

**Proximate and Mineral Composition of a Non-Alcoholic Beverage
Spiced With *Aframomum melegueta* Extract Produced from
Sorghum bicolor Stem Sheath**

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Abstract

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 revealed that the beverage is a nutrient dense commodity with health promoting substances and high level of protein and fat: the moisture content ranged between 88.230-87.725%, crude protein ranged between 0.005--0.009% and crude fat from 0.009-0.140% while pH and TTA were 7 and 4 for all the beverage samples, respectively. The plain beverage sample had the least protein and fat content this thereby revealing the significant effect of the spice on the beverage samples at $p < 0.05$. The proximate composition of the beverage samples increased with increase in concentration of the added spice. High mineral contents were also recorded for the spiced beverage samples: magnesium ranged between 200.40-181.10mg/100ml, sodium ranged between 25.330-15.170mg/100ml, potassium ranged between 28.180-23.025mg/100ml, calcium 54.540-50.000mg/100ml, iron 5.910-4.000mg/100ml, zinc 3.505-2.500mg/100ml, manganese 0.890-0.380 and copper 0.0720-0.0605mg/100ml while the plain beverage sample had the least mineral content. 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: poporo, beverage, proximate, mineral, sensory.

32 INTRODUCTION

33 Sorghum is an important staple food crop in African, South Asia and Central America, is the
34 fifth major cereal crop in the world after wheat, rice, maize and barley (Kochar, 1981). It is also
35 grown in the United States, Australia, and other developed nations for animal feed. Sorghum is most
36 extensively cultivated in the drier Northern Guinea, Sudan Savannah and Greenland of African, Plains
37 of India and the Great plains. United State of America (FAO, 1988). It has grown in India and China
38 for almost 2000 years. It is a vastly complex genus, embracing hundreds of variants of different
39 characteristics and adapted to different ecological riches and with a variety of economic uses. It
40 resembles maize in its vegetative character but different in having narrow leaves and a waxy bloom
41 covering the leaves and stem. It also has a well-developed root/stem which is twice as efficient as that
42 of maize although its leaf area is only half that of maize (Hartman *et al.*, 1988).

43 Historically, sorghum has been used in West Africa to color leather goods which include
44 suitcases, shoes, baskets, hats and book covers. Traditionally, bundles of leaf sheaths are extracted in
45 a laborious cottage –industry process. Other uses of sorghum include the production of industrial
46 alcohol from the seeds, vegetable oil, broom-making, adhesives, waxes, sizing papers and cloth
47 (Marley *et al.*, 1997). *Sorghum bicolor* are popularly used nationwide to prepare a gruel meal or pap.
48 The gruel has been found to be highly nutritious (Olukemi and Olukemi, 2005). There is a huge
49 potential benefit, both economic and health wise if this food crop is developed as a natural food
50 colorant in Nigeria. The stem has been used in the preparation of local medicine to treat anaemia and
51 other related blood ailment. It has been reported to be used as an anti-malarial and anthelmintic
52 (Wood and Pittler, 2000).

53 The *Sorghum bicolor* L. Moench stem is sweet to taste and is found to contain some sugar
54 and minerals ; this sugary nature makes it to be easily chewed in African and Asia and is used for
55 manufacture of syrup (Odetokun, 1997). It is also used as color additive in cooking meals and taken
56 as beverages when steeped or boiled in water in many homes in Nigeria (Adetuyi, 2004). The use of
57 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. In view of these, it is therefore deemed fit to analyse the sorghum stem sheath beverage in combination with ginger for its nutritive value.

MATERIALS AND METHODS

Mature reddish-purple *Sorghum bicolor* L. Moench stem sheath locally known as *poporo*, alligator pepper (*Aframomum melegueta*) and food grade sucrose. Sorghum stem sheath in dry form and alligator pepper were purchased from market in Osogbo, Osun State. The method described by Adetuyi *et al.* (2007) was adopted with some modifications. The sorghum stem sheath was dry cleaned and further dried in an air oven at 30°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.

