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Sensory and Nutritional Evaluation of Fermented and Unfermented Beetroot-ginger-garlic Beverages

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Abstract

The study was carried out to produce beetroot-ginger-garlic drink. The drink was produced with the mixture of beetroot, ginger and garlic at the ratio of 4:2:1 respectively. Two different drinks were produced, one was fermented for 24 hrs while the other unfermented, was soaked in water for 2hrs. The fermented and unfermented drinks were divided into two and poured into four separate 75 cl containers. Sugar (4 g) was added into one fermented and one of unfermented 75 cl containers while no sugar was added to the others. Bacteriological examination, proximate analysis, and micronutrient content were determined. Sensory evaluation was carried out using hedonic rating test. The results obtained were analyzed statistically using degree of freedom. Isolated organisms from the drinks was *Lactobacillus sp*. which was only isolated from fermented beet root ginger- garlic beverage. Proximate analysis showed very minimal variations in moisture, ash, fiber, protein, fat, and carbohydrate content between fermented and unfermented drinks. Micronutrient content showed significant differences in selenium, calcium, zinc, copper, iron, magnesium, sodium, lead, cadmium, and potassium. Sensory evaluation showed significant differences in taste, mouth feel, flavor, and overall acceptability. The sensory showed that fermented beetroot-ginger-garlic drink with sweetener have highest overall acceptability (5.67±0.58) followed by fermented beetroot-ginger-garlic beverage without sweetener (5.33±0.58) and unfermented beetroot-ginger-garlic beverage without sweetener (2.33±0.58) have the least overall acceptability. Fermented and unfermented beetroot-ginger- garlic drinks have potential nutritional benefits and acceptable sensory properties. This study provides insights into the production and evaluation of functional beverages from beetroot-ginger-garlic and the beverage is better fermented before drinking.

Keywords: Fermented and unfermented; Micro-nutrient; Beetroot-ginger-garlic; Sensory; Anti-nutrient

1. Introduction

Beetroot-ginger-garlic beverage is a dark red drink made from a blend of beetroot, ginger, and garlic. Epidemiological research has shown that consuming fruits and vegetables has protective effects against chronic and degenerative diseases like cancer [1, 2]. Recent studies have explored the composition profiles of these lesser-used foods and their by-products to assess their potential as functional foods [3, 4, 5].

Beetroot is a root crop known scientifically as *Beta vulgaris*, and also referred to as red beet, garden beet, table beet, or simply beet. It belongs to the *Chenopodiaceae* family, and the edible part is the root [3]. This tuber is rich in vitamins (vitamins A, C, B6, folic acid, niacin, and biotin), fiber, and minerals (iron, selenium, magnesium, potassium, zinc, phosphorus, calcium, and sodium), giving it a high nutritional value, mainly as a result of its carbohydrate content [6]. Frequent intake of vegetables and fruits, which are sources of numerous bioactive compounds, have several advantages

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on the human health by reducing the risk of chronic and cardiovascular diseases [7]. Beetroots, filled with vital nutrients, are a great source of fiber, manganese, vitamin C, potassium, iron and folate (vitamin B9). Beetroots and beetroot juice are linked to several health benefits, such as improved blood flow, reduction in blood pressure, and high rate of exercise performance [8]. A number of these benefits are attributed to their high concentration of inorganic nitrates [9]. Beetroot is rich in dietary NO3-, and numerous studies have explored its possibility for the reduction of blood pressure in humans, which seems to be highly potent in men [10, 11, 12]. Although beetroot shows the ability to lower blood pressure, prior studies in free-living subjects have been limited and have usually used a controlled diet in a mixture with beetroot juice. It is unclear as to the extent of blood pressure reduction that will be observed when beetroot juice is taken alongside a normal diet [13]. Beetroots are delicious when consumed raw but are more commonly pickled or cooked. Their leaves can also be cooked and enjoyed like spinach.

