PROXIMATE AND MINERAL COMPOSITION OF A SORGHUM STEM SHEATH BEVERAGE (*Poporo*) SPICED WITH AFRAMOMUM MELEGUETA EXTRACT

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ABSTRACT

This study investigated the nutritional quality of a non-alcoholic beverage produced from sorghum stem sheath (Poporo) spiced with alligator pepper *(Aframomum melegueta)*. The most appropriate ratio of 1:30 (w/v) stem sheath flour to water based on preliminary test was employed for the beverage formulation. Alligator pepper was added in sequential concentrations of 0.5, 1, 1.5, 2, and 2.5% making a total of 6 samples with the control. The nutritional quality of laboratory produced poporo beverage (obtained from aqueous extract of dried stem sheath of *Sorghum bicolor* was investigated. The samples were subjected first to pasteurization at 75°C for 15mins. The formulated beverage samples with alligator pepper extract were analyzed to determine its nutrient profile: proximate and mineral composition. Proximate analysis of the spiced stem sheath beverage showed the moisture content to range between 88.2-87.7%, crude protein between 0.047--0.005% and crude fat from 0.140-0.009% while pH and titratable acidity were 7 and 4 for all the beverage samples respectively. The plain beverage sample had the least protein and fat contents thereby indicating the significant effect of the aframomum melegueta spice on the beverage samples at $p<0.05$. High mineral contents were also recorded for the spiced beverage samples: magnesium ranged between 145.00-200.40mg/100ml, sodium ranged between 25.20-25.00mg/100ml, potassium ranged between 26.68-23.03mg/100ml, calcium 50.00-54.54mg/100ml, iron 4.00-5.91mg/100ml, zinc 2.50-3.51mg/100ml, manganese 0.38-0.89 and copper 0.041-0.079mg/100ml while the plain beverage sample had the least mineral contents. The nutrient profile increased significantly at $p < 0.05$ with the addition of alligator pepper, the degree of enhancement was dependent on the concentration of the spice. The overall sensory evaluation revealed that acceptability was in order of 0.5% extract of alligator pepper being the best preferred by the panelists.

Key words:*beverage, proximate composition, mineral, sensory, sample*

1.0 INTRODUCTION

Many human degenerative diseases like cancer, diabetics, hypertension, cardiovascular, age-related macular, cyclophosphamide induced oxidative stress and neuro-degenerative diseases have been recognized as being a consequence of free radical damage which are becoming rampart among Nigerian populace. Nevertheless, there have been many studies undertaken on how to delay or prevent the onset of these diseases (Oboh*et al.* 2008). The most likely and practical way to fight degenerative disease is to improve body antioxidant status, which could be achieved by higher consumption of foods rich in antioxidant substances. It is widely accepted that plant-based diets with high intake of fruits, vegetables, and other nutrient-rich plant foods may reduce the risk of oxidative stress-related diseases (Karslen*et al.* 2007). There is consistent evidence, primarily from epidemiology, that diets high in vegetables and fruits can decrease burden of chronic/ degenerative disease, with the evidence for reduced risk of many cancers being particularly strong. In fact, increasing fruit and vegetable consumption is regarded as the second most important strategy for cancer prevention after reducing smoking (Bray, 2008; 2010; Van Dam and Seidell, 2007).

Studies indicate that urbanization and economic development have led to the emergence of a

nutritional transition characterized by shift to higher caloric content diet and or reduction of physical activity (Popkin, 2003). This transition creates enormous public health challenges, failure to address which may impose significant burden for the health sector and the economy of Nigeria (Asfaw, 2005). In Nigeria, many populations are living with higher levels of chronic disease and disability which makes the government to have to cope with social and health care costs (Thomasset*et al.* 2009; Karslen*et al.,* 2007; Neto, 2007; Hou, 2003). Also, evidence suggests that the increasing burden of chronic diseases has grave consequences as very few people will seek treatment, leading to high morbidity and mortality rates from potentially preventable diseases (Dada *et al.* 2007).

