PHYSICOCHEMICAL AND MICROBIAL ANALYSIS OF LOCALLY FERMENTED DRINKS (BURUKUTU AND PITO) FROM CEREALS IN NORTH CENTRAL NIGERIA

Supported by tetfund TERTIARY EDUCATION TRUST FUND

Ishaq S. Eneji*, Andrew A. Asan and Adams U. Itodo
Department of Chemistry, Federal University of Agriculture, PMB 2373 Makurdi, Nigeria
*Corresponding author: ishaqeneji@gmail.com

Received: January 10, 2017 **Accepted:** March 29, 2017

Abstract: Locally fermented drinks (Burukutu and Pito) were collected from seven states of North Central, Nigeria and were analyzed for physicochemical and trace metals. The trace metals were analyzed using Atomic Adsorption Spectrophotometric techniques. Its temperature, pH, titratable acidity, specific gravity and alcohol content were 25.3±1.9 – 31.0±1.2^{o}C, 3.90±0.3 – 4.40±1.2, 0.062±0.04 – 0.117±0.07, 0.718±0.00 and 5.71±0.01, respectively for Burukutu. Suspected microbes for burukutu include: streptococcus species, staphylococcus species and entrobacter species, while for fungi include: saccharomyce species, aspergillus species, penicillium species, sporontrichum species, rhizopus species, mucor species, blastomyces species, mould species, paracoccidioicides species and Coccidioidesimmitis. The result for physicochemical parameters for pito include: 28.3±1.1 – 31.0±3.5 ^{0}C, 4.60±0.8 –5.30±0.4, 0.102±0.12 – 0.147±0.04, 0.718±0.0 and 5.71±0.00, respectively. In addition to the suspected bacteria in Burukutu, others found in pito include klebsiella species, micrococcus species and salmonella specie. The mean metal concentrations (mg/L) for burukutu include Cd (0.015± 0.035 –0.024 ± 0.02), Cr (0.36 ± 0.02 – 2.16 ± 0.4), Pb (1.20±0.6 – 1.93±0.2), Zn (0.23±0.02 – 0.54 ± 0.5), Fe (2.81 ± 1.2 – 8.12 ± 0.8) and Ni (0.000 ± 0.0 – 0.94 ± 2.1). Trace metal content for pito was also reported. Most of the heavy metals concentration in burukutu and pito were higher than the maximum permissible limit set by the WHO, for drinking water. There was also a significant difference ($p<0.05$) of metals analysed for burukutu and pito. The daily consumption of these local drinks have been associated with risk of some form of cancer, heart disease, stroke and some other chronic ailments.

Keywords: AAS, Burukutu, microbial culture, physicochemical, Pito, trace metals

Introduction

Cereals are widely utilized as food in African countries which account for 77% of total calorie consumption in African countries (Kolawole *et al.*, 2007). A majority a traditional cereal-based food consumed in Africa and mainly processed by natural fermentation. Fermented cereals are important as dietary staples for adults in Africa. Major cereals grown in Africa, include sorghum, rice, maize and millet. Sorghum is one of the cereals cultivated in the tropical region of Africa and is about the largest cultivated crop in the northern Guinea savanna areas of Nigeria (Kolawole *et al.*, 2007). It constitutes a major source of energy and it serves as a staple food of many of the world's poorest and least privilege people (Michodjèhoun-Mestres *et al.*, 2005). According to Abdelmoneon *et al*. (2005), Sorghum products have poor nutritional value due to their deficiency in lysine, threonine and tryptophan and presence of anti-nutritional factors such as tannins and phytatates. These factors interact with proteins, vitamins and minerals, thus restricting their bio-availability. The above factors contribute to anemia and other nutritional diseases in developing countries where the consumption of Sorghum products is high (Abdelmoneon *et al*., 2005). However, various techniques have been investigated to improve the protein digestibility and mineral availability of sorghum by reducing its tannin and phytate content. These include malting, fermentation and cooking (Achi, 2005). General burukutu and pito is very rich in levels of thianin, riboflavin, niacin and lysine; with important sources of dietary proteins, carbohydrates, the B-complex vitamin, vitamin E, iron, trace metal and fibres. Several works had been carried out on the effect of fermentation on nutritional improvement of sorghum drinks such as burukutu and pito; there was a significant decrease in starch while there was a significant increase in ascorbic acid, reducing sugars and free amino acid (Gaffa *et al.*, 2011).Burukutu and pito contains all the essential amino acid in required proportion except cyteine and tryptophan which are completely destroyed by heat during boiling (Odetokun, 2006).

