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Studies on Development of Yoghurt Flavoured with Beetroot Juice (*Beta vulgaris* L.)

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Abstract

Milk and yogurt are important elements of the human diet, due to their high nutritional value and their appealing sensory properties. Yoghurt was formulated and flavored with prepared beetroot (*Beta vulgaris* L.**)** juice at different concentration levels (0, 10, 20, 30, 40 and 50 mL). The most preferred flavored yoghurt samples were obtained by sensory scores (color, flavor, mouth feel, aftertaste and overall acceptability). The most preferred sample was then subjected to proximate, physico-chemical, microbiological and micro-nutrient analysis. The result obtained showed that the pH value ranged between 6.5 and 7.8. Thus, this showed that the product was quite good. However, ash and moisture content increased with addition of the beetroot juice, while micro-nutrient, (Mg, Na, K, Ca and Vitamin C) increased with the addition of the juice. There was no significant difference (*P*> 0.05) in the overall acceptability of all products. There was no coliform and mould growth in all the samples. The best concentration level in the samples was 90 mL of yoghurt and 10 mL of beetroot juice. Therefore, the beetroot flavored yoghurt could be said to be nutritious, safe and an acceptable product by the panelists.

Keywords: Beetroot, yoghurt, sensory properties, micronutrients.

1. Introduction

Yogurt is defined as the product being manufactured from milk with or without the addition of some natural derivative of milk, such as skim milk powder, whey concentrates, caseinates or cream with a gel structure that results from the coagulation of the milk proteins, due to the lactic acid secreted by defined species of bacteria cultures.Yoghurt is the most widely consumed fermented dairy dessert worldwide. Yoghurt is a fermented milk product produced by adding a starter of active yoghurt containing a mixed culture of *Lactobacillus bulgaricus* (or occasionally acidophilus) and *Streptococcus thermophilus.* These produce lactic acid during fermentation of lactose. The lactic acid lowers the pH, makes it tart, causes the milk protein to thicken and act as a preservative since pathogenic bacteria cannot grow in acid condition. The partial digestion of the milk when these bacteria ferment milk makes yoghurt easily digestible. It is consumed by people of all ages including pre-school children and expectant mothers. It is also consumed by people of variable physical status, from the youthful athlete to the old and infirmed adult. The nutritional and healthy benefits of yoghurt are numerous. It is a good source of protein, energy (calories), vitamins and minerals. As a fermented product, it may also have therapeutic value and may also result in reduced incidences of lactose intolerance. The fermentation of milk to yoghurt takes relatively short period of time, 3-4 hours, because it is done at a higher temperature (42-46 °C) and also uses culture that have fast growth rates. In yoghurt making, the major fermentation product is lactic acid which is responsible for

coagulation of the milk caseins. Other metabolites that are responsible for the yoghurt flavor are also produced during the fermentation and these include diacetyl, acetaldehyde and acetone.

Fruits are added to the fermentation media to enhance organoleptic properties. In stirred yoghurt, fruits are added post fermentation and in set yoghurt, they are added prior to the fermentation. To modify certain properties of yoghurt, various ingredients may be added for examples, to sweeten yoghurt, sucrose may be added to increase the calorie artificial sweetener such as aspartame may be added, cream could also be added to provide texture. The consistency and shelf stability of the yoghurt could be improved by the inclusion of stabilizers such as food starch, gelatin, locust bean gum and pectin. To improve taste and flavor, many kinds of fruit may be added such as vanilla, orange, pineapple, strawberry, raspberry, milk, cinnamon, bananas, peaches, mandarins and passion fruit. The indigenous fruit used in this study is called Beetroot (*Beta vulgaris* L.), had already been established as a flavoring agent or a special flavor that is generally liked by the people who have known its benefit, functions and also how it will enhance the keeping quality of yoghurt.

