were calculated by differences i.e. carbohydrate = 100 - (protein + moisture + ash + fat + fibre). Each analysis was carried out in triplicate.

Qualitative Analysis of Potassium Bromate in Bread

5 g of sample from each bread brand was measured out into different test tubes.10 ml of distilled water was added to the samples after which 0.5 ml of 1 % potassium iodide solution in 2 ml hydrochloric acid was added. The test tubes were appropriately labelled, covered with foils and allowed to stand for a day according to the methods described by Uwague (2017). The change of colour from light yellow to purple colour in the samples indicates the presence of potassium bromate in the bread samples. The degree of color change was taken as the quantity of potassium bromate in the bread samples as described by Emeje *et al.* (2010).

Preparation of standard solution

The preparation of the standard solution was carried out according to the method outlined by Alli *et al*. (2013) Aliquots of 100, 200, 400, 600, 800, and 1000 µl from the primary stock solution of potassium bromate were placed in 20 ml capacity test tubes, and 1 ml of 0.01M promethazine (FDA approved, CAMEO chemical grade) was added. The mixtures were then diluted with distilled water up to 10 ml to obtain a final concentration of bromate in the range of 0.5 to 5 µg/ml and 0.2 ml of 3 M hydrochloric acid (Analytical method and Food grade) was added. The mixtures were shaken for 1 min and the absorbance measured at 515 nm against a blank reagent and results were used to plot the calibration curve.

Quantitative Analysis of Potassium Bromate in Bread

10 g of each of bread sample was weighed and oven-dried at 75°C for an hour. The dried crust was pulverized and 1 g of each powdered sample was weighed into a clean 250 cm^3 beaker and 20 cm^3 of distilled water was added. The mixture was stirred thoroughly using a spatula and then filtered using a filter paper. 8 ml of the filtrate solution was transferred into a 20 ml volumetric tube and mixed with 1 ml of 0.01 M promethazine. 0.2 ml of 12 M hydrochloric acid was added, the mixture was shaken for 1 min and absorbance of the coloured solution obtained was measured using a spectrophotometer at 515 nm. The concentration was calculated from the linear regression curve obtained from the standard solutions of potassium bromate as mentioned above (Alli *et al*., 2013). Each analysis was carried out in triplicate.

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Data Analysis

Data obtained in triplicates for proximate and potassium bromate analyses were subjected to Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) Post hoc test using SPSS version 23.

RESULTS

Table 2 shows the proximate composition of the twenty selected bread samples. The result revealed significant differences ($P<0.05$) for percentages moisture, ash, crude fibre, fat, protein and carbohydrate among the samples.

The moisture contents of the investigated bread samples ranged from 24.30 ± 0.30 to 34.40 ± 1.00 %. A significantly low moisture content (24.30 ± 0.30 %) was recorded in bread sample N obtained from bread vendor while bread sample R obtained from eatery had the highest moisture content (34.40 ± 1.00 %).

The Ash contents ranged from 3.00 ± 0.20 to 13.20 ± 0.03 %. The low ash value of 3.00 ± 0.20 % recorded in samples B and M from hawkers at bus stop/open market and bread vendor respectively was not significantly different from every other sample, except samples L (9.60 ± 0.20 %) and E (10.00 ± 1.00 %). Bread sample A from bread hawkers at bus stops/open markets had significantly high fat value of 13.20 ± 0.03 %.

The crude fibre ranged from 2.00 ± 1.00 to 24.00 ± 2.00 %. Bread samples from bus stop/open market (A) and tea seller (G) did not differ significantly from each other in terms of their crude fibre contents of 2.00 ± 1.00 % and 2.00 ± 2.00 % respectively while sample T obtained from eatery had significantly high value of 24.00 ± 2.00 %.

The fat contents ranged from 1.70 ± 0.30 to 8.90 ± 0.20 %. Significantly low - fat value of 1.70 ± 0.30 % was recorded in sample B while significantly high fat value of 8.90 ± 0.20 % was recorded in sample A both from bread hawkers at bus stops/open markets.

The protein contents ranged from 4.90 ± 0.10 to 15.20 ± 0.20 %. A significantly low value of protein (4.90 ± 0.10 %) was recorded in sample P obtained from eatery. This value is not significantly different from the 5.10 ± 0.30 % recorded in sample F obtained from tea seller, while the significantly high protein value of 15.20 ± 0.20 % was recorded in bread sample G obtained from tea seller was not significantly different from the values of 14.57 ± 0.95 % obtained in sample C and 15.20 ± 2.00 % obtained in sample J.

