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# The Effect of Ginger Extract on the Acceptability and Storability of a Non-alcoholic Beverage (Sorghum Stem Sheath Drink) in Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author BIOA designed and supervised the study; author IBO monitored some components of the work at Food Science &Technology Laboratory, FUTA and also corrected the manuscript while author TOA did the study and wrote the initial manuscript. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** This study investigated the acceptability and preservative influence of ginger extract on sorghum stem sheath drink.
**Study Design:** Factorial design was used for this study.
**Place and Duration of Study:** This study was carried out in the Food Processing, Sensory and Microbiology Laboratories in the Department of Food Science and Technology, Federal University of Technology, Akure, Ondo State between September 2010 and December, 2010.
**Methodology:** The sorghum stem sheath was dry cleaned, pulverized and packed in air tight containers until utilized. The stem sheath flour was soaked, boiled and filtered. The filtrate was sweetened with food grade sucrose to a brix level of 10° before dispensing into previously sterilized

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bottles and pasteurized at 75°C for 30 mins. The dry crude extract of *Zingiber officinale* was weighed differently and prepared with distilled water at 0.5%, 1.0%, 1.5%, 2.0% and 2.5% concentrations. The drink was treated respectively with different concentrations. Changes in quality of ginger *(Zingiber officinale)* spiced poporo during accelerated storage at 50°C were evaluated for 4 weeks.

**Results:** The sensory evaluation revealed over 80% preference for the 0.5% ginger extract inclusion by the panelists. The microbiological analysis showed that Coliform and total viable bacteria were found to be completely absent in the pasteurized samples. Bacteria was also absent in spiced samples stored for 2 weeks (14 days). The microbial load increased from 4-8 $x10^2$ cfu/ml to 7-15 $x10^2$ cfu/ml in the spiced beverage from week 3 to 4, depending on the concentration of the spice, whereas the control sample showed considerable bacteria growth (2-20 x $10^2$ cfu/ml) from week 1 to week 4 but both spiced and control samples showed no Coliform growth throughout the storage period. The pH in the control and spiced samples decreased gradually from 7.00-5.20 while the titratable acidity increased from 0.040-0.076% lactic acid with increase in ginger concentrations from 0.5 to 2.5% in the spiced samples. Decrease in vitamin C from 232.64-138.60 mg/100ml throughout the storage period followed similar trends.

**Conclusion:** The anti-microbial activity of the spice was established with the microbial profile of the spiced beverages during storage at an elevated temperature of 50°C in which the total viable bacteria count was absent for two weeks (14days) and Coliform bacteria was completely absent in all samples throughout storage period. 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.

*Keywords: Poporo; ginger; microbial; $p^H$; vitamin C.*

## 1. INTRODUCTION

The stem of Sorghum plant is largely treated as a waste in Nigeria. This wastes which arises from an annual production of about 6 million tons is quite colossal [1]. Hence the development of a proclaimed health drink from it as variously reported is a very welcome development. The stem is said to be sweet and contains some sugars and minerals which make it suitable for syrup manufacture, brewing alcoholic and non-alcoholic drinks as well as in the baking and confectionery industry in Nigeria [2-4]. The drink is reported to have a very short shelf life despite its numerous nutritional and health benefits. Most of the information available in the literature reveals that the sorghum stem sheath is still confined to traditional use only and that the drinks produced naturally from it has few hours shelf life, hence the need for incorporation of a preservative to extend its shelf life [5]. The preservative effects of ginger have been variously reported [6,7]. The 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. The use of local spices to control the activities of micro-organisms in food has been reported [8,9]. 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 therefore the aim of this study to exploit the use of ginger which is a locally available spice as a natural preservative in the formulation of a non- alcoholic beverage from Sorghum *bicolor* stem sheath.

## 2. MATERIALS AND METHODS

Mature reddish-purple *Sorghum bicolor* L. Moench stem sheath locally known as *Poporo,* ginger (*Zingiber officinale*) and food grade sucrose were purchased from Igbonna market in Oshogbo, Osun State. 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 450 µm aperture sieve. The flour samples were packed in air tight containers until utilized. The stem sheath flour was soaked for 30 mins at ambient temperature before boiling for another 30 mins. 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 30mins. The beverage samples were then subjected to further investigations.