These local drinks were cheap and affordable; therefore it is consumed as food in African countries, than in the developed world. The major problems associated with the processing of traditional drinks such as burukutu and pito, the use of untreated water supplied by hawkers and such water could be a potential vehicle for the spread and contamination of the brew with pathogen micro-organism. The processing areas are filthy and in some cases are located near toilet. Utensils, cups and other measuring devices such as calabash are not properly washed after use or before serving customers. Food poisoning outbreaks are often recognized by the sudden onset of illness within a short period of time among many individuals who have consumed contaminated fermented drinks (burukutu and pito). The role of aluminium boilers or cooking pots as well as "off gases" from burning of wood and fuel are other sources for metal loading.

The purpose of this study is to determine the physicochemical parameters, microbial screening and levels of selected metals (Cd, Cr, Pb, Zn, Fe and Ni) in burukutu and pito from seven States obtained from selected local government areas to determine their physicochemical parameters and carry out microbial culture of the two locally fermented brews (burukutu and pito), with the aim of establishing baseline data for consumers, stakeholders, existing legislation and the government.

Materials and Methods

Sample collection

Locally made alcohol (Burukutu and Pito) was bought from seven States, North central of Nigeria. Nyanya Abuja; Lafia, Nasarawa State; Tudunwada, Jos-Plateau State; Ankpa, Kogi State; North Bank- Makurdi- Benue State; Suleja-Niger State; OkeOyi Ilorin- East, Kwara State, between the month of September and October, 2015. Six samples of Burukutu and pito was obtained from each of the state. All the 42 samples were collected, put separately in acid cleaned high density 1litre polyethylene sampling bottle, according to strict sampling protocols described by American Public Health

Association (APHA, 1998). The samples were transported in ice cooler on ice and stored in cold room prior to analysis. Chemical analyses of the samples were conducted using standard procedures recommended by Wardlow (1999). Locally prepared brews (burukutu and pito drinks) under Laboratory condition was used for control experiment. Analytical grade reagent was used except otherwise stated.

Physicochemical analysis of local brew drinks

Temperature was taken at the point of sample collection using the thermometer and pH measurement was carried out by dipping the electrode of the pH meter into the sample. The titratable acidity was determined by titrating 2 mL of samples with 0.1M NaOH to the phenolphthalein end point. The titratable acidity was expressed as the volume of NaOH solution required to neutralize the free acid contained in the sample as described by Achi (2005) in the equation below:

$$T.A.(g/100ml) = \frac{0.075 \times M_1 \times 100 \times V_2}{V_1 ml} \quad (1)$$

Where M_1=Molarity of the NaOH, V_2= Titre value, V_1= Volume of the sample (5 mL) and 0.075= Equivalent weight for tartaric acid

Specific Gravity: This was determined using a density bottle. The samples were poured into a 50 mL density bottle and weighed. Specific gravity was calculated as shown as follow

$$\frac{Density\ of\ sample}{Density\ of\ water} = \frac{X(g/mL)}{0.998(g/mL)} \quad (2)$$

Where $X = \frac{w_2 - w_1(g)}{VmL}$, W_2 = Weight Sample in the density bottle, W_1 = Weight of density bottle and V = Volume of the density bottle (50 mL)

Alcoholic content

Hydrometer method was used in determining the alcohol content. Distilled local brew drinks (Burukutu and Pito) were poured into 250 mL measuring cylinder and the hydrometer was gently introduced inside the contents and it was allowed to settle, the reading was taken from the calibration values, to determine the percentage alcoholic by weight and alcoholic by volume from the specific gravity obtained.

Microbial Culture of Burukutu and Pito

Serial dilution of the natural sample, (10^{-3}) were introduced into a nutrient agar prepared with 2 g of ampiclox (antibiotic) for bacteria isolation and potato dextrose agar for fungi isolation for 48 and 72 h, respectively. Bacterial identification was carried out using gram staining reaction and fungi identification was carried out by microscopic examination. The media were prepared according to the manufacture's instruction (Gloven, 2005).