The carbohydrate contents ranged from 30.20 ± 0.20 to 49.30 ± 0.20 %. A significantly low carbohydrate value of 30.20 ± 0.20 % was recorded in sample S obtained from eatery while significantly high percentage carbohydrate (49.30 ± 0.20 %) was recorded from sample obtained from tea vendor.

The percentage ranges of proximate values obtained on the bread samples in this study were within the regulatory specifications of moisture 40 % maximum, ash 1.1 %, fat 10 % maximum, fibre 6 %, protein 20 % and carbohydrate 37 % minimum except the range obtained for ash and some crude fibre values which were above the regulatory specifications recommended for wheat bread by SON.

The inscriptions on the labels of the bread samples generally did not conform to the nutritional compositions of the samples except for samples P and T both from eateries.

Table 3 shows the results of the qualitative (colour change) and quantitative analyses of potassium bromate of the twenty bread samples. Four out of the twenty bread samples (samples O, R, S and T) assessed representing 20.00 % did not show any visible colour change when they were treated with potassium iodide (Table 3 and Plate 1). Seven out of the twenty bread samples (samples D, E, G, L, N, P and Q) assessed representing 35 % showed light purple when treated with potassium iodide. Five out of the twenty bread samples (samples A, F, I, K and M) assessed representing 25 % showed purple when treated with potassium iodide, while four of the twenty bread samples (samples B, C, H and J) assessed representing 20 % showed dark purple when treated with potassium iodide.

The result of quantitative analysis of the potassium bromate levels of the twenty bread samples in Table 3 revealed that only three out of the twenty bread samples analyzed in this study representing 15.00 % contain potassium bromate within the permissible level. The remaining seventeen bread samples analyzed representing 85.00 % had potassium bromate levels higher than 0.02 μg/g, which is the permissible safe level of potassium bromate allowed in bread by FDA.

The potassium bromate range of 0.018 ± 0.001 μg/g to 3.107 ± 0.002 μg/g was obtained in sample T (from an eatery) and J (from a tea seller) respectively. The intensity of colour change obtained for qualitative assessment (colour change) correlated well with the amount of potassium bromate analyzed from each sample quantitatively.

Table 2: Proximate composition of the twenty loaves of bread studied.