According to World Health Organization (WHO) estimates, about 60% of deaths in the world are caused by non-communicable diseases. In 2005, an estimated 17.5 million people died of cardiovascular disease (CVD) representing 30% of all global deaths of which 80% were from low- and middle-income countries (WHO, 2010). By 2020, studies reveal that mortality by CVD is expected to increase by 120% for women and 137% for men. These findings highlight the need to explore possibilities of minimizing or eradicating CVDs and other non-communicable diseases in developing countries such as Nigeria (BeLue*et. al.,* 2009).The seasonal nature of most fruits and vegetables available on the Nigerian market coupled with inadequate storage and processing facilities has limited the consumption of these commodities by majority of the people in the country. Industrial exploitation of indigenous plants such as sorghum (S*orghum bicolor)* stem sheath reported to be nutritive and high in antimicrobial and antioxidant substances (Adetuyi*et al*.,2007) in developing a non -alcoholic beverage will indeed be of benefit to the people in terms of food quality, well- being and economy.

Sorghum is one of the most important staple crops in Nigeria. Its production was estimated to surpass all other cultivated crops in Nigeria as reported by Murty and Kumar (1995). For instance, in the Nigeria savannah zone, sorghum is grown on an estimated area of 4.5 million hectares with annual production output of about 6 million tonnes (FAO, 1995a). The leaves and grains are also incorporated into livestock feeds and the stalks for thatching houses and making fences (Rooney and Waniska, 2000).Thestem is sweet and contains some sugars and minerals which make it useful for syrup manufacture. The dried stem is used as fuel in the tropics (Taylor and Dewar, 2000). It is a very valuable industrial crop for brewing alcoholic and non- alcoholic drinks as well as in the baking and confectionery industry in Nigeria (Odetokun, 1997). Sorghum has greater unutilized potentials than any other crop. Information available in the literature reveals that the sorghum stem sheath is still confined to traditional use only. Presently, sorghum stem sheath is being used locally in herbal preparation in Nigeria to cure certain diseases, however information on its composition and food potentials are scarce which may be attributed to its being underutilized in food processing. Hence, its industrial exploitation in beverage making would be of great advantage to the people of Nigeria and beyond in terms of nutrition, food and livelihood security.

The mature black purple sheath of the stem (locally known as poporo) generally sold in small bundles is used as color additives in cooking meals and also taken as beverages when steeped or boiled in water in many homes (Adetuyi, 2004). It can also be used to extend food shelf life. Sorghum bicolor has the highest known concentration of apigenin which corresponds to its anthocyanin quantity thereby making it a great commercial value as natural colorant in Nigeria (Ilori and Odukoya, 2005).Sorghum stem sheath extractas folklore for the management of anaemia and some other diseases in many Nigeria homes. It is used to boost blood levels to treat anaemia, stop pain and inflammation, reverse cell damage (antioxidant) and increase cellular immunity in persons living with HIV/AIDS (Aiyeloja and Bello,2006). In South Western Nigeria, the extract has been used for many generations to treat sickle cell anemia, leukemia, multiple mycloma, headaches, heart and other blood-related disorders. Consumption of fermented drink from sorghum bicolor seeds alone for seven days can serve as good anti-sickling drugs (Ogunyemi, 2004). The stem of *Sorghum bicolor* has also been reported to be used as an anti-malaria and anthelmintic (Dada *et al,* 2003). Higher consumption of food of plant origin such as *Sorghum bicolor* stem extract rich in natural antioxidants that can scavenge free radicals has been reported to fight against degenerative diseases (cyclophosphamide-induced oxidative stress) thereby improving the body's antioxidant status (Oboh*et al.,* 2010).

Antioxidant properties of spices have been recognized about six decades ago when it was demonstrated that spices effectively increased the antioxidant capacity of foods and that their effects depended on food matrices (Ben- Nwadibia and Ndukwu, 2005). Studies on culinary and medicinal herbs identified the superiority of spices in antioxidant capacity to berries, other fruits, vegetables and nuts (Wood and Pittler, 2000). The use of local spices to control the activities of micro-organisms in

food has been reported (Akpomedaye and Ejechi, 1998; Nwafor and Ogiehor, 2003). Apart from antimicrobial activities, spices are believed to have medicinal value (especially in African settings) and have desirable determinative influences on the overall organoleptic analysis when used. It is desirable therefore that further exploitation of locally available spices in the formulation of acceptable non- alcoholic beverage be encouraged for the benefit of the local people and the nation at large. This study therefore, seeks through intensive investigation to develop an acceptable non- alcoholic beverage from *Sorghum bicolor* stem sheath in combination with alligator pepper.