Ginger (*Zingiber officinale*) is a rhizome with a warm, sweet, strongly aromatic odor and sharp pungent flavor [14]. Both ginger and garlic are natural herbs that act as tonics to keep your health fit and sound. They have many remedial properties and benefits known worldwide. Today, doctors often prescribe them as natural medicines for treating various health diseases [15]. Ginger is used as an essential spice in curry powder, gingerbread, some beers, and other drinks. The taste and pungency of ginger increase with the plant's maturity, with young rhizomes being juicy and fleshy with a very mild taste, while juice from older rhizomes is extremely potent and sharp, often used as a spice in Chinese cuisines [14]. Ginger is a therapeutic plant, where a portion of the root is primarily consumed for the cure of various ailments. Ginger juice is extremely beneficial and effective in treating several conditions, including nausea, motion sickness, abdominal cramps, heartburn, and stomach upset [15, 16]. Ginger tea is particularly efficient for treating morning sickness, maintaining optimal cholesterol levels in the blood, aiding digestion, and stimulating the assimilation process quickly and efficiently. It is also used to assuage toothache and is highly beneficial against colds, cough, flu, and sore throat. Additionally, ginger assists liver functions and helps eliminate toxins from the bloodstream.

Garlic (*Allium sativum*) are bulb vegetables belonging to the *Alliaceae* family that contains biologically active compounds and is applied in cooking and pickling as a form of flavor, oftentimes consumed raw as whole or grated cloves, and occasionally processed as a cooking extract in dressings and sauces [17]. The distinctive pungent smell and spicy flavor makes it mostly used as recipes for cooking [18, 17]. Locally, it is frequently paired with ginger for stews and soups as a condiment and can be applied in preparing baked goods, gravies, puddings, meat products, soft candy and non-alcoholic beverages [19]. Both ginger and garlic have significant nutritional value, making them unique, useful, and potent for good health. Numerous trials and contemporary science have established that ginger and garlic can be used as herbal medicine and should be taken daily in specific amounts. Garlic is often considered as a wonder drug, due to its curative properties and benefits which are broadly recognized by consumers. It can be applied as a natural herbal remedy for many health disorders, containing several potent and effectual components, which includes allicin, vitamin B, diallyl sulfide, ajoene, minerals, proteins, enzymes, saponins, and flavonoids [20, 21]. These elements are useful, effective, and beneficial for good health. Numerous studies have shown that garlic possesses antibacterial, antiviral, and antifungal properties [22, 23]. It assists in the prevention and treatment of atherosclerosis, high blood pressure, influenza, elevated cholesterol, and cancer [24]. Garlic is also used against fungal skin diseases and to control the overgrowth of internal fungi, such as *Candida albicans* [25]. Garlic helps manage cholesterol levels in the blood by elevating good cholesterol and decreasing bad cholesterol. It contains powerful antioxidants that protect the body from free radicals, which are harmful and toxic [15]. In medicine, garlic is used as a digestive stimulant, diuretic, and anti-spasmodic. This study aims to determine the nutritional and anti-nutritional composition of fermented and unfermented beetroot- ginger - garlic beverages.

2. Materials and Methods

2.1. Sample Collection

Matured fresh tubers of beetroot (*Beta vulgaris*), ginger, garlic, and sugar were purchased at Eke Awka Market and were taken to the nutrition and dietetics laboratory of Anambra State Polytechnic, Mgbakwu for processing.

2.2. Preparation of fermented and unfermented beetroot- ginger-garlic beverage

The preparation was carried using a modified version of the method described by Emelike et al. [26]. Beetroot tubers (400g) were sorted, washed, the skin scraped, rewashed and weighed with the support of a digital electronic balance. The tubers were sliced into 2 – 3 mm thick. The 200 g and 100g of ginger rhizomes and garlic bulbs were washed with water severally. The skin was peeled off and then sliced into cutlets. The unfermented were mixed and soaked in water for 2 h, while the fermented were soaked in water for 24hrs to ferment. The three samples were grated into mash for improved juice extraction using a blender (Philips HR2000) for 10 mins. The mash obtained was used for juice

extraction using 2:2 of mash to water. It was filtered with sieve cloth folded into multiple layers, to obtain beetroot-ginger- garlic drink. After the juice was gotten, the fermented and unfermented were divided into two in a separate sterile container and 4 g of sugar was added to one of each and no sugar was added to the rest. Another unfermented beetroot-ginger-garlic drink was also produced using the similar method as described above but without soaking in water, and this serves as control.

2.3. Determination of Bacteria load

Bacteriological examinations of the beetroot-ginger-garlic drinks were carried out in the laboratory using standard procedures for aerobic bacteria. Ten milliliter of each sample was dissolved in 100 ml of distilled water in a conical flask. Then 1 ml of the sample suspension was diluted using a ten-fold serial dilution prior to the inoculation on the media. All culture media was prepared according to manufacturer's instruction.