Beetroot, as a flavoring agent, is a member of the Chenopodiaceae family which includes silver beet, sugar beet and fodder beet. They are biennials although they are usually grown as annuals and believed to have originated from Germany. Beetroot produces green tops and a swollen root during growing season. It is highly productive and usually free of pests and diseases. It is rich in several vitamins; hence it is an ideal vegetable for health conscious people. Beetroot is usually grown for salad and extraction of sugar from roots. The ball is usually round and small with thin red-brown skin and notably sweet flavor. Red Beetroot has the peculiarity of bleeding a crimson dye called betanin . Beetroot is usually cooked, blanched, steamed or boiled whole with some of greens left intact. When sliced after cooking, it has a tendency to stain other ingredients. Beetroot is a crop of temperate region where cool weather and high humidity are available. Its performance is better in long days having low night temperature.

Beetroot pigments are betalian pigment, which they replace in some organisms. They are named after the Beet family of plant (Beta) but are also found in fungi (fly-Agaric the red, spotted one). In petals, they presumably attract pollinating insect and may be present in seeds/fruits to encourage birds to eat them and so disperse the seeds. Beetroot has been selected for color because it is more attractive and also because it may be well linked to genes for flavor too. Beetroot pigment is used commercially as a food dye. It changes color when heated, so it can only be used in ice-cream, sweets, yoghurt and other confectionary, and it is a good flavoring agent, but it has no known allergic side effects. Beetroot is a common salad ingredient when cooked vinegar is added to the water to lower the pH. Beetroots are a rich source of potent antioxidants and nutrients, it can be used for blood pressure, for cardiovascular disease prevention, for healthy liver function, for cancer prevention among others. Beetroot juice has been shown to lower blood pressure and thus, help prevent cardiovascular problems. Research published in the American Heart Association Journal Hypertension showed drinking 500 mL of beetroot juice led to a reduction in blood pressure within one hour.

The main aim of this research was to formulate yoghurt flavoured with Beetroot *(Beta vulgaris* L.) juice of different concentrations and to determine the microbial, proximate, physiochemical and micronutrient composition of the beetroot flavored yoghurt.

2. Materials and Methods

The materials used for the production of flavored yoghurt were beetroot, milk, starter culture (yoghurmet). Beetroot and other materials, (starter culture, skimmed milk and sugar) were purchased at Ogige main market, Nsukka, Enugu State, Nigeria.

Sample Preparation

A liter of yoghurt was produced by mixing 150 g of skimmed milk with 850 mL of distilled water. Pasteurization was done at the temperature of about 80-85 °C for 15 min, the milk was cooled at the temperature of about 42-45 °C for 20-30 min. The starter culture was added at this temperature and mixed thoroughly, and refrigerated immediately at the temperature of about 4 °C after 12 h to stop fermentation. The yoghurt sample was flavored with different concentrations of the root juice (beetroot).
Beetroot pulp was prepared using the method of FAO as shown in Fig. 1.

The total weight of beetroot (204 g) was taken by weighing using electrical weighing balance (Digital balance, Model no. 302N, made in England).

Sorting was done by manual removal of contaminated ones. The beetroot was cleaned by washing in water to remove sand, adhering dirt and extraneous material. The beetroot was cut into slices of about 2-3 mm thick, and subjected to extraction using juice extractor (Binatone, model JE-500). The beetroot pulp was sieved using a muslin cloth to obtain a clear filtered juice, then the filtered juice was pasteurized at 85 °C to destroy enzymes and reduce the microbial load. About 600 mL of the juice was obtained using 100mL of distilled water. The beetroot juice was stored in an air-tight container until used.

Yoghurt was prepared using the method of Egan. Below is the flowchart of its production (Fig. 2) and the formulated yoghurt flavored with beetroot juice.

Methods

Moisture, ash, fat and protein contents were determined using standard AOAC [12] procedure.

Carbohydrate content was determined by difference. It was done by subtracting other food component (moisture, ash, fat and protein) obtained by analysis from 100. The difference consists almost of digestible energy providing calories from carbohydrate.

Percentage carbohydrate =
100 – (% protein + % fat + % moisture + % ash).

pH determination

pH was determined using a pH meter (model EAL 920). Five milliliters of the sample was measured out and homogenized in 50 mL of distilled water. pH meter was first standardized using buffer solution of pH 4.0-9.0, sufficient time was allowed for stabilization before reading.

Total solid determination

This was carried in accordance with the methods described by AOAC. About 10 mL of yoghurt sample was pipetted into washed, dried and weighed crucible. The dish and its contents were out in an oven and dried at the temperature of about 70 °C for 3 h under pressure. It was cooled in a desiccator and weight of the solid determined.