The specific objectives were:

(1) to formulate an acceptable beverage from the sorghum stem sheath in combination with alligator pepper;
(2) to evaluate the nutritional composition of the spiced sorghum stem sheath beverage.

2. METHODOLOGY

2.1 SOURCE OF MATERIALS

Mature reddish-purple *Sorghum bicolor* L. Moench stem sheath locally known as *poporo,* alligator pepper (*Aframomummelegueta*)and food grade sucrose. Sorghum stem sheath in dry form and alligator pepper were purchased from a local market in Osogbo, Osun State, Nigeria.

2.2 PREPARATION OF SORGHUM STEM SHEATH FLOUR

The sorghum stem sheath was dry cleaned and further dried in an air oven at 50°C for 6 hrs for moisture uniformity. The dried samples were milled separately into flour using a coffee mill and sieved through 450µm aperture sieve. The flour samples were packed in air tight containers until utilized.

2.3 PREPARATION OF POPORO EXTRACT

The stem sheath flour was soaked for 30mins at ambient temperature before boiling for 30mins. The extract was then filtered with clean muslin cloth to obtain clear filtrate. The filtrate was sweetened with food grade sucrose to a brix level of 10°.The sweetened beverage was then dispensed into previously sterilized bottles before pasteurization at 75°C for 15mins (Adetuyi,2007).

2.4 PREPARATION OF LIQUID EXTRACT OF ALLIGATOR PEPPER

The method described by Adegoke*et al.* (2000) was adopted with some modification. The alligator seeds were sorted and cleaned from extraneous materials. It was further dried in an oven at 50°C for 48hrs only. It was further pulverized in an hammer mill and sieved in a powdered form. The powdered spice was then packed in an air tight container. The flowchart for the process is described in Figure 1.

Moreover, the dry crude extract of alligator pepper (*Aframomummelegueta*) was weighed differently andmixed with distilled water at (50:100, 100:100, 150:100, 200:100, 250:100) w/v to make 0.5%, 1.0%, 1.5%, 2.0% and 2.5% concentration. Each mixture was then pasteurized at 75°C for 15minutes and the liquid extracts were kept in previously sterilized bottles and cooled at ambient temperature before storage in a refrigerator (8 ± 2°C) until used.

2.5 BEVERAGE FORMULATION FROM THE STEM SHEATH FLOUR AND THE SPICE EXTRACT

The most appropriate ratio of 1:30 (w/v) stem sheath flour to water was used for the beverage preparation. The filtrate obtained was mixed with the extracts of alligator pepper (*Aframomummelegueta*) at above concentrations. This implies a total of 6 samples including beverage without spice (control). The mixture was sweetened as described above before boiling for 30mins.The beverage samples were pasteurized as described above to obtain a ready to drink beverage. The flowchart for the process is described in Figure 2.

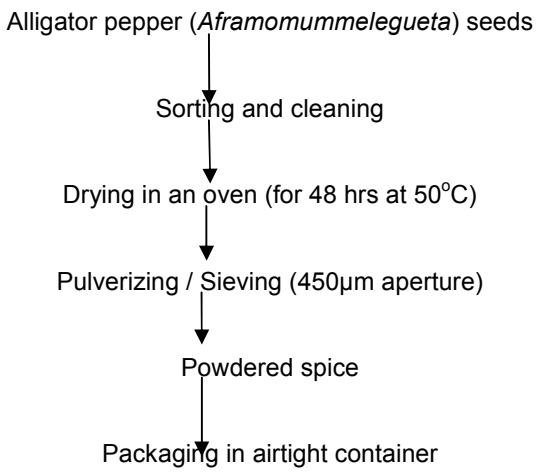
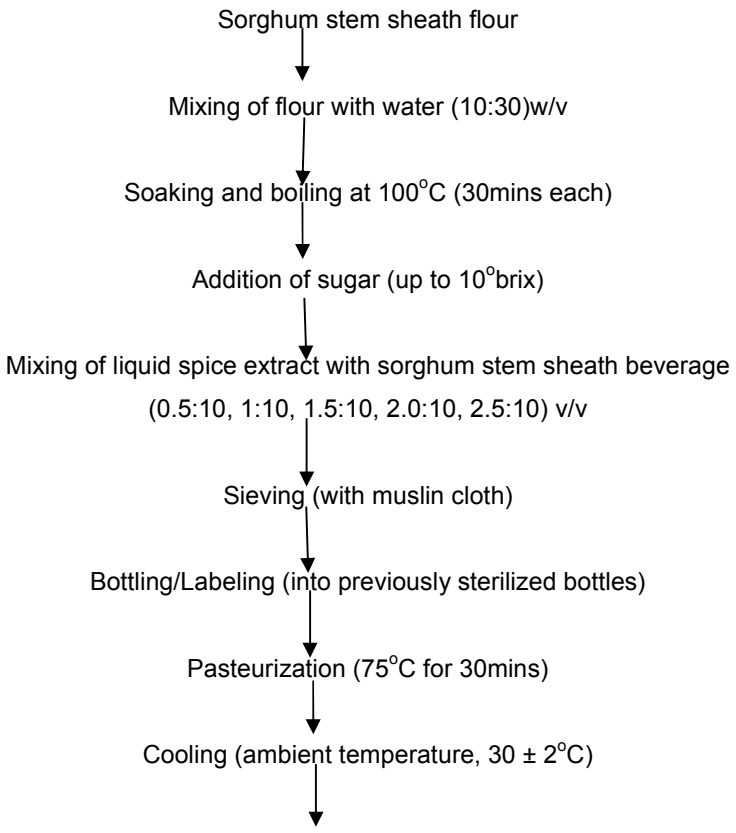