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. The beverage samples were then subjected to further investigations. The beverage samples were represented by plates 1 and 2.

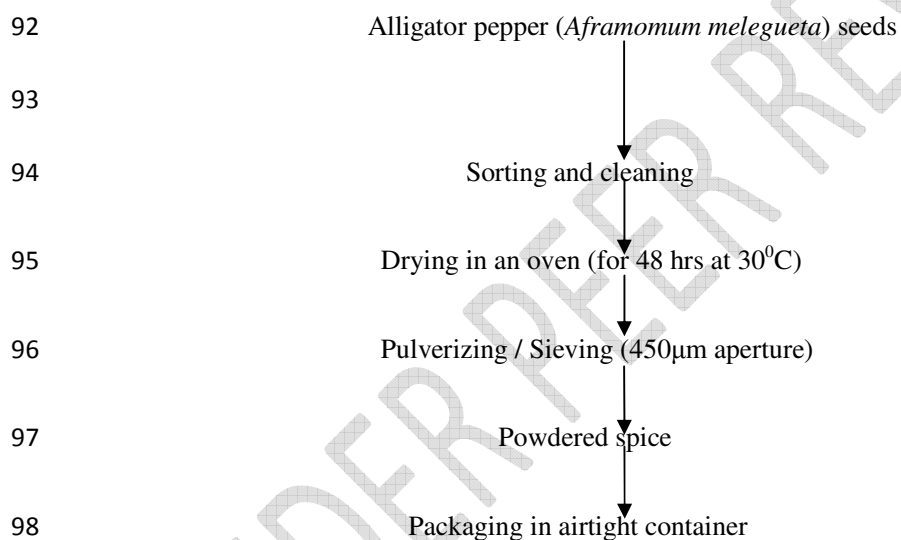
Preparation of liquid extract of alligator pepper.

The method described by Adegoke *et al.* (2000) was adopted with some modification. The dry crude extract of alligator pepper (*Aframomum melegueta*) was weighed differently and prepared with distilled water at 0.5%, 1.0%, 1.5%, 2.0% and 2.5% concentration. Each mixture was pasteurized at 75°C for 30minutes and the liquid extracts were kept in previously sterilized bottles and cooled at

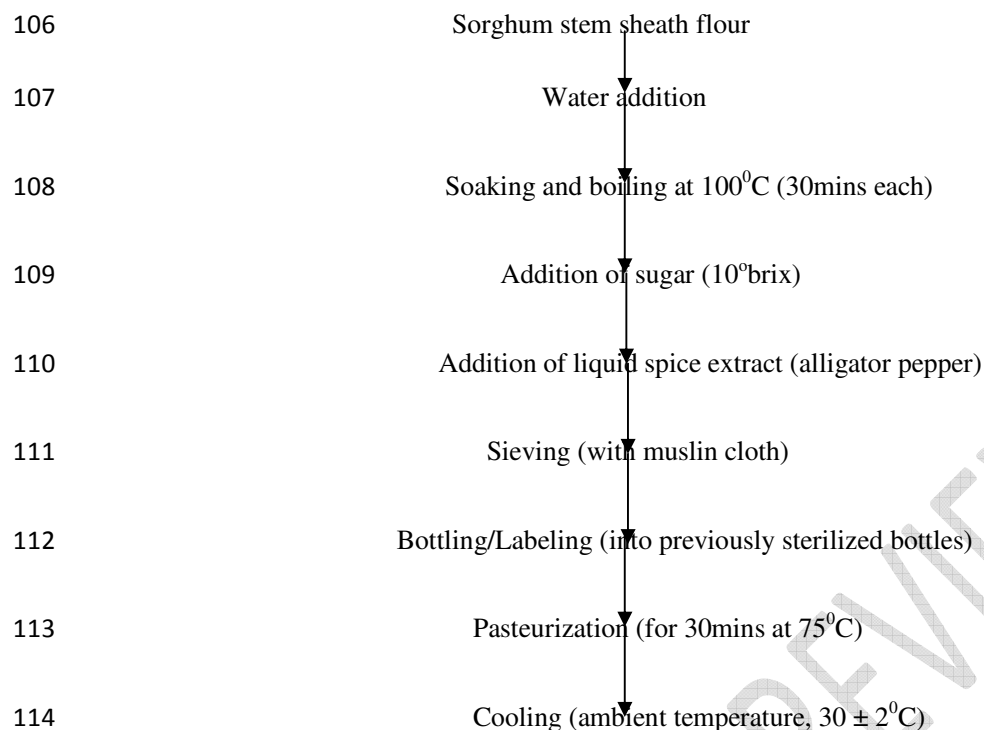
83 ambient temperature before storage in a refrigerator ($8 \pm 2^{\circ}\text{C}$) until used. The flowchart for the
84 process is described in Figure 1.