Sample codes	Moisture (%)	Ash (%)	Crude Fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)
A	30.00 ±2.00^{cde}	5.00 ±0.20^{a}	2.00 ±1.00^{a}	10.10 ±1.00^{cde}	8.90 ±0.20^{k}	43.00 ±2.17^{i}
B	28.00 ±2.00^{abcd}	3.00 ±0.20^{a}	18.00 ±3.00^{f}	10.00 ±2.00^{cd}	1.70 ±0.30^{a}	39.30 ±0.30^{efg}
C	29.80 ±0.20^{bcde}	13.20 ±0.30^{c}	2.00 ±1.70^{a}	14.57 ±0.95^{h}	3.90 ±0.10^{ef}	36.20 ±0.20^{d}
D	34.40 ±1.00^{f}	4.60 ±0.30^{a}	8.00 ±0.10^{c}	9.00 ±0.10^{c}	2.70 ±0.20^{bc}	41.10 ±0.16^{h}
E	30.00 ±0.30^{cde}	10.00 ±1.00^{b}	14.00 ±1.00^{de}	10.40 ±0.20^{cdef}	4.93 ±0.15^{hi}	30.50 ±0.20^{ab}
F	30.60 ±1.00^{cde}	4.40 ±0.50^{a}	4.00 ±2.00^{ab}	5.10 ±0.30^{a}	8.60 ±0.26^{k}	49.30 ±0.20^{l}
G	30.00 ±4.00^{cde}	5.00 ±0.20^{a}	2.00 ±3.00^{a}	15.20 ±0.20^{h}	6.40 ±0.46^{j}	41.40 ±0.40^{h}
H	26.67 ±0.60^{abc}	4.20 ±0.50^{a}	4.00 ±1.00^{ab}	11.50 ±0.50^{fgh}	4.93 ±0.20^{hi}	48.30 ±0.30^{k}
I	28.00 ±1.00^{abcd}	5.00 ±2.00^{a}	14.00 ±3.00^{de}	10.30 ±0.30^{cdef}	3.60 ±0.40^{de}	39.10 ±0.14^{ef}
J	32.20 ±0.30^{ef}	4.80 ±0.50^{a}	4.00 ±1.00^{ab}	15.00 ±2.00^{h}	4.40 ±0.20^{fg}	39.60 ±0.40^{fg}
K	28.00 ±2.00^{abcd}	5.00 ±2.00^{a}	4.00 ±1.00^{ab}	12.30 ±0.30^{g}	4.20 ±0.26^{fg}	46.50 ±0.25^{j}
L	30.40 ±0.40^{cde}	9.60 ±0.20^{b}	18.00 ±2.00^{f}	10.20 ±0.40^{cde}	2.50 ±0.30^{b}	39.30 ±0.30^{efg}
M	28.00 ±3.00^{abcd}	3.00 ±2.00^{a}	6.00 ±1.00^{bc}	15.10 ±0.26^{h}	5.80 ±0.40^{i}	40.10 ±0.33^{g}
N	24.30 ±0.30^{a}	4.70 ±0.20^{a}	8.00 ±1.00^{d}	11.20 ±0.20^{efgh}	4.10 ±0.30^{efg}	47.70 ±0.30^{k}
O	26.00 ±3.00^{ab}	5.00 ±1.00^{a}	12.00 ±2.00^{e}	10.30 ±0.28^{cdef}	5.40 ±0.40^{ig}	41.30 ±0.31^{h}
P	32.00 ±3.00^{ef}	5.00 ±2.00^{a}	6.00 ±1.00^{bc}	4.90 ±0.10^{a}	4.60 ±0.40^{gh}	47.50 ±0.20^{k}
Q	28.00 ±2.00^{abcd}	10.00 ±3.00^{b}	8.00 ±1.00^{d}	11.70 ±0.20^{gh}	3.93 ±0.14^{ef}	38.40 ±0.260^{h}
R	38.00 ±3.00^{g}	5.00 ±1.00^{a}	12.00 ±2.00^{e}	9.20 ±0.30^{c}	2.90 ±0.40^{bc}	32.90 ±0.40^{c}
S	29.60 ±0.60^{bcde}	4.40 ±0.30^{a}	16.00 ±3.00^{ef}	10.40 ±0.80^{cdef}	2.40 ±0.30^{b}	30.20 ±0.20^{a}
T	31.10 ±0.10^{def}	3.90 ±0.10^{a}	24.00 ±2.00^{g}	6.50 ±0.20^{b}	3.20 ±0.20^{cd}	31.30 ±0.35^{b}
LSD Value	0.44	2.90	1.42	0.38	0.42	0.75
SON Recommendation	Maximum of 40%	Maximum of 1.10%	Maximum of 6.00%	Maximum of 20%	Maximum of 10%	Minimum of 37%

*Means with the same letters in the same column are not significantly different at 5% level of significance
Letters A to T represent the codes for different loaves of bread analyzed.
Values represent mean ±SD of 3 replicate determinations. SON - Standard Organization of Nigeria

Table 3: Qualitative and Quantitative Determination of Potassium Bromate Level in the Twenty Loaves of Bread Studied

Sample codes	(Qualitative test) Colour change	(Quantitative test) Quantity of bromate(µg/g)
A	Purple	1.106 ± 0.003^{gh}
B	Dark purple	2.114 ± 0.002^{j}
C	Dark purple	2.215 ± 0.001^{k}
D	Light purple	0.082 ± 0.003^{cd}
E	Light purple	0.092 ± 0.002^{f}
F	Purple	1.519 ± 0.002^{i}
G	Light purple	0.093 ± 0.002^{f}
H	Dark purple	2.111 ± 0.001^{j}
I	Purple	1.108 ± 0.001^{h}
J	Dark purple	3.107 ± 0.002^{l}
K	Purple	1.102 ± 0.001^{g}
L	Light purple	0.086 ± 0.003^{de}
M	Purple	1.103 ± 0.001^{gh}
N	Light purple	0.078 ± 0.003^{c}
O	No visible change	0.020 ± 0.001^{ab}
P	Light purple	0.089 ± 0.001^{ef}
Q	Light purple	0.093 ± 0.002^{f}
R	No visible change	0.024 ± 0.003^{b}
S	No visible change	0.019 ± 0.001^{ab}
T	No visible change	0.018 ± 0.001^{a}
LSD Value		0.032
FDA permissible Standard		0.02

*Means with the same letters in the same column are not significantly different at 5% level of significance
Letter A to T represents the code for different loaves of bread analyzed.
Values represent mean ± SD of 3 replicate determinations