Fig. 1: Flow chart for production of crude spice extracts from*Aframomummelegueta*

Source: Adegoke*et al.* (2000)



Poporo

Fig.2: Flow chart for the production of spiced beverage samples from sorghum stem sheath flour

Source: Adetuyi*et al. (*2007)

2.3 PROXIMATE COMPOSITION OF THE STEM SHEATH BEVERAGE

Crude protein and fat, dry matter and moisture content were determined according to AOAC (2005).

2.4 CHEMICAL ANALYSIS

2.4.1 Determination of pH and titratable acidity: Thesewere done according to AOAC,2005

2.4.2 Determination of mineral contents.

The method described by AOAC (2005) using Atomic Absorption Spectrophotometer (AAS) Buck Scientific East Norwalk, CT, USA was used for mineral contents determination. The minerals determined were potassium, sodium, calcium, iron, magnesium, copper, manganese, lead and zinc. The main specification wavelength range was 190-900nm, the wavelength accuracy was ±0.25nm, two spectral lines of Mn at 279.5nm and 279.8nm was separated with the spectral bandwidth of 0.2nm and valley-peak energy ratio was less than 30%. The baseline stability was 0.004A/30min, the D2 lamp background correction capability was at 1A. The S-H background correction capability was at 1.8A.Hollow Cathode Lamp turret was 6-lamp turret 4-lamp turret, lamps auto-alignment was fully automated scan and peak-picking. Lamp current was automatically adjusted and displayed, wide pulse current was 0~25mA, narrow pulse current was 0~10mA. Lamp power supply mode was 100Hz narrow square wave pulse+400Hz -. Czerny-Turner design grating monochromatic was used. Gratingwas 1800 l/mm, focal length was 277mm and blazed wavelength was 250nm.Spectral Bandwidth of 0.1nm, 0.2nm, 0.4nm and 1.2nm were used. Auto-switch over Graphite Furnace Temperature range Room temperature was ~3000°C, the heating rate was 2000°C/s.Graphite tube dimension was28mm(L) x 8mm(OD). The standard used was RS-232 serial port communication, characteristic Air-C H flame Cu: characteristic concentration≤0.025mg/L, Detection limit was ≤0.006mg/L; 2 2. The concentrations of the various metallic mineral elements were determined. The analysis was done in triplicates.

2.5 SENSORY EVALUATION

The beverage samples were presented as coded samples to 10 semi -trained panelists according to the method reported by Meilgaard (1991). The panelists were asked to indicate their observations using a 9- point hedonic scale for taste, after taste, flavor/aroma, color, consistency and overall acceptability. The coded samples were served in clean transparent bottles at room temperature (25°C). Samples presented to the panelist were at random and one at a time .The panelists were given enough water to rinse their mouths between each sample. Like extremely and dislikes extremely were ranked 9 and 1 respectively. Statistical analysis was done using Statistical Analysis Software (SAS, 1999) package (version 8.2 of SAS Institute, Inc.). The sensory scores from the ratings were subjected to analysis of variance (ANOVA) and means were separated using Duncan multiple range test (Duncan, 1955) and the significance was accepted at $p<0.05$.