85 Beverage formulation from the stem sheath flour and the spice extract

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



99 **Fig 1: Flow chart for production of crude spice extract from *Aframomum melegueta***



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

118 Proximate composition of the stem sheath beverage

119 Determination of crude protein

120 About 1g of the samples was weighed into micro Kjeldahl digestion flask and one tablet of
 121 Selenium catalyst was added .The mixture was digested on an electrothermal heater until clear
 122 solution was obtained. The flask was allowed to cool after which the solution was diluted with
 123 distilled water to 50ml and 5ml of this was transferred into the distillation apparatus, 5ml of 2% boric
 124 acid was pippered into a 100ml conical flask (the receiver flask) and four drops of screened methyl
 125 red indicator were added. About 50% NaOH was continually added to the digested sample until the
 126 solution turned cloudy which indicated that the solution had become alkaline.

Then distillation was carried out into the boric acid solution in the receiver flask with the delivery tube below the acid level. As the distillation was going on, the pink colour solution of the receiver flask turned blue indicating the presence of ammonia. Distillation was continued until the content of the flask was about 50ml after which the delivery of the condenser was rinsed with distilled water. The resulting solution in the conical flask was then titrated with 0.1M HCl (Pearson, 1976).

Calculation:

$$\% \text{Nitrogen} = \frac{\text{Titre value} \times 0.1 \text{HCl} \times 0.014 \times 100 \times 50}{5 \times \text{Original weight of the sample}}$$

Determination of dry matter and moisture content.

About 2ml of each sample was measured into a previously weighed crucible, dried over water for sometimes. The crucible plus sample taken was transferred into the oven set at 100⁰c to dry to a content weight for 24hour overnight. At the end of 24hours, the crucible plus sample was removed from the oven and transfer to the desiccator, cooled for ten minutes and weighed (A.O.A.C, 2005). The weight of empty crucible plus sample was W₁ while the weight of crucible plus oven dried sample was W₃.

$$\% \text{ Dry matter} = \frac{W_3 - W_0}{W_1 - W_0} \times 100$$

$$\% \text{ Moisture} = \frac{W_1 - W_3}{W_1 - W_0} \times 100$$

$$\% \text{ Moisture content} = 100 - \% \text{Dm}$$

Crude fat determination

This was carried out using the method of AOAC (2005). Clean and dried thimble was weighed(W1)and 5g oven dried sample was added and re-weighed (W2).Round bottom flask was

filled with petroleum (ether 40-60)⁰C up to ¾ of the flask. Soxhlet extractor was fixed with a reflux condenser to adjust the heat sources so that the solvent boils gently, the samples were put inside the thimble and inserted into the soxhlet apparatus and extraction under reflux was carried out with petroleum ether for 6 hours. After the barrel of the extractor is empty, the condenser was removed and the thimble was removed, taken into the oven at 100⁰C for 1 hour and later cooled in the dessicator and weighed again (W3).