Digestion

The 42 composite samples of burukutu and pito collected in a clean rubber container were digested to extract metals following the method described in details (with some modifications) by APHA (1998). Exactly 5.0 mL of the samples each of Burukutu and Pito were introduce into beakers and 5.0 mL of concentrated HCl was added, followed by 15.0 mL of concentrated HNO_3 and the mixture was heated in a hot plate at temperature between 40 – 60°C for 45 min for complete digestion. The digest was allowed to cool in the fume cupboard and the solutions were made up to 50.0 mL mark and filtered through Whatman number 42 filter paper, then it was transferred to sample holder and labeled for analysis. Results were presented as mean ± standard deviation. Test of significant ($p<0.05$) was carried out usingStudents t-test and Analysis of Variance (ANOVA) using Statistical Packages for Social Sciences (SPSS 16.0) version for window (SPSS Inc., USA)

Results and Discussion

The physicochemical parameters of burukutu and pito namely: temperature, pH, titratable acidity, specific gravity and alcoholic content are represented in Table 1. Microbial culture of naturally fermented samples and suspected bacteria/fungi for burukutuand pito are represented in the Tables 2 – 5. Mean concentration of heavy metals in analysed brews are shown in Table 6. The mean concentration (mg/L) was in order of Pb> Cd > Cr > Fe > Ni > Zn.

Temperature: The temperature values of burukutu ranges from 30.0±1.1 – 31.0 ±2.4°C as shown in Table 1. The highest temperature for burukutu was found in LAB which is 31.0±2.4°C while the least temperature value was found in APB as 30.0±1.2°C. Also the temperature for pito ranges from 28.3±1.1 to 31.0±3.5°C with highest value found in NYP (31.0±3.5°C), while the least temperature was found in TJP (28.3±1.1°C). The increase in temperature is linked to the fact that all organisms function best at a particular optimum temperature(Lamed and Zeikus, 1980).The optimum temperature depend on whether the organism is mesophilic or thermophilic. Mesophilic organisms function between 30° to 38°C while thermophilic function between 60 – 65 °C.

Table 1: Physicochemical parameters of Burukutu and Pito samples

S/N	Sample code	Tempt. (°C)	pH	Titratable Acidity (M)	Specific Gravity (g)	Alcoholic content (%w)
1	NBB	30.1±1.3	3.90±1.1	0.084±0.05	0.718	5.71
2	SJB	28.4±1.3	4.20±0.4	0.076±0.09	0.718	5.71
3	APB	30.0±1.2	4.10±0.2	0.117±0.07	0.718	5.71
4	TJB	25.3±1.9	3.90±0.3	0.062±0.04	0.718	5.71
5	OIB	29.2±1.5	4.30±0.2	0.069±0.06	0.718	5.71
6	NYB	29.7±1.5	4.40±1.2	0.076±0.02	0.718	5.71
7	LFB	31.0±2.4	4.30±0.3	0.093±0.07	0.718	5.71
8	NBP	31.0±2.3	5.20±1.0	0.102±0.12	0.718	5.71
9	SJB	30.7±1.9	4.60±0.8	0.109±0.05	0.718	5.71
10	APP	30.0±1.2	5.10±0.4	0.104±0.06	0.718	5.71
11	TJP	28.3±1.1	4.70±0.2	0.147±0.04	0.718	5.71
12	OIP	29.0±1.2	5.30±0.4	0.104±0.09	0.718	5.71
13	NYP	31.0±3.5	5.10±0.2	0.132±0.12	0.718	5.71
14	LFP	30.31.54	5.40±0.5	0.104±0.11	0.718	5.71

pH: Result in Table 1 also revealed that pH of Burukutu ranges from 3.90±0.3 to 4.40±1.2. The highest pH value was found in NYB as 4.40±1.2, while the least pH value was found in TJB to be 3.90±0.3. The pH value (3.9 – 4.4) reported for this study is in good agreement with those (3.36-4.86) presented by Igyor *et al.* (2006). The pH value of the fermented alcoholic beverage may have favoured the growth of fungi and this could have resulted from the species of the organism isolated (Kolawole *et al.*, 2007). The pH value of pito ranges from 4.60±0.8 to 5.40±0.5. The highest pH value of pito was found in LFP, which is 5.40±0.5, while the least pH value of pito was found in SJP as 4.60±0.8. The pH value of pito obtained from the present study fell within the range (3.8 – 6.8) reported by Orji *et al*. (2003).