3. RESULT AND DISCUSSION

3.1 PROXIMATE COMPOSITION, pH AND TITRATABLE ACIDITY OF SORGHUM STEM SHEATH BEVERAGE

The proximate composition of sorghum stem sheath beverage is presented in Table 1. The moisture content of the beverages ranged from 87.73-88.23% significant ($p < 0.05$). The sample with the lowest moisture content was those spiced with 5% alligator pepper. It was observed that all the spiced samples had higher moisture content than the controli.e.(without spice). This implies that addition of spice had a significant effect on the moisture content. A decreasing trend in the moisture content with increasing concentration of alligator pepper (*Aframomummelegueta*) in the samples was observed with the exception of the sample spiced with 0% alligator pepper. High moisture content makes beverage suitable as a refreshing and quench-thirsting product which is characteristic of good beverage although is an indication of short shelf life. This might make the beverage to be more pepprish.

Alligator pepper (*Aframomummelegueta*)spiced samples had higher protein content than the plain beverage. The protein content of alligator pepper (3.85%) has contributed significantly at ($p<0.05$) to the increase in protein content of beverage. (Gbadamosi*et al.,* 2011). Plain beverage had a protein content of 0.005% while a range of 0.005 to 0.047% was recorded for samples containing alligator

pepperextracts at varying concentrations, respectively. The observation shows a progressive significant decrease in the protein content with increasing alligator pepper concentration in the sample. This may be attributed to the effect of heat process involved in the extraction which might have destroyed some amino acids with consequent reduction in total nitrogen content of the resulting beverage (Oluwaniyi*et al.,* 2009). However, the protein contents of the alligator pepper spiced samples (0.092-0.052) % were found to be higher than that of the zobo drink (0.046) % produced from *Hibiscus sabdarriffa*calyxes.

Table 1: Chemical and Proximate Composition (%) of Poporo Beverage

Level of addition (%)	Samples	Moisture	Protein	Crude fat	pH	TTA
Control	XK	87.9b	0.005d	0.009c	7.00a	4.00a
0.5	XA	88.2a	0.047a	0.140a	7.00a	4.00a
1.0	XB	88.0bc	0.033b	0.130ab	7.00a	4.00a
1.5	XC	87.9b	0.029b	0.120ab	7.00a	4.00a
2.0	XD	87.8bc	0.018c	0.110b	7.00a	4.00a
2.5	XE	87.7c	0.009d	0.110b	7.00a	4.00a

Key: XA: 0.5% alligator pepper (A.P.) XB: 1.0% alligator pepper XC: 1.5% alligator pepper XD: 2.0% alligat or pepper XE: 2.5% alligator pepper XK: control (without spice).Values are means of 4 determinations. Values with the same letter along the column are not significantly different at p >0.05.

The spiced samples had higher crude fat content than the plain beverage sample. The ether content of alligator pepper (11.00%) has contributed significantly at p<0.05 to the increase in fat content of beverage though the beverage is not a good source of fat (Gbadamosi*et al.,* 2011). Plain beverage had a crude fat content of 0.005% while a range of 0.009 to 0.140% was recorded for samples containing alligator pepperextracts at varying concentrations, respectively. The result showed a progressive significant decrease in the moisture, protein and fat contents as the level of alligator pepperconcentration exceeds 1.5% in the sample. Hence, its inclusion beyond this level may not be advisable.

The pH of the freshly prepared beverage samples with spice was found to be 7 which was neutral while the titratable acidity was found to be 4% which remained fairly constant. The pH of the stem sheath was higher than 0.2 obtained from pre-treated tigernut juice as reported by Ade-Omowaye*et al.* (2009). This is alsoan indication that the beverage is less acidic which may be advantageous to patients with stomach and peptic ulcer and other related problems. The observation reveals that the extract is neutral suggesting the need for inclusion of preservative to extend its shelf-life.