% Fat = $\frac{\text{Weight loss of sample (extracted fat)}}{\text{Original weight of sample}} \times 100$

$\frac{W2 - W3 \times 100}{W2 - W1}$

p^H measurement

The p^H was measured using a P^H meter, digital model EA513-055, ELE, England standardized with buffer solution of 4.0 and 7.0 (AOAC, 2005). The glass electrode of pH meter was dipped in 30mls of the beverage sample measured into a curvette at ambient temperature and was allowed to stabilize for sometimes after which the reading was taken.

Titrateable acidity

About 4 ml of the sample was measured into a 250ml conical flask and 200ml of carbon dioxide with distilled water added. The flask was allowed to stand in a water bath at 40⁰c for 1hr. It was swirled occasionally to ensure complete mixing before filtration. Phenolphthalein was added after filtration and then titrated against 0.1m NaOH solution (AOAC, 2005). The result was expressed as % lactic acid equivalent present in the beverage.

Acidity (% lactic acid) = $\frac{\text{Volume of 0.1M NaOH Used} \times 0.09 \times 100}{\text{Weight of the sample}}$

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. While operating the AAS, all controls on the left front panel, right front panel and the pressure regulator were set at zero mark. Thereafter, required hollow cathode (HC) lamp corresponding to the required mineral and the holders in the lamp compartments was installed. On turning on the switch and utilizing the appropriate lamp current meters, the concentrations of the various metallic mineral elements were determined. The analysis was done in triplicates.

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 (25⁰C). 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 carried out using Statistical Analysis Software (SAS, 1999) package (version 8.2 of SAS Institute, Inc.). The 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 $p < 0.05$.

RESULT AND DISCUSSION

Proximate composition, pH and TTA value 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 88.230-87.725% 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 control without spice. This implies that addition of spice had significant effect on the moisture content. A decreasing trend in the moisture content with increasing concentration of alligator pepper (*Aframomum melegueta*) 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 is similar to the report given by Oshuntogun and Aboaba, (2004). The moisture content of zobo drink (88.88) % was higher than that of sorghum stem sheath beverage (88.230-87.725)% and also the moisture content of kunnu 84.90% ,was lower than that of the stem sheath beverage (Agarry *et al.*,2010; Egbere *et al.*,2007) .

Alligator pepper (*Aframomum melegueta*) 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 0.009% was recorded for samples containing alligator pepper extracts at varying concentrations, respectively. Though beverage is not a good source of protein but addition of alligator pepper to the sorghum stem sheath beverage resulted in significant ($p<0.05$) increase in their protein level. The observation shows a progressive significant decrease in the protein content with increasing alligator pepper (*Aframomum melegueta*) 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 sobo drink (0.046) % produced from *Hibiscus sabdariffa* calyxes.

Table 1: Proximate Composition (%) of the non-alcoholic Beverage

Samples	Moisture	Protein	Crude fat	pH	TTA
XK	87.890a	0.005k	0.009k	7.00a	4.00a
XF	88.230g	0.047f	0.140f	7.00a	4.00a
XG	88.015h	0.033g	0.130g	7.00a	4.00a
XH	87.980i	0.029h	0.120h	7.00a	4.00a
XI	87.850j	0.018i	0.110i	7.00a	4.00a
XJ	87.725k	0.009j	0.100j	7.00a	4.00a

Key words: XF: 0.5% alligator pepper (A.P.) XG: 1.0% alligator pepper XH: 1.5% alligator pepper XI: 2.0% alligator pepper XJ: 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 $p > 0.05$

Alligator pepper (*Aframomum melegueta*) 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 pepper extracts at varying concentrations, respectively. The observation shows a progressive significant decrease in the fat content with increasing alligator pepper concentration in the sample. This might be attributed to the effect of direct heat on fat soluble components of the beverage during the process of extraction (Adelakun *et al.*, 2009). The fat content of sobo drink (0.15)% compares favourably well with that reported for the spiced sorghum stem sheath (0.009-0.140) % (Egbere *et al.*, 2007)

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. This is similar to 6.8 and 4.0% obtained from sorghum stem sheath flour by Oluwaniyi *et al.*, (2009) but 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 an 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. The pH 5.79 and titratable acidity 2.30% of kunnu were found to be lower than that of the sorghum stem sheath beverage while soya milk with pH of 6.90 was near the pH of the stem beverage 7.0 %.