Titratableacidity: The titratable acidity value of burukutu is shown in Table 1. The titratable acidity ranges from 0.069±0.04 to 0.117±0.07. The highest titratable value of burukutu was found in APB which is 0.117±0.07, the least titratable acidity of burukutu was found in TJB as 0.06±0.04. The titratable acidity value found in the present study is lower than titratable acidity of 1.55 ± 0.3 reported by Eze *et al.* (2011). According to Wonang and Opoefe (1999), the high titratable acidity of burukutu may be due to traditional methods of production which are non- standardized in terms of raw materials, equipment and finished product quality as well as handling. The tittratable acidity of pito (0.102±0.1 to 0.147±0.04) are presented in Table 1. The highest titratable

acidity was found in TJP (0.147±0.04), while the least titratable acidity was found in NBP as 0.102±0.1. Fadahunsi *et al.* (2013) reported titratable acidity of pito from daily bases range from 1.65 – 1.92, this is higher than the value reported in the present study. High titratable acidity could be linked to the duration of fermentation where in carbondioxide formed is oxidized to acetic acid (Prescott *et al*., 2005).

Specific gravity: The mean specific gravity values measured for Burukutu samples are the same (0.718±0.0). The specific gravity of 0.99±0.02 was reported by Eze*et al.* (2011), which was higher than the value reported in the present study. The low value of the samples could be an indication that some of the sugar has been converted into alcohol which is less dense than water. Results from Table 1 also show that the specific gravity of pito for all samples is the same (0.718±0.0). Orji *et al*. (2003) reported specific gravity of pito to range from 1.02 to 1.04, which was higher than the value obtained in the present study. The high specific gravity may be due to the amount of the sugar present in pito which are yet to be converted to alcohol (Egemba and Etuk, 2007).

Alcoholic content: The determination of alcoholic content of burukutu revealed that all the samples have the same alcoholic content (5.71). The value was higher than the alcoholic content of 2.8 reported by Fadahunsi*et al.* (2013). The elevation in the alcoholic content could be due to available fermentable sugar. Similar results for alcoholic content (5.71) were observed for pito. The value was higher than those (3.09) reported by Fadahunsi*et al.* (2013). The increase in the alcoholic content may be due to the presence of the fermentable sugar in beer.

Table 2: Suspected bacteria isolates in Burukutu samples

S/N	Bacteria	Microscopic identification	Number of isolate
1	*Streptococcus species*	Gram positive cocci chains	11
2	*Staphylococcus species*	Gram positive cocci clusters	9
3	*Entrobacter species*	Gram negative rod	1

Table 3: Suspected bacteria isolates in Pitosamples

S/N	Bacteria	Microscopic Identification	Number of isolates
1	*Streptococcus species*	Gram Positive Cocci in Chain	10
2	*Staphylococcus species*	Gram positive cocci in clusters	9
3	*Klebsiella species*	Gram negative non motile rods	3
4	*Micrococcus species*	Gram positive Cocci in tiny form	1
5	*Salmonella species*	Gram negative non spore forming rods	1

Microbial culture of naturally fermented sample: Bacterial identification was carried out using gram staining reaction and fungi identification was carried out by microscopic and macroscopic examination. Microscopic examination of the sample indicated the presence of microorganism. Bacteria culture of burukutu (Table 2) indicated the suspected organisms to be *Streptococcus species*, *Staphylococcus species*, and *Entrobacter species*. On the contrary, five micro-organisms were suspected as present in pito (Table 3). They include *Streptococcus species*, *Staphylococcus species*, *Klebsiella species*, *Micrococcus species and salmonella species*.

Tables 4 and 5 show the common micro-organisms that are suspected for the fungi culture of burukutu and pito, respectively. The result obtained was in agreement with those reported by Kolawole *et al.* (2007). These micro-organisms isolates are of great concerned since most of them are pathogenic to man. The presence of *Staphylococcus species* in the samples may be attributed to handling during production. *Staphylococcus species* in a normal flora of the body and mucous membrane is linked to aetiological agent of septic arthritis (Ellen and Sydney, 1990). The organisms can pass onto the food during harvesting, processing or even storage. The consumer is at risk of acquiring food borne disease. *Saphylococcus species* is the major cause of staphylococcal poisoning which is characterized by diarrhea and vomiting (Eze *et al.*, 2008).