For Bacterial total viable count, culture was incubated for 24 hours at 37℃. The total viable count was obtained using TVC= N/V X D

Where TVC= Total Viable Count, N= Mean Colony, V= Volume of sample inoculated and D= Dilution Factor. Each single colony

2.4. Characterization and Identification of Isolates

Pure cultures of the isolated organisms were identified by the observation of colonial characteristics, Gram's reaction, and biochemical tests such as catalase test, motility test, citrate test indole and methyl red test. Both microscopic and macroscopic techniques were employed for the identification of the organisms.

2.5. Proximate Analysis of beetroot-garlic and ginger beverage

2.5.1. Determination of moisture content

Method of AOAC [27] was used. The Petri dish was washed and oven dried. The weight of empty Petri dish was obtained and 2g of the sample weighed into Petri dish, the weight of the Petri dish and the sample was taken before drying. The Petri dish containing the samples were put in the oven and heated at 100℃ for 1hr the result was taken and heated another 1hr until a steady result is obtained and the weight measured, the drying procedure was continued until a constant weight was obtained.

$$\%\text{moisture content} = \frac{W1 - W2}{\text{Weight of sample}} \times 100$$

Where
W1= weight of Petri dish and sample before drying
W2 = weight of Petri dish and sample after drying.

2.5.2. Determination of ash content

Method of AOAC [27] was used. Empty platinum crucible was dried and the weight measured. Wet sample (2 g) was weighed into the platinum crucible and placed in the muffle furnace at 500℃ for 3hrs; the sample was cooled in a dessicator after burning and weighed.

Calculations

$$\%\ \text{Ash content} = \frac{W3 - W1}{W2 - W1}\ \text{x}\frac{100}{1}$$

Where;
W1 = weight of empty platinum crucible
W2 = weight of platinum crucible and sample before burning
W3 = weight of platinum and ash.

2.5.3. Determination of crude fiber

Sample (2 g) was soaked in 1.25 g sulphuric acid; 100ml of distilled water was poured inside and was covered with aluminum foil, then heated in a water bath for 30mins then was filtered with filter paper and the residue collected. It was re-soaked in 100ml of water and 1.25 g of sodium hydroxide was added and covers in a foil, heated in a water bath for 30 mins, filtered again with filter paper and residue collected. An empty crucible was weighed and the residue was transferred into the crucible and was dried in an oven at 100℃ for 30mins. It was brought out and was put in a muffle furnace and was ash in 450℃ for 2 hrs. The fiber was determined using the following formula:

Weight of crucible after ashing - weight of empty crucible x 100

2.5.4. Determination of protein

The method described by AOAC [27] was used. Sample (2 g) was weighed into 30 ml kjehdal flask and 20ml surphuric acid was gently added and then the flasks were stoppered and shaken. Then 0.5 g of the kjedahl catalyst selenium powder was added. The mixture was heated cautiously in a digestion rack under hot plate until a clear solution appeared. The clear solution was then allowed to stand for 30minutes to cool. After cooling 100ml of distilled water was added to avoid caking and then 50 ml was transferred to the kjedahl distillation apparatus.

A 100 ml receiver flask containing 5 ml of 2 % boric acid and indicator mixture containing 5drops of bromocresol blue and 1drop of methlene blue was placed under a condenser of the distillation apparatus so that the tap was about 20cm inside the solution. The 5 ml of 40 % sodium hydroxide was added to the digested sample in the apparatus and distillation commenced immediately until 50drops get into the receiver flask, after which it was titrated to pink color using 0.01n hydrochloric acid.

Calculations

%nitrogen = Titre value x 0.01 x 14 x 4

% protein = %Nitrogen x 0.25

2.5.5. Determination of crude fat

About 2 g sample was placed into a soxhlet extractor. The extractor was placed into a pre-weighed dried distillation flask. Then the solvent (petroleum ether) was introduced into the distillation flask via the condenser end attached to the soxhlet extractor. The setup was held in place with a retort stand clamp. Cooled water jet was allowed to flow into the condenser and the heated solvent was refluxed as a result, the lipid in the soxhlet chamber was extracted in the process of continuous refluxing. The fat was extracted to concentrate the fat, then the flask was dried with the air oven to constant weight and re-weighed to obtain the weight of fat.

% fat = weight of flask and extract – weight of flask/weight of sample extract X 100/1.