Calculation:

The percentage by mass of solid =

$$100 \times \frac{\text{Weight of dried solid}}{\text{Weight of sample 1}}$$

Titrable acid determination

Titrable acidity was determined according to AOAC . Titrable acid determination was carried out using about 5 mL of the sample which was taken and titrated with 0.1 N alkali (NaOH) using 0.5 mL phenolphthalein as indicator. Titration continued until there is a change in color to a pink end point, the titration was repeated to get average result.

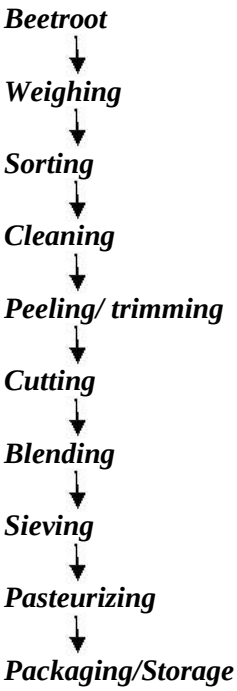

Fig. 1 Flowchart of Beetroot juice production.

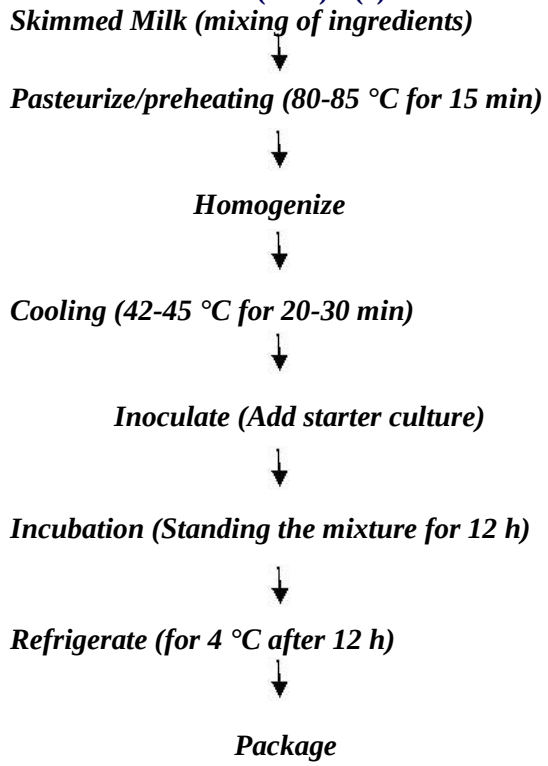

Fig. 2 Flowchart of yoghurt production.

Lactose determination

The percentage of lactose was determined by means of sample calculation the total weight of fat, protein and ash was subtracted from the weight of the total solid.

Calculation = Total solid – (% fat + % protein + % ash).

Total viable count

The total viable count test was carried out using Prescott [15]. Using of sample and sterilized quarter strength ringer solution as diluents, 1 mL of the sample and 9 mL ringer solution was made serial dilutions. The diluted sample was pipetted into a marked Petri dish, swirled to mix and incubated at the temperature of about 37 °C for 24 h. After incubation, the number of colonies was counted and represented as colony forming unit per milliliter.

Total viable count (cfu/mL) = number of colony dilution factor

Coliform determination

Prescott was used in this determination. About 10 mL of prepared Mac Conkey agar was added into the Petri dish containing 1 mL of the sample. After inoculation, it was incubated at temperature of about 37 °C for 24 h, after incubation, the number of colony was counted and represented as colony forming unit.

Mould count determination

Mould count determination was done according to Prescott. The agar used was Sabouraud dextrose agar. About 12-15 mL of Sabouraud dextrose agar was added to the 1 mL of sample in the Petri dish. It was thoroughly mixed and allowed to set before incubating at the temperature of 37 °C for 48 h. After incubation, the number of colonies was counted and represented as colony forming unit per gram.

Lactic acid bacteria determination

This was done by carrying out a serial dilution on the sample in duplicate. Then using the pour plate method, the sample and MRS agar were put in the Petri dish and incubated under anaerobic condition the temperature of 37 °C for 48 h.