Heavy metals analysis: The trace metal levels were determined using AAS and the trends in burukutu and pito samples were in decreasing order of Pb> Cd > Cr > Fe > Ni > Zn. Statiscal analysis shows that there was a significant difference ($p<0.05$) of metals analysed for burukutu and pito.

Table 4: Suspected fungi isolated in Burukutu samples

S/N	Fungi	Macroscopic Identification	Microscopic Identification	Number of Isolates
1	*Saccharomyce species*	Brown creamy round growth	Cells are large globes and also budding	7
2	*Aspeergillus species*	Black colonies	Steplate hyphae with v-shaped branching	10
3	*Penicillium species*	Pink creamy hairy colonies	Cells are cover with hairy growth	7
4	*Sporontrichum species*	Green creamy round colonies	Cells are clusters and trade like form	7
5	*Rhizopus species*	Black creamy scalter colonies	Cells are round shape	7
6	*Mucor species*	Black round sharp with small black pore	Cells are enclosed	4
7	*Blastomyces species*	Mycelia growths	Cells growth with little branches	3
8	*Mold species*	Black spongy	Cells are spongy like growth	1
9	*Paracoccidioicides species*	Green yellow growth	Cells are larger with thinner walls	1
10	*Coccidioidesimmitis*	Blue wish growth	Cells form chain	1

Table 5: Suspected fungi isolates in Pito samples

S/N	Fungi	Macroscopic Identification	Microscopic Identification	Number of Isolates
1	*Saccharomyce species*	Brown creamy round growth	Cells are large globes and also budding	6
2	*Aspeergillus species*	Black colonies	Steplate hyphae with v-shaped branching	12
3	*Penicillium species*	Pink creamy hairy colonies	Cells are cover with hairy growth	12
4	*Sporontrichum species*	Green creamy round colonies	Cells are clusters and trade like form	8
5	*Rhizopus species*	Black creamy scatter colonies	Cells are round shape	9
6	*Mucor species*	Black spongy	Cells are spongy like growth	5
7	*Blastomyces species*	Mycelia growths	Cells growth with little branches	1
8	*Mold species*	Black spongy	Cells are spongy like growth	1

Table 6: Mean concentration of trace metals (mg/L) in Burukutu and Pito samples

S/N	Sample code	Cd	Cr	Pb	Zn	Fe	Ni
1	NBB	0.016±0.003	1.24±1.9	1.83±0.3	0.23±0.2	7.78±0.5	0.47±1.1
2	SJB	0.023±0.002	0.47±0.20	1.93±0.2	0.33±0.1	3.45±0.1	0.02±0.03
3	APB	0.019±0.01	2.16±0.40	1.76±0.04	0.32±0.2	8.12±0.8	0.94±2.1
4	TJB	0.019±0.01	0.50±0.24	1.69±0.2	0.46±0.4	3.84±0.5	0.04±0.1
5	OIB	0.015±0.04	0.36±0.02	1.60±0.02	0.54±0.54	3.84±2.5	ND
6	NYB	0.018±0.01	0.62±0.66	1.20±0.6	0.300±0.02	2.81±1.2	0.13±0.3
7	LFB	0.024±0.02	0.80±0.90	1.75±0.2	0.28±0.1	4.99±0.4	0.21±0.4
8	NBP	0.024±0.02	0.81±1.1	1.35±0.5	0.22±0.2	5.30±0.6	0.33±0.6
9	SJP	0.009±0.01	0.91±1.3	1.66±0.3	0.17±0.2	2.20±0.1	0.27±0.5
10	APP	0.021±0.01	0.94±1.3	1.52±0.5	0.28±0.01	4.79±2.2	0.28±0.6
11	TJP	0.013±0.01	0.79±0.9	1.54±0.4	0.11±0.2	3.06±0.4	0.21±0.4
12	OIP	0.017±0.01	0.77±0.9	1.61±0.4	0.18±0.3	3.26±0.5	0.24±0.6
13	NYP	0.015±0.001	0.74±0.9	1.40±0.5	0.11±0.1	2.76±0.3	0.25±0.6
14	LFP	0.017±0.01	1.82±0.3	1.80±0.1	0.12±0.2	8.13±0.7	0.77±1.7