2.5.6. Determination of carbohydrate

(Differential method)

100-(% protein + Moisture +Ash + fat + fibre)

2.6. Sensory Evaluation

The consumer's acceptability of processed drinks was evaluated by the selection of panelist. The hedonic scale was used to establish the acceptability as described by Emelike et al. [26]. The panelists were selected from the lectures, students of Anambra State Polytechnic, Mgbakwu. The products were served to each judge who independently examined the following characteristics (a) Color (b) Flavor (c) Mouth feel (d) Taste (e) Overall acceptability. A 9 hedonic scale was used, with 9= Like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 3= dislike moderately, 2= dislike very much and 1= dislike extremely. Prior to each assessment, the panelists were informed about the task of the test. In addition to the information, a detailed set of written instruction on testing method was available in each table. To eliminate bias, un-labeled samples were presented to the panelist individually with sufficient privacy to guarantee independent judgment. The acceptability of the samples was based on the scores and remarks made by the panelists. The result of the test was assessed using the Hedonic preference test. The scores

for the samples were analyzed statistically using Anova. Mineral and water were available as neutralizers. The same subjects were used in all the steps of the sensory evaluation, so accurate data collection could be obtained.

2.7. Statistics Analysis

The data generated were performed in duplicate. Difference between the mean was evaluated using degree of freedom. Statistical significant difference was stated at $p<0.05$.

3. Results

Microbial loads of the fermented and unfermented of the beetroot-ginger- garlic beverage was carried out and the bacteria colonies counted as stated in table 1. The unfermented drink showed no presence of microbial growth. The isolates found in the fermented drink were identified as probable *Lactobacillus* sp for both the sweetened and unsweetened (Table 2).

Proximate analysis of fermented and unfermented beetroot-ginger-garlic drinks was conducted (Table 3). At 0.05 level of significance and 10 degree of freedom, critical or table value of t= 1.812 and the calculated value of t=0. There was very little variation between the components of the fermented and non-fermented drinks

Table 1 Total bacterial isolated from Fermented and Unfermented Beetroot-Ginger-Garlic Drink

Sample	TBC/cfu/ml
A	3.2x10
B	2.7x10
C	-
D	-

A= fermented beetroot-ginger-garlic drink with sweetener, B= fermented beetroot-ginger-garlic without sweetener, C= unfermented beetroot-ginger-garlic without sweetener, D= unfermented beetroot-ginger-garlic with sweetener

Table 2 Probable isolates from Fermented and Unfermented Beetroot-Ginger-Garlic Drink

Sample	Probable Isolates
A	*Lactobacillus* sp
B	*Lactobacillus* sp
C	-
D	-

A= fermented beetroot-ginger-garlic drink with sweetener, B= fermented beetroot-ginger-garlic without sweetener, C= unfermented beetroot-ginger-garlic without sweetener, D= unfermented beetroot-ginger-garlic with sweetener

Table 3 Proximate Analysis of Fermented and Unfermented Beetroot-Ginger-Garlic Drink

Parameter	Fermented beetroot ginger- garlic drink (%)	Unfermented beetroot ginger- garlic drink (%)
Moisture	35.90	36.01.
Ash	6.90	6.89
Fibre	4.5	4.5
Protein	2.8	3.0
Fat	2.0	1.8
Carbohydrate	47.9	47.80

At 0.05 level of significance and 10 degree of freedom, critical or table value of t= 1.812 and the calculated value of t=0.

The micro-nutrient of fermented and unfermented beetroot-ginger-garlic drinks was analyzed and the results shown in Table 4. The statistical analysis showed that at 0.05 level of significance and degree of freedom, critical or table value of t=0.024, there was significant difference between the fermented and unfermented beetroot-ginger-garlic drink.

Table 5 shows the sensory evaluation of the beetroot-ginger-garlic drinks in which the statistical analysis show that there was no significant difference between colors of all samples, with A, having a value of 7.67±0.58, B (7.33±0.58), C (8.33±0.58) and D at 8.00±0.00. The sensory evaluation showed that sample A had the highest taste (6.67±0.58), mouth feel (5.67±0.58), flavor (5.33±0.58) and acceptability (5.67±0.58) overall compared to the rest. Significant difference was recorded for the taste, mouth feel, flavor and general acceptability of all the samples.