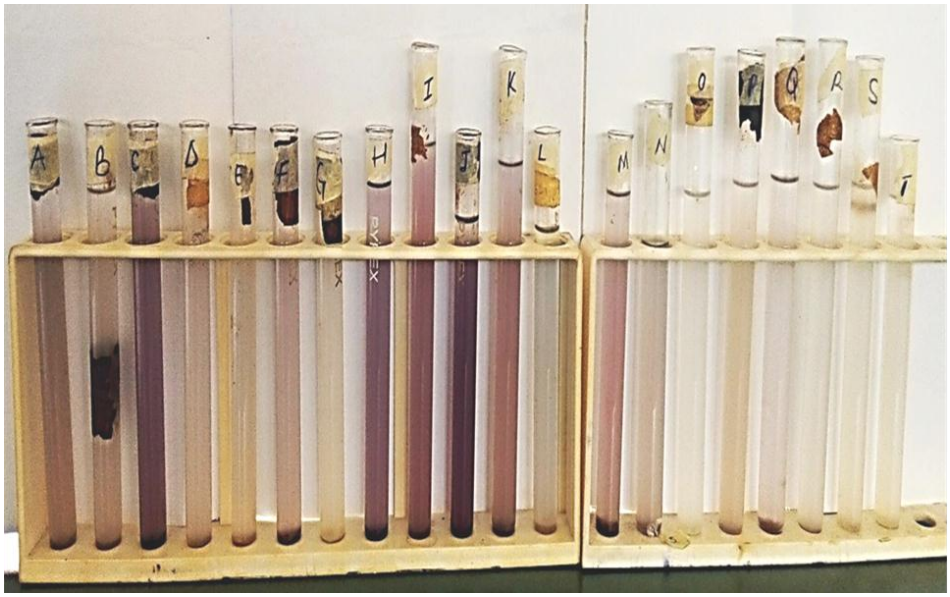

Plate 1: Test tubes showing colour change in relation to potassium bromate composition for the twenty bread samples.

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DISCUSSION

The statistical significant differences obtained on the six proximate parameters studied for the twenty bread samples suggested that the breads vary from brand to brand due to different types of flour and additives used for their production. This agrees with the report of Alli *et al.* (2013) on selected bread samples from Gwagwalada area council. The proximate composition range of 24.30 ± 0.30 to 34.40 ± 1.00 %, 3.00 ± 0.20 to 13.20 ± 0.03 %, 2.00 ± 1.00 to 24.00 ± 2.00 %, 1.70 ± 0.30 to 8.90 ± 0.20 %, 4.90 ± 0.10 to 15.20 ± 0.20 % and 30.20 ± 0.20 to 49.30 ± 0.20 % for moisture, ash, crude fibre, fat, protein, protein and carbohydrate respectively obtained in this study is in line with the proximate range of moisture as 30 - 35 %, crude protein as 8.75 - 14.22 %, crude fat as 2 - 13 %, crude fibre as 0.70 - 1.052 %, ash as 0.40 - 0.60 % and carbohydrate as 35.82 - 48.20 % reported by Eke *et al.* (2013) on bread sold in Benue and Nasarawa States. The values obtained in this study is also in close agreement with the values of moisture (26.43 - 42.92 %), ash (0.88 - 1.88 %) fat (7.34 - 18.51 %), protein (8.97 - 12.01 %), crude fibre (1.47 - 4.26 %) and carbohydrate (32.11 - 47.60 %) for local bread from Port Harcourt metropolis reported by Wordu and Akusu (2020).

The percentage ranges of proximate values reported on the bread samples in this study were within the regulatory specifications of the SON (2004) for moisture, ash, fat, fibre, protein and carbohydrate which indicate that the bakers complied with the regulatory standards to some extent. In contrary, the higher values recorded for the ash and crude fibre contents of the twenty samples compared to the regulatory specifications recommended by the SON (2004) for wheat bread may be attributed to different additives used in producing the breads. Eke *et al.* (2013) attributed the high values of protein, fat, fibre and ash obtained in bread samples from Benue and Nasarawa States to the flour used in composite with wheat and other additives used in producing these bread samples.

Potassium bromate form complex with potassium iodide to give a purple colouration. The colour change ranged from light purple to dark purple with increase in concentration. The fact that four (samples O, R, S and T) out of the twenty bread samples analyzed representing 20.00 % did not show any visible colour change when treated with potassium iodide suggested the possibility that they did not contain potassium bromate or that the amount of residual potassium bromate present in the samples could not be detected by the reagent. This finding corroborates the report of Kelle (2017) that bread samples that did not show visible colour change do not contain potassium bromate or might be present in low concentration that is below detection limit. Samples D, E, G, L, N, P and Q representing 35 % of the studied bread samples showed light purple colour when treated with potassium iodide may be due to the low level of potassium bromate in the bread samples. The report of Wordu and Akusu, (2020) that bread samples showing light purple colouration after reacting with potassium iodide contain minute level of potassium bromate in them and cannot react with the reagent extensively supported this finding. Five (A, F, I, K and M) and four (B, C, H and J) samples out of the twenty bread samples showed purple and dark purple colour respectively when treated with potassium

iodide. This finding indicates high level of potassium bromate in the bread samples.