Mineral composition of the non-alcoholic beverage

The mineral composition of sorghum stem sheath beverage is as presented in Table 2. Alligator pepper (*Aframomum melegueta*) spiced 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. Plain beverage (control) had a magnesium content of 145.00mg/100ml while a range of 200.42-159.10mg/100ml was recorded for samples containing alligator pepper extracts at varying concentrations respectively. However, the magnesium content of kunnu 30.03mg/100ml was lower than that of the stem sheath beverage (Agarry *et al.*, 2010).

All ginger spiced samples had higher sodium content than the plain beverage. 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 pepper (*Aframomum melegueta*) extracts 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

sobo drink 5.90mg/100ml was found to be lower than that of the stem sheath beverage (Obboh and Elusiyan, 2004).

Alligator pepper (*Aframomum melegueta*) spiced beverage samples significantly ($p < 0.05$) had higher potassium content than the unspiced beverage. A decreasing trend in potassium content with increasing concentration of ginger in the samples was observed. Plain beverage had a potassium content of 23.02mg/100g while a range of 28.18-23.71mg/100g was recorded for samples containing alligator pepper extracts at varying concentrations, respectively. The potassium content of kunnu 134.27mg/100ml was however higher than that of the stem sheath beverage (Agarry *et al.*, 2010). Nevertheless, it could be seen from the information contained in Table 2 that addition of spice significantly enhanced the potassium content of the beverage samples.

Alligator pepper (*Aframomum melegueta*) spiced samples had higher calcium content than the plain beverage. Plain beverage had a calcium content of 50.00mg/100ml while a range of 54.54-50.18mg/100ml was recorded for samples containing alligator pepper extracts at varying concentrations respectively. However, the calcium content of kunnu 5.18mg/100ml and sobo drink 6.00mg/100ml were lower than that of the stem sheath beverage (Agarry *et al.*, 2010; Obboh and Elusiyan, 2004). The observation shows a progressive significant decrease in calcium content in the beverages with increasing concentration of alligator pepper.



Plate 1: Sorghum stem sheath drink with alligator pepper (*Aframomum melegueta*) extract



Plate 2: Sorghum stem sheath drink without spice (control)

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

Samples	Mg	Na	K	Ca	Fe	Zn	Mn	Cu
XK	145.000k	25.000h	23.025j	50.000g	4.000k	2.500k	0.380k	0.0605c
XF	200.400c	25.200j	28.180c	54.540a	5.910a	3.505a	0.890f	0.059c
XG	190.200e	25.075i	26.580e	53.010b	5.750b	3.300b	0.755g	0.072a
XH	181.100g	25.170k	25.480f	52.190c	5.520c	3.100d	0.635h	0.069a
XI	170.200i	25.250g	25.110h	51.730d	5.370d	2.900g	0.500i	0.066b
XJ	159.100j	25.330f	23.710i	50.180e	5.195f	2.700i	0.420j	0.068b

Key words: XF: 0.5% alligator pepper (A.P.) XG: 1.0% alligator pepper XH: 1.5% alligator pepper XI: 2.0% alligator pepper XJ: 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 $p > 0.05$