Table 4 Micronutrient contents of fermented and unfermented beetroot-ginger-garlic drinks

	Fermented beetroot ginger-garlic drink	**Unfermented beetroot ginger-garlic drink**
Parameter	Concentration (ppm)	
Selenium	1.143	1.140
Calcium	6.958	6.762
Zinc	2.513	2.515
Copper	0.134	0.132
Iron	2.768	2.768
Magnesium	15.874	15.875
Sodium	0.602	0.600
Lead	0.304	0.304
Cadmium	0.390	0.391
Potassium	3.204	3.206

Table 5 Sensory evaluation of beetroot-ginger-garlic drinks

Sample code	**Color**	**Mouth feel**	**Taste**	**Flavor**	**Overall acceptability**
A	7.67±0.58	5.67±0.58	6.67±0.58	5.33±0.58	5.67±0.58
B	7.33±0.58	4.33±0.58	4.33±0.58	3.33±0.58	5.33±0.58
C	8.33±0.58	2.33±0.58	3.33±0.58	2.33±0.58	2.33±0.58
D	8.00±0.00	5.33±0.58	5.33±0.58	2.33±0.58	3.64±0.58
ANOVA	0.163(NS)	0.000(S)	0.001(S)	0.001(S)	0.000(S)

(NS) = Not significantly different, (S) = Significantly different; Keys: A= fermented beetroot-ginger-garlic drink with sweetener, B= fermented beetroot-ginger-garlic without sweetener, C= unfermented beetroot-ginger-garlic without sweetener D= unfermented beetroot-ginger-garlic with sweetener

4. Discussion

Epidemiological studies have demonstrated the protective effect of fruit and vegetable intake against chronic and degenerative diseases such as cancer [1, 2]. Ginger contains low calories, low carbohydrate and low protein. Calcium, protein and carbohydrate which are the major nutrient the body needed to grow. Protein is an essential constituent of a balance diet, and garlic and beetroot has highest percentage of protein, garlic is an excellent source of protein of about 24 % as well as calcium (20.3 %) and carbohydrate (724 kg) and beetroot has very good source of folic acid, high in fiber content manganese and potassium. For this reason the three different herbs were incorporated and produce as drink which now enhance their nutritional value. This was evident in the proten and carbohydrate level reported in this study which was higher than that of the beetroot-soy-carrot reported by Bango et al. [28]. The fermented and unfermented drink differs from their proximate composition and micronutrient. The three different herbs were

incorporated and produce as drink which now change their nutritional value. The fermented and unfermented drink differs from their proximate composition and micronutrient. The micronutrient of the fermented drink was high in calcium, magnesium and potassium, the zinc and iron which fall almost the same range (2.513 and 2.768). The fermented drink has the highest percentage of carbohydrate (47.90%) the ash content was about 6.90 % and also has moderate fiber content about 4.5% low protein and low fat which fall the same way range of 2.0 % for fat and 2.8 % for protein.

In regard to these the ash content of unfermented and fermented has the same equal percentage (6.90) which is higher than that reported in the work of Bango et al. [28] for the study of juice blend of beetroot-soy-carrot. The moisture content of that of unfermented was higher about (36.01). The micronutrient of the fermented and unfermented drink has the highest percentage of calcium about 6.958 than non-fermented one which is 6.762 of calcium content. Both the fermented and unfermented drink has low copper, lead, sodium and cadmium content, which also fall within the range of (0.132-0.602) in that case, they are very low in that micronutrient. Beetroot, garlic-ginger drink are combine together in order to increase the nutritional value of the drink, since its high in calcium, magnesium and potassium since its high in calcium, magnesium and potassium it will help to increase the nutrient and also balance on drinks.

Consumer acceptability of a product is generally based on the organoleptic attributes which includes color, taste, flavor, mouth feel and general acceptability. This current study showed great acceptability to the mixed beverages. Emelike et al. [26] observed that the sensory properties of the beetroot juice with different levels of ginger were significantly better. Another study by Banigo et al. [28] showed that blends of beetroot/soy/carrot were better in comparison to other individual juice samples. Fruit juice blends have shown to be more acceptable and nutritionally effective [26].

5. Conclusion

It has been concluded that beetroot-ginger-garlic have a higher nutritional and micronutrient that are highly beneficial to human health. And fermented beetroot-ginger-garlic has higher overall acceptability.

Recommendation

- It is recommended that the production of beetroot-ginger and garlic drinks should be introduced in our society and people should be encouraged in using it because of its medicinal values.
- Beetroot should also be produced in a larger scale.
- Enlighten and educating the general public on the important of consumption of these drinks should be done, to educate them on health and beneficial effect of this drinks.
- It is also recommended that this drink should be fermented before drinking.
- Nutritionist and doctors should start recommending these drinks to their patients.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors state that there are no conflicts of interest in the publication of this article.

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