### 2.1 Preparation of Liquid Extract of Ginger

The method described by [10] was adopted with some modification. The dry crude extract of *Zingiber officinale* was weighed differently and prepared with distilled water at 0.5%, 1.0%, 1.5%, 2.0% and 2.5% concentrations. Each mixture was pasteurized at 75°C for 30 minutes 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.

### 2.2 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 ginger (*Zingiber officinale)* at the above indicated concentrations. This implies a total of 6 samples including the sample 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.

### 2.3 Sensory Evaluation

The beverage samples were presented as coded samples to 10 semi -trained panellists according to the method reported by [11]. The panellists were asked to indicate their observations using a 9- point hedonic scale for taste, after taste, flavour/aroma, colour, consistency and overall acceptability. The coded samples were served in clean transparent bottles at room temperature (25°C). Samples presented to the panellists were at random and one at a time. The panellists 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 [12] 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 [13] and the significance was accepted at $p<0.05$.

### 2.4 Physico-chemical Analysis

A pH meter (Jenway, model 3020) was used to determine the pH of the samples. The titratable acidity (% lactic acid) and vitamin C content (%) were determined according to the methods of [14].

### 2.5 Microbiological Analysis

#### 2.5.1 Total viable count of bacteria (TVC)

The microbiological analysis was carried out according to [15]. A well homogenized sample was serially diluted with 0.1% peptone water up to $10^{-6}$. One ml aliquot from a suitable dilution was transferred aseptically into sterile Petri dishes. To each plate about 15ml of melted and cooled Potato Dextrose Agar (PDA) was added. The inoculate was evenly mixed with media by rotating the plates and allowed to solidify. The inverted plate was incubated at 30°C for 48 hours. The TVC (cfu/ml) was determined using a colony counter.

#### 2.5.2 Total Coliform bacteria

Mac Conkey broth was used for the detection of Coliform bacteria by the multiple tube technique. The medium was distributed in 9ml quantities standard test tubes with inverted Durham tube and was then autoclaved for 20mins at 121°C. Well homogenized samples were serially diluted ($10^{-1}$, $10^{-2}$, $10^{-3}$ and $10^{-4}$) with 0.1% peptone water. One (1) ml from each dilution was aseptically inoculated into triplicate of 9 ml sterile Mac Conkey broth in standard test tubes and incubated for 48 hrs at 37°C. Positive tests gave gas in the Durham tubes and changed the color of the medium [15].

## 3. RESULTS

The results of the effect of ginger extract on the acceptability and storability of a non-alcoholic beverage (sorghum stem sheath drink) are presented in Tables 1, 2, 3, 4, 5 and 6.

## 4. DISCUSSION

The sensory evaluation revealed 80% preference for the sample with 0.5% ginger extract inclusion compared to the other concentrations by the panelists. However, increase in % extract inclusion had negative / undesirable effects on the physical characteristics of the products such as bitter taste and after taste which might have resulted in reduced preferenceby the panelists. This is similar to the report documented for *Hibiscus sabdariffa* drink by [16] in which 0.2% ginger extract inclusion was most preferred among other concentrations used.

**Table 1. Mean sensory quality attributes of the fresh formulated sorghum stem sheath beverage**

| % of ginger inclusion | Color | Taste | After taste | Consistency | Flavor | Overall acceptability |
|---|---|---|---|---|---|---|
| Control (0.0) | 5.00c | 3.17e | 3.50d | 3.33d | 3.00f | 4.83c |
| 0.5 | 6.85a | 6.50a | 6.50a | 6.58a | 6.80a | 7.20a |
| 1.0 | 6.80a | 6.17ab | 6.17ab | 6.17ab | 6.67ab | 7.00ab |
| 1.5 | 6.67ab | 5.50abc | 5.83ab | 6.17ab | 6.40abc | 6.80ab |
| 2.0 | 6.50ab | 5.33bc | 5.67abc | 5.50abc | 6.17abc | 6.50abc |
| 2.5 | 6.50ab | 5.17bcd | 4.83bcd | 5.20abcd | 6.00abc | 6.00abc |