Vitamin C determination

According to Pearson [16] method, vitamin C determination, about 5 g of the sample and 2.5 mL of 20% metaphosphoric acid used as a stabilizing agent and diluted with distilled water was weighed into a 100 mL volumetric flask, 10 mL of the solution and 2.5 mL of acetone was added. The absorbance reading at 264 nm wavelength, using UV spectrophotometer gives the vitamin C content.

Calcium determination

According to Pearson [16] method, about 10 mL of the sample was pipetted into 250 mL conical flask and 25 mL potassium hydroxide (KOH) and a pinch of calcine indicator was also added and titrated against ethylene diamine tetra-acetate (EDTA) solution to the end point. The volume of EDTA is the equivalent volume of calcium in the sample.

Calculation: Percent calcium =

$$\frac{\text{Volume of EDTA} \times \text{atomic weight of calcium} \times 100 \times \text{DF}}{1000 \times \text{weight of sample used} \times 10}$$

DF = dilution factor.

Potassium determination

This was carried out according to method of Kirk and Sawyer [17]. About 5 mL of the sample was wet ash and transferred into a 400 mL beaker. Using 100 mL water, 10 mL concentrated hydrochloric acid was added and set to boil for several minutes, after boiling it was allowed to cool and then diluted with water to 500 mL, filtered and diluted again to a final concentration of approximately 15 mg/L K_2O. Series of solution from the freshly prepared standard dilute potassium solution containing 10, 12, 14 16, and 20 mg/L K_2O were prepared, using a filter to give a spectral range of 766-770 nm. The sensitivity of the flame photometer was set so that the full deflection equivalent to 20 mg/L. Each standard solution was sprayed at least three times, checking the sensitivity between each reading against the 20 mg/L solution.

Sodium determination

Sodium determination was performed using procedure described by Kirk . About 10 mL of sample was wet ash followed by addition of water and 5 mL concentrated nitric acid, stirred and transferred to 100 mL volumetric flask with water and made up to the mark. The flame photometer was set up so that the scale reads zero with distilled water and 100 divisions when standard dilute sodium was sprayed. The sample solution was sprayed (suitably diluted to give a reading within the 0-100 range) and the sodium was calculated by simple proportion.

Magnesium determination

Magnesium was determined by method according to Onwuka. About 1.0 g of magnesium ribbon was accurately weighed and dissolved in 10 mL of concentrated hydrochloric acid (HCl); the solution was boiled and evaporated to dryness on a water bath. De-ionized water was added and the solutions were transferred into a 100 mL volumetric flask and made up to the mark with de-ionized. From the stock, solution of concentrations 0.0, 0.5, 1.0 and 1.5 ppm was prepared to each of the magnesium solution strontium chloride solutions, was added such that there was 1,500 mg of strontium ion in the final solution.

Sensory evaluation

The best product was determined through sensory evaluation. This was done using 20-man semi-trained panelist from the Department of Food Science and Technology, College of Food and Dairy Technology, Chennai. The panelists were instructed to indicate their preferences for each of the samples. A nine point hedonic scale where nine was the highest score and one was the lowest score for each attribute such as color, flavor, mouth feel, aftertaste and overall acceptability was used to evaluate the product and also the interpretation of the consumer responses with respect to acceptance of the product.

Data Analysis

The sensory evaluation were subjected to one-way analysis of variances, the means were separated using Duncan multiple Range test and least significant difference at significant level of $P > 0.05$ using SPSS version 17 computer statistical package. Microbial analysis will be subjected two-way analysis of variance.