Cadmium (Cd): The concentration of Cd in burukutu sample ranges from 0.015±0.04 mg/L to 0.024±0.02 mg/L (Table 6). The highest mean concentration was found in LFB which is 0.024±0.02 mg/L while the lowest mean concentration was found in OIB as 0.015±0.04 mg/L. The high concentration of Cd in LAB could be as a result of the deposition of Cd contained in water and materials like plates, jewelries, cigarettes filters, battery works and exhaust pipe. The detected concentration of Cd in all the sample of burukutu, were far above the WHO (2006) limit of 0.003 mg/L in drinking water. Food is the main source of daily exposure to Cd. Severe toxic symptoms resulting from cadmium ingestions are reported between 10 to 32 mg (Anim *et al.*, 2011). The concentration of Cd in the pito sample ranges from 0.009±0.01 – 0.024±0.02 mg/L. The highest mean concentration was found in NBP which is 0.024±0.02 mg/L while the lowest mean concentration was found in SJB as 0.009±0.01 mg/L. The high concentration of Cd in pito sold in NBP may be due to vehicular emission of Cd pigments as well as agricultural activities such as application of fertilizer and herbicide on the farm land where the grain is planted. Cd has been noted for its high mobility in soils and underground water (Fotiadis and Lolas , 2011).

Chromium (Cr): The concentration of Cr in the sample of burukutu which ranges from 0.36±0.02 to 2.16±0.40 mg/L. The highest mean concentration was found in APB which is 2.16±0.40 mg/L, while the least mean concentration was found in OIB as 0.36±0.02 mg/L. The elevated concentration of Cr in burukutu may be due to fossil fuel burning, preparation of nuclear fuels, electroplating, dye and pigments. The concentration of Cr in the Pito which ranges from 0.74±0.9 to 1.82±0.3 mg/L was shown in Table 6. The mean concentration of Cr was higher at LFP which is 1.82±0.3 mg/L, while the least mean concentration was found for NYP. The higher concentration could be linked to water used during the production and handling. Chromium has been reported to have beneficial effects on type II diabetes (Hague *et al.*, 2008). The possible sources of Cr in pito could be that of processing and storage. The permissible limit of Cr in drinking water in Nigeria is set at 0.05 mg/L (NIS, 2007).

Lead (Pb): High levels of Pb in some of the sample may result to food poisoning in humans acute or chronic exposure. The concentration of Pb in burukutu samples ranges from 1.20±0.05 to 1.93±0.2 mg/L. The highest mean concentration was found in SJB as 1.93±0.2 mg/L, while the lowest concentration was reported for NYB as 1.20±0.06 mg/L. High amount of Pb may be linked to the water source and soil nature containing high lead content. Higgings and Dasher (1986) pointed out that water contamination can be by many manufacturing processes and by wastewater from sewage. The Pb concentration detected in burukutu was far above the WHO permissible limit (WHO, 2006). The concentration of Pb in Pito samples range from 1.40±0.5 mg/L to 1.80±0.1 mg/L. The highest mean concentration of Pb was at LFP, while the least mean concentration was found in NYP. According to report by Duodo *et al*. (2012), Pb concentrations of pito ranged from 0.01 to 0.272 mg/L with the highest and lower detectable concentrations of 0.272 mg/L and 0.056 mg/L, respectively. This concentration range is lower than that of the present study. Pb concentration in the drinks may be due to the water used for preparation and as well as the level in the cereal used. Pb may cause kidney damage, and anaemia, nerve and brain damage, and even death (Comrad and Umbriet, 2000).