*Values are means of 3 determinations, values with the same letter along the same column are not significantly different at p>0.05*

**Table 2. Effect of storage time on selected beverage properties at weeks 1 and 2**

| % of ginger inclusion | pH1 | pH2 | TTA1 ( %) | TTA2 (%) | Vit.C1 (mg/100ml) | Vit. C2 (mg/100ml) |
|---|---|---|---|---|---|---|
| 0.0 | 7.00a | 6.90a | 0.040b | 0.050f | 232.64a | 215.10a |
| 0.5 | 7.00a | 6.80b | 0.040b | 0.051e | 220.49b | 210.20b |
| 1.0 | 6.80b | 6.70c | 0.041b | 0.052d | 218.82c | 200.70c |
| 1.5 | 6.70c | 6.60d | 0.042b | 0.053c | 205.07d | 193.00d |
| 2.0 | 6.60d | 6.50e | 0.043b | 0.054b | 195.74e | 183.00e |
| 2.5 | 6.40e | 6.30f | 0.045b | 0.056a | 190.50f | 175.00f |

*1 rep1$^{st}$ week; 2 rep 2$^{nd}$ week, values are means of 3 determinations. values with the same letter along the same column are not significantly different at p>0.05*

**Table 3. Effect of storage time on selected beverage properties at week 3 and 4**

| % of ginger inclusion | pH3 | pH4 | TTA3 ( %) | TTA4 (%) | Vit.C3 (mg/100ml) | Vit. C4 (mg/100ml) |
|---|---|---|---|---|---|---|
| 0.0 | 6.60a | 6.20a | 0.060f | 0.070f | 200.50a | 150.90a |
| 0.5 | 6.40b | 6.00b | 0.062e | 0.071e | 195.00b | 148.80b |
| 1.0 | 6.20c | 5.60c | 0.064d | 0.072d | 180.70c | 145.10c |
| 1.5 | 6.00d | 5.00f | 0.066c | 0.073c | 175.60d | 142.50d |
| 2.0 | 5.80e | 5.40d | 0.068b | 0.074b | 160.40e | 140.60e |
| 2.5 | 5.60f | 5.20e | 0.072a | 0.076a | 155.20f | 138.60f |

*3 rep 3$^{rd}$ week; 4 rep 4$^{th}$ week, values are means of 3 determinations.values with the same letter along the same column are not significantly different at p>0.05*

**Table 4. Microbial characteristics of freshpasteurized beverage samples**

| % of ginger inclusion | Total viable count(cfu/ml)×10$^2$ | Total viable count(cfu/ml)×10$^2$ |
|---|---|---|
| 0.0 | - | - |
| 0.5 | - | - |
| 1.0 | - | - |
| 1.5 | - | - |
| 2.0 | - | - |
| 2.5 | - | - |

*Note: - means no growth*

The values for pH, titratable acidity and vitamin C contents showed an increasing acidity and a decreasing vitamin C contents as storage progressed. A decrease in pH is synonymous to increase in acidity. There were increase in acidity and depletion of Vitamin C contents as the levels of ginger extract inclusion in the drink increased (Tables 2 and 3). The vitamin C content of the beverage (232.64mg/100ml) was found to be more than one-third of the daily requirement [17]. This is of great health significance; vitamin C is involved in protein metabolism and is an

important physiological antioxidant which helps to prevent molecular changes caused by oxidation [18-20]. During the 4th week of storage period, there was reduction in vitamin C content of the beverage from 232.64 to 138.60mg/100g. The decrease in vitamin C may be due to possible utilization by associated micro-organisms, bioconversion into organic acids and other organic compounds. Similar findings have been reported for related food items by [21]. These may partly explain the significant decrease in pH as storage progresses which are also an indication of increased acidity. Similar trend was also observed in the titratable acidity.