332

333 Alligator pepper (*Aframomum melegueta*) spiced beverage samples significantly
334 ($p<0.05$) had higher iron content than the unspiced beverage. A decreasing trend in iron
335 content with increasing concentration of ginger in the samples was observed with the
336 exception of the sample spiced with 0% ginger. Plain beverage had iron content of
337 4.00mg/100ml while a range of 5.910-5.195mg/100ml was recorded for samples containing
338 alligator pepper extracts at varying concentrations respectively. Addition of alligator pepper
339 significantly enhanced the iron content of the beverage samples when compared to the
340 control. However, the iron content of kunnu 70.02mg/100ml was higher than that of the
341 stem sheath beverage (Agarry *et al.*, 2010) while the iron content of the sobo drink
342 2.40mg/100ml was much lower than that of the stem sheath beverage (Obboh and Elusiyan,
343 2004)

344 Alligator pepper (*Aframomum melegueta*) spiced samples had lower zinc content than the
345 plain beverage. Plain beverage had a zinc content of 2.50mg/100ml while a range of 3.505-
346 2.700mg/100ml was recorded for samples containing alligator pepper extracts at varying
347 concentrations respectively. The zinc content of kunnu 3.30mg/100ml and sobo drink 2.68mg/100ml
348 were found to be much higher than that of the stem sheath beverage (Adebayo *et al.*, 2010; Adetuyi *et al.*, 2007). The observation shows a progressive significant decrease in zinc content with increasing
349 concentration of the spice in the beverage. A pronounced impact of the spice on the zinc content is
350 noted with the zinc content of all spiced beverages compared with the control.

352 Ginger spiced beverage samples significantly ($p<0.05$) had higher manganese content than
353 the unspiced beverage. A decreasing trend in manganese content with increasing concentration of
354 ginger in the samples was observed. Addition of ginger into the beverage which has contributed
355 significantly to the enhancement in the manganese content of the beverage (Gbadamosi *et al.*, 2011).
356 Plain beverage had manganese content of 0.38mg/100ml while a range of 0.0899-0.400mg/100ml was
357 recorded for samples containing alligator pepper (*Aframomum melegueta*) extracts at varying

concentrations respectively. The manganese content of kunnu 1.05mg/100ml was found to be much higher than the ginger spiced samples (Adebayo *et al.*, 2010).

Similar copper content was recorded for almost all the beverages. Plain beverage had a copper content of 0.060 mg/100ml while a range of 0.059-0.068mg/100ml was recorded for samples containing alligator pepper (*Aframomum melegueta*) extracts at varying concentrations, respectively. However, the copper content of kunnu 0.011mg/100ml was found to be lower than that of the sorghum stem sheath beverage (Adebayo *et al.*, 2010).

Sensory attributes of the beverage samples

The sensory attributes of the formulated beverage samples are presented in Table 4. Beverage spiced with 0.5% alligator pepper (*Aframomum melegueta*) had the best ratings in all sensory attributes evaluated. Unspiced 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. 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.

Table 4: Mean sensory quality attributes of the formulated sorghum stem sheath beverage

Sample code	Colour	Taste	After	Consistency	Flavour	Overall
Taste				Acceptability		
XF	6.40ab	5.00bcd	4.83bcd	5.00abcd	5.20bcd	5.83abc
XG	5.67bc	4.80bcd	4.800bcd	4.83abcd	4.83cde	5.83abc
XH	5.33c	4.50cde	4.60bcd	4.80abcd	4.83def	5.40bc
XI	5.17c	4.50cde	4.50bcd	4.33bcd	4.17def	5.33bc
XJ	5.17c	3.50de	4.00cd	4.17cd	3.33ef	5.33bc
XK	5.00c	3.17e	3.50d	3.33d	3.00f	4.83c

Key words: XF: 0.5% alligator pepper (A.P.) XG: 1.0% alligator pepper XH: 1.5% alligator pepper XI: 2.0% alligator pepper XJ: 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 $p > 0.05$

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, minerals contents increased noticeably in all the spiced samples. The most abundant minerals in the sorghum stem sheath 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 in the beverage which could be attributed to the dilution factor by other components in the spices.

The result of this study reveals that nutritious and relatively shelf stable non-alcoholic beverage could be produced from sorghum stem sheath and local spices without the use of chemical preservatives.

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