3.2 MINERAL COMPOSITION OF THE NON-ALCOHOLIC BEVERAGE

The mineral composition of poporo is presented in Table 2. Plain beverage (control) had a magnesium content of 145.00mg/100ml while a range of 159.10-200.42mg/100ml was recorded for samples containing alligator pepperextracts at varying concentrations respectively. Alligator pepperspiced beverage samples significantly (p<0.05) had higher magnesium content than the unspiced beverage. A significant (p < 0.05) decreasing trend in the magnesium content with increasing concentration of alligator pepper in the samples was observed. Control sample had the least magnesium content in the beverage indicating the advantage of spicing the beverage with alligator pepper. However,the magnesium content of zobo30.03mg/100ml was lower than that of the stem sheath beverage (Egbere*et al*.,2007)

Plain beverage had a sodium content of 25.00mg/100ml while a range of 25.20- 25.33 mg/100ml was recorded for samples containing alligator pepperextracts at varying concentrations respectively. The observation shows a progressive significant decrease (p< 0.5) in the sodium content with increasing concentration of alligator pepper in the beverage. However, the sodium content of the zobo drink 5.90mg/100ml was found to be lower than that of the stem sheath beverage (Oboh and Elusiyan, 2004).

Table 2: Mineral Composition (mg/100ml) of the non-alcoholic Beverage

Sample code	Mg	Na	K	Ca	Fe	Zn	Mn	Cu
XK	145.00^{d} ± 0.001	25.00^{c} ±0.001	23.03^{c} ±0.001	50.00^{d} ±0.001	4.00^{e} ±0.001	2.50^{f} ±0.001	0.380^{d} ±0.001	0.06^{a} ±0.001
XA	200.40^{a} ±0.001	25.20^{a} ±0.001	28.68^{a} ±0.001	54.54^{a} ±0.001	5.91^{a} ±0.001	3.51^{a} ±0.001	0.89^{a} ±0.001	0.06^{a} ±0.001
XB	190.20^{b} ±0.001	25.18^{ab} ±0.001	26.55^{ab} ±0.001	54.41^{ab} ±0.001	5.75^{b} ±0.001	3.30^{b} ±0.001	0.76^{b} ±0.001	0.07^{a} ±0.001
XC	181.10^{bc} ±0.001	25.15^{b} ±0.001	25.48^{b} ±0.001	54.39^{b} ±0.001	5.52^{c} ±0.001	3.10^{c} ±0.001	0.64^{c} ±0.001	0.07^{a} ±0.001
XD	170.20^{c} ±0.001	25.13^{bc} ±0.001	25.31^{bc} ±0.001	54.35^{bc} ±0.001	5.37^{d} ±0.001	2.90d ±0.001	0.50^{d} ±0.001	0.07^{a} ±0.001
XE	159.10^{c} ±0.001	25.10^{c} ±0.001	23.24^{c} ±0.001	54.28^{bc} ±0.001	5.20^{d} ±0.001	2.70e ±0.001	0.42^{d} ±0.001	0.07^{a} ±0.001

Key: XA: 0.5% alligator pepper (A.P.) XB: 1.0% alligator pepper XC: 1.5% alligator pepper XD: 2.0% alligator pepper XE: 2.5% alligator pepper XK: control (without spice). Values are means ±S.D. of 4 determinations. Values with the same superscript along the column are not significantly different at p >0.05

Plain beverage had a potassium content of 23.02mg/100g while a range of 23.71-28.18mg/100g was recorded for samples containing alligator pepper extracts at varying concentrations respectively. Alligator pepperspiced beverage samples significantly ($p<0.05$) had higher potassium content than the unspiced beverage. A decreasing trend ($p<0.5$) in potassium content with increasing concentration of alligator pepper in the samples was also observed. Nevertheless, it could be seen from Table 2 that the addition of spice significantly enhanced the potassium content of the beverage samples.

Plain beverage had a calcium content of 50.00mg/100ml while a range of 50.18-54.54mg/100ml was recorded for samples containing alligator pepper extracts at varying concentrations respectively. Alligator pepper spiced samples had higher calcium content significantly ($p<0.5$) than the plain beverage. However, the calcium content of zobo drink 6.00mg/100ml was lower than that of the stem sheath beverage (Agarry*et al.,* 2010; Oboh and Elusiyan, 2004). The observation shows a progressive significant ($p<0.5$) decrease in calcium content in the beverages with increasing concentration of alligator pepper.