Zinc (Zn): The concentration of Zn in burukutu samples range from 0.23±0.02 to 0.54±0.5 mg/L. The highest mean concentration was found in OIB which is 0.54±0.5 mg/L, while the least was found in NBB as 0.23±0.02 mg/L. The Zn concentration in all sample are below the maximum limit WHO (2006). The permissive limit of Zn in alcohol is set at 5.0 mg/L (OIV, 2008). Woldemariam and Chandravanshi (2008)reported Zn concentrations in the range of 1.82 –2.70 mg/L in Ethiopian wines. The concentration of Zn found in this study is lower than those reported in literature for the Ethopian wine. The concentration of Zn in Pito ranges from 0.11±0.02 to 0.28±0.02 mg/L. The highest mean concentration of Zn was found in APP which is 0.28±0.02 mg/L, while the least mean concentration was found in TJP as 0.11±0.02 mg/L. The concentration of Zn in Pito were below the acceptable limits (WHO , 2006). Anim *et al.* (2011) reported that the lowest concentration of Zn in pito is 0.45 mg/L for Bolgatanga while the highest concentration 0.910 mg/L was measured for pito in Accra. The concentration of Zn recorded by Anim *et al.* (2011) was higher than the value of Zn in the present study.

Iron (Fe):- The concentration of Fe in burukutu sample ranges from 2.81± 1.2 to 8.12± 0.8 mg/L. The higher mean concentration of Fe was found in APB as 812±0.8 mg/L while the least mean concentration was found in NYB (2.81±1.2 mg/L). The high concentration of Fe in the study area may be traceable to its abundance in the earth crust. High concentrations of Fe in soils relative to other metals have been reported in various studies, confirming that natural soils contain significant levels of Fe (Aluko and Oluwande, 2003). Salako *et al.* (2016) reported the concentrations of the Fe content in alcoholic and non alcoholic drinks to range between 1.09 – 2.46 mg/L and 0.572 – 1.73 mg/L. The concentration of Fe reported in the present study is higher than the

concentration of Fe reported in the literature for alcohol and non alcohol drinks. The concentration of Fe with in pito sample ranges from 2.20±0.1 to 8.13±0.7 mg/L. The highest mean concentration of Fe was found in LFP which was 8.13±14.1 mg/L while the least mean concentration of Fe was found in SJP to be 2.20±1.2 mg/L. Fe has the highest levels amongst the trace metals studied. Fe is an essential element in human diet and is found in natural fresh water at levels ranging from 0.5 to 50 mg/L. Estimate of the minimum daily requirement for Fe depend on age, sex, physiological status and Fe bioavailability and range from about 10 to 50 mg/day (WHO/EU, 2011). It forms part of haemoglobin, which allows oxygen to be carried from the lungs to the tissues. Severe Fe deficiency causes anaemia in human (Nyanzi and Jooste, 2012).

Nickel (Ni): The concentration of Ni in burukutu ranges from 0.02±0.03 to 0.94±2.1 mg/L. The highest mean concentration is found in APB which was 0.94±2.1 mg/L, while the least mean concentration of Ni was found in SJB to be (0.02±0.03 mg/L). The concentration of nickel in burukutu is above the maximum limit of WHO (2006). The concentration of Ni in Pito sample ranges from 0.21±0.41 to 0.77±1.7 mg/L. The highest mean concentration of Ni was found in LFP which is 0.77±1.7 mg/L, while the least mean concentration was found TJP as 0.21±0.41 mg/L. The concentration of Ni is above the WHO guideline for Ni in drinking water (0.02 mg/L) (WHO, 2006). The major source of Ni in humans is food and uptake from natural sources, as well as food poisoning (NAS-NRC, 1982). Increase incidence of cancer of the lung and nasal cavity caused by high intake of Ni has been also been reported in workers of Ni smelters (NAS-NRC, 1975). Natural concentration of Ni in soil is less than 100 mg/kg, though it can be exceptionally high in some cases especially in soil formed from ultra-basic rocks.

Conclusion

The study revealed that burukutu has the highest concentrations of Pb, Fe and Zn while pito has the highest values of Cd, Cr and Ni. The concentration levels of Cd, Cr, Pb, Fe and Ni for burukutu and pito were above recommended maximum limit, while the concentration of Zn in the sample was within the acceptable limit (WHO/EU, 2011). The variation of elemental concentration observed may be due to the difference in the level of these trace metals in raw materials especially the grains, water used, the extent and nature of water purification and quality control procedure, utensils for cooking or boiling and fuel emission gasses.However, some of the samples analysed for Ni fell within the acceptable limit, while some are below the maximum limit in drinking water. There was also a significant difference ($p<0.05$) of metals analysed for burukutu and pito. Generally, findings from this study could add to existing data in the Nigerian food drink compilation and baseline data to the food – drink compilation table of some of the states. It could be a wakeup call to habitual consumers and unsuspecting populace.

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