For quantitative analysis of the potassium bromate levels, only three (i.e., O from bread vendor, S and T both obtained from eateries) out of the twenty bread samples (15 % of the analyzed bread in this study) contain potassium bromate within the permissible level which implies that these three bread samples are safe for human consumption as far as potassium bromate content is concerned. Therefore, eateries comply more with addition of minimum potassium bromate to their bread than any other outlet considered in this study. In this study, it was also observed that mostly bread hawked at bus stops/open markets and sold by tea sellers contain higher quantities of potassium bromate; and obviously bakers of these bread samples did not comply with the rule of maintaining the amount of potassium bromate within the permissible level (0.02 μg/g).

The amount of potassium bromate in 17 bread samples analyzed is higher than 0.02 μg/g, which is the permissible safe level of potassium bromate allowed in bread by the US Food and Drug Agency (FDA) (Ekpo *et al*. 2008) and it also contravenes the NAFDAC (2004) ban on use of potassium bromate in bread. This implies that, 85.00 % of the bread samples analyzed from Lokoja metropolis in the study are not safe for human consumption as far as potassium bromate is concerned. Alli *et al.* (2013) reported that potassium bromate degrade essential vitamins and is a possible carcinogenic and mutagenic agents.

The range of potassium bromate values obtained in this study (0.018 ± 0.001 - 3.107 ± 0.002 μg/g) is lower than the values (2.51 – 11.52 μg/g) reported by Emeje *et al.* (2010) on bread brands from Eastern part of Nigeria, (2.46 – 13.60 μg/g) reported by Magomya *et al.* (2013) on bread samples from Zaria, (1.4 μg/g - 5.1 μg/g) reported by Kelle *et al.* (2017) on bread samples sold in Asaba, (0.02 – 10.12 μg/g) reported by Airaodion *et al.* (2019a) on bread samples from Ogbomosho metropolis, (1.24 – 9.31 μg/g) reported by Airaodion *et al.* (2019b) reported on bread samples sold in Ibadan and (2.51 – 11.52 μg/g) reported by Magomya *et al.* (2020) on bread from Jalingo metropolis. The amount of potassium bromate reported in this study is higher than the 0.02- 0.04 μg/g reported by Wordu and Akusu (2020) on bread brands from Port Harcourt metropolis.

The observed correlation between the qualitative and quantitative assessments of the potassium bromate compositions of the 20 bread samples conform to the report of Emeje *et al*. (2010), that any of qualitative and quantitative methods could be used effectively to assess the level of potassium bromate in bread. Therefore, any of the two methods could be used reliably to effectively assess the level of potassium bromate in bread samples.

This study also revealed that bread samples with "bromate free" in their labels contain higher potassium bromate concentrations. Airaodion *et al.* (2019a) and Wordu and Akusu (2020) gave similar reported on the quantity of potassium bromate in Ogbomoso metropolis and Port Harcourt metropolis respectively. This shows the level of insincerity in the bakery industry not just in Lokoja metropolis but in Nigeria as a whole.

Considering the high amount of potassium bromate found in the analyzed bread samples and coupled with the fact that bread

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is a staple food consumed on a daily basis by residents of Lokoja irrespective of their social economic status, we can conclude that there is high dietary exposure of Lokoja residents to potassium bromate through bread consumption. Ayo *et al.* (2002) reported that ascorbic acid compared favorably with potassium in improving the loaf volume of bread. Alternatively, bread improvers such as yeast and ascorbic acid should be used in place of potassium bromate, since the excessive use of the chemical had been banned in Nigeria by NAFDAC.

Bread sample T (from an eatery) had most of its proximate compositions and potassium bromate value within the SON (2004) permissible levels; therefore, its consumption could be encouraged if the level of ash and crude fibre is improved on.

CONCLUSION

This study revealed that the percentage ranges of proximate composition obtained on the twenty bread samples in this study were within the acceptable ranges except the values of ash and crude fibre which were above the regulatory specifications. Also, only 15.00 % of the twenty bread samples studied contained potassium bromate within the safe limits recommended by SON and NAFDAC. It is recommended that routine checks should be carried out by regulatory authorities in order to ensure that bakers always comply with rules and regulations guiding bread production in Nigeria.

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