Plain beverage had iron content of 4.00mg/100ml while a range of 5.20-5.91mg/100ml was recorded for samples containing alligator pepper extracts at varying concentrations respectively. Addition of alligator pepper significantly enhanced the iron content of the beverage samples when compared to the control. However, the iron content ofzobo drink which is reported to be 2.40mg/100ml is much lower than that of the stem sheath beverage (Oboh and Elusiyan,2004)

Thespiced samples had significantly ($p< 0.05$) lower zinc content than the plain beverage. Plain beverage had a zinc content of 2.50mg/100ml while a range of 2.70-3.51mg/100ml was recorded for samples containing alligator pepper extracts at varying concentrations respectively. The zinc content of zobo drink which is 2.68mg/100ml is found to be much lower than that of the spiced stem sheath beverage (Adetuyi*et al.,* 2007). The observation shows a progressive significant decrease in zinc content with increasing concentration of the spice beyond 1.5% in the beverage. A pronounced impact of the spice on the zinc content is noted with the zinc content of all spiced beverages compared with the control.

The spiced beverage samples significantly ($p<0.05$) had higher manganese content than the unspiced beverage. A decreasing trend in manganese content with increasing concentration of alligator pepper in the samples was observed. Addition of the spice into the beverage has contributed significantly to

the enhancement in the manganese content of the beverage. This is similar to the findings of Gbadamosi*et al.,* 2011. Plain beverage had manganese content of 0.38mg/100ml while a range of 0.0899-0.400mg/100ml was recorded for samples containing alligator pepper (*Aframomummelegueta*) extracts at varying concentrations respectively.

3.3 SENSORY ATTRIBUTES OF THE BEVERAGE SAMPLES

The sensory attributes of the formulated beverage samples are presented in Table 3. Beverage spiced with 0.5% alligator pepper (*Aframomummelegueta*) had the best ratings in all sensory attributes evaluated.Unsliced beverage (control) had the least ratings in all the sensory attributes indicating the potential of the spices in producing acceptable beverage from sorghum stem sheath. Interestingly, this observation agrees with the results of the chemical analyses in which 0.5% alligator pepper had the highest rating.Varying the concentration of alligator pepper in the beverage did not result in significant ($p<0.05$) changes in almost all the studied sensory attributes. From the information contained in table 3, beverage formulated with 0.5% alligator pepper was best preferred by the panelists.

Table 3: Mean sensory quality attributes of the formulated sorghum stem sheath beverage

Sample code	Colour	Taste	After taste	Consistency	Flavor	Overall acceptability
XK	5.00c	3.17d	3.50d	3.33d	3.00c	4.83c
XA	6.40a	5.00a	4.83a	5.00a	5.20a	5.83a
XB	5.67ab	4.80a	4.80ab	4.80b	4.83ab	5.80a
XC	5.33b	4.50b	4.60b	4.80b	4.33b	5.40b
XD	5.17bc	4.50b	4.50b	4.33c	4.30b	5.33b
XE	5.17bc	4.20c	4.00c	4.33c	4.28b	5.30b

Key: XA: 0.5% alligator pepper (A.P.) XB: 1.0% alligator pepper XC: 1.5% alligator pepper XD: 2.0% alligator pepper XE: 2.5% alligator pepper XK: control (without spice).Values are means of 4 determinations. Values with the same letter along the column are not significantly different at $p >0.05$.

4. CONCLUSIONS

This study has drawn attention to the potential of sorghum stem sheath and local spices in formulating nutritious and health promoting non-alcoholic beverage for the consumption of the Nigerian populace. From the foregoing, it can be concluded that sorghum stem sheath is a promising rich plant material that could be used in the formulation of functional foods as evidenced in its nutritional profile recorded in this study. Protein, fat and mineral contents increased significantly in all the spiced samples. The most abundant minerals in the drink were magnesium followed by calcium, potassium, sodium, iron, manganese, copper and zinc. However, progressive decrease in the nutrient was observed with increasing concentration of the spices beyond 1.5%. This could be attributed to the dilution influence by other components in the spices at higher levels of spice inclusion. The result of this study reveals that nutritious non-alcoholic beverage could be produced from sorghum stem sheath with local spice.

5. RECOMMENDATIONS

The following recommendation could be made from this study:

The formulated beverage could serve as a refreshing drink to people of all social classes thereby replacing synthetic drinks which are detrimental to human health. Industrial production of this beverage should therefore be encouraged, which would not only alleviate the longing for fluid intake in warm tropical climate but could also provide a cheaper and more nutritive drink than the sugar laden fizzy drinks in the market. Further studies are needed on the synergetic effect of two local spices. Other spices are recommended to generate more data which could assist in the commercial production of the product.

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