**Table 5. Microbial load of the beverage samples after storage for weeks 1 and 2**

| % of Ginger inclusion | Total viable count (cfu/ml)×$10^2$ (week 1) | Total viable count (cfu/ml)×$10^2$ (week 2) |
|---|---|---|
| 0.0 | 2.0 | 5.0 |
| 0.5 | - | - |
| 1.0 | - | - |
| 1.5 | - | - |
| 2.0 | - | - |
| 2.5 | - | - |

*Note: - means no growth*

**Table 6. Microbial load/ total viable count (cfu/ml) x102 of the beverage samples for weeks 1 to 4**

| % of ginger inclusion | WK 1 | WK 2 | WK 3 | WK 4 |
|---|---|---|---|---|
| 0.0 | 2 | 5 | 10 | 20 |
| 0.5 | - | - | 8 | 15 |
| 1.0 | - | - | 7 | 12 |
| 1.5 | - | - | 6 | 10 |
| 2.0 | - | - | 5 | 8 |
| 2.5 | - | - | 4 | 7 |

The microbial analysis of the fresh beverage in Table 4 revealed that there were no bacteria and coliform growths. This is an indication that the beverage was produced hygienically. In Table 5, bacteria growth was detected in the control sample having no ginger spice after the first week ($2.0x10^2$cfu/ml) and increased to $5.0x10^2$cfu/ml in the 2nd week whereas no growth were observed in the ginger spiced samples during these two weeks. As shown in Table 6, the spiced samples started to show microbial growths in week 3 but at a lower rate than the control as storage progressed to the 3rd and 4th weeks. However, the microbial load obtained at the 3rd and 4th weeks of storage are within the safe limits of $1.0x10^5$cfu/ml as reported by [22,23]. There was however a decreasing trend of microbial growth with increase in the level of the ginger extracts inclusions. The fact that ginger extract addition to the sorghum stem sheath drink prevented microbial growth in the drink samples shows that ginger has potential antimicrobial activity. Ginger has been shown to possess anti-tumour, anti-proliferative, antihypertensive, bactericidal and nematocidal properties due to its 6-gingerol, 6-paradol, shagaols and zingiberene contents [7]. It is also anti-inflammatory and cancer inhibiting [7]. The extent to which a material is used as a spice is dictated primarily by its essential oils or oleoresins [24]. The volatile oils being responsible for the aroma and taste of most spices, as it contains terpenes, sesquiterpenes, alcohols, esters, aldehydes, ketones, and phenols [23]. Similar findings have been documented for *Hibiscus sabdariffa* drink [16] in which shelf-life was extended by a period of 2 weeks with inclusion of 0.2% ginger extract. There was no coliform growth in the beverage throughout the period of storage as presented in Table 7.

**Table 7. Total coliform count (cfu/ml) x102 of the beverage samples for weeks 1 to 4**

| % of ginger inclusion | WK 1 | WK 2 | WK 3 | WK 4 |
|---|---|---|---|---|
| 0.0 | - | - | - | - |
| 0.5 | - | - | - | - |
| 1.0 | - | - | - | - |
| 1.5 | - | - | - | - |
| 2.0 | - | - | - | - |
| 2.5 | - | - | - | - |

*Note: - means no growth*

## 5. CONCLUSION

Based on the results obtained, it could be concluded that there were consistent decrease in pH, vitamin C and increase in titratable acidity during the period of storage. The pH, titratable acidity and brix level remained fairly constant in the pasteurized sample of the sheath drink.The extract of the ginger spice preserved the beverage for 2 weeks (14 days) after which microbial activities set in slowly till the end of the 4 weeks storage period. The anti-microbial activity of the spice was established with the microbial profile of the spiced beverages during storage at an elevated temperature of 50°C in

which the total viable bacteria count was absent for 2 weeks and coliform bacteria was completely absent in all samples throughout storage duration. The result of this study alsoreveals that nutritious and relatively shelf stable non-alcoholic beverage could be produced from sorghum stem sheath and 0.5% ginger extract (spice) without the use of chemical preservatives.

## 6. RECOMMENDATION

Bacterial growth was detected in ginger spiced drinks just only after 2 weeks of preservation which is relatively short for good preservation. It is therefore recommended that further research work be carried out to investigate the preservative effects of other spices like garlic. alligator pepper, cloves etc. either singly or in combination with one another.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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