Results and Discussion

Microbial Content of Beetroot Flavoured Yoghurt

In the microbial analysis carried out on the formulated products, there was coliform growth observed in sample B_5. This means that there were faecal contamination in the sample and this could have been due to the environment and water used during processing, however, decrease in the activity of the lactic acid bacteria caused an increase in the pH. Total viable count ranged from 6.4 10^3 cfu/mL. This count could be responsible by the organisms that makes up the starter culture used for the fermentation of the milk (*Streptococcus* spp. and *Lactobacillus* spp.). This could be compared with the report of other researchers that the bacteria that make up the starter culture used for the fermentation could give a count of 10^8 per gram of yoghurt. Lactic acid bacteria count is ranged

from 1.5 10-4.9 10^2 cfu/mL. This could be compared with the values of Oberman and Libudzisz which ranged between 200-1,000 million per mL of yoghurt. In Table 1 below, it is observed that increase in lactic acid bacteria count caused a decrease in total viable count. Mould growth occurred in the sample that contained no beetroot juice. According to Adams and Moss [19], satisfactory yoghurt should contain (> 10^8 cfu/g of the starter culture < 1 coliform/g < 1 mould g^{-1} and < 0 yeast g^{-1}) of yoghurt.

Table 1 Total viable, coliform, mould and Lactic acid bacteria (LAB) count of the beetroot flavoured yoghurt.

Samples	TVC	Coliforms	Mould count	LAB
B_0	1.5×10^4	-	8.0 10	4.9×10^2
B_1	3.1×10^3	-	-	3.8×10^2
B_2	1.3×10^4	-	-	4.4×10^2
B_3	1.6×10^4	-	-	3.4×10^2
B_4	6.4×10^3	-	-	4.7×10^2
B_5	9.8×10^3	1.0 10	-	2.5×10^2
B_6	1.04×10^4	-	-	1.5×10^2
B_7	1.76×10^4	-	-	1.2×10^3
B_8	1.89×10^4	-	-	3.3×10^2

Values are mean ± standard deviation of duplicate determinations;
Key: - → No growth; B_0 = 100 mL of yoghurt; B_1 = 90 mL of yoghurt + 10 mL of beetroot; B_2 = 80 mL of yoghurt + 20 mL of beetroot; B_3 = 70 mL of yoghurt + 30 mL of beetroot; B_4 = 60 mL of yoghurt + 40 mL of beetroot; B_5 = 50 mL of yoghurt + 50 mL of beetroot.

Micronutrient Content of Beetroot Flavoured Yoghurt

From Table 2 below, vitamin C content is ranged from 6.50-9.50 mg/mL. The result showed that there was an increase in vitamin C content with the increased concentration of the beetroot juice as seen in sample B_5. Michael stated that treatments reduce the amount of vitamin C in foods. Magnesium (Mg) content is ranged from 0.15 to 4.75 mg/100 mL. Sample B_4 has the highest amount of Mg content. Magnesium increased with decrease in concentration of the beetroot juice content of the product. Calcium has the highest content ranged from 33-87 mg/100 mL. McCance and Widdowson reported calcium value in yoghurt to be 120 mg/100 mL. The values of calcium obtained in the beetroot flavoured yoghurt were less compared with Hiroya. This may probably be due to the addition of the juice. In Sodium (Na), sodium content is ranged from 1.0 to 1.7 mg/100 mL. Sodium content increased with decrease in the concentration of the beetroot juice, as seen in sample B_2. Potassium increased in the sample with high concentration of beetroot juice. For potassium (K), sample G_4 has the highest Potassium content.

Table 2 Selected minerals and vitamin composition of beetroot flavoured yoghurt.

Samples	Vitamin (mg/mL)		Mineral (mg/100 mL)			
	Vit. C		Mg	Ca	Na	K
B_0	7.15	± 0.07	0.20 ± 0.00	77.0 ± 0.28	1.0 ± 1.12	14.0 ± 0.07
B_1	9.10	± 0.00	4.20 ± 2.26	61.0 ± 0.00	1.5 ± 0.07	14.0 ± 0.07
B_2	7.70	± 0.14	0.20 ± 0.00	69.0 ± 0.07	1.7 ± 0.07	13.0 ± 0.07
B_3	8.25	± 0.07	0.45 ± 0.00	63.0 ± 0.07	1.6 ± 0.14	14.0 ± 0.07
B_4	6.50	± 0.14	2.75 ± 0.07	87.0 ± 0.07	1.5 ± 0.14	16.0 ± 0.07
B_5	11.50	± 0.42	0.40 ± 0.00	63.0 ± 0.07	1.6 ± 0.14	15.0 ± 0.07
B_6	7.90	± 0.00	3.15 ± 0.00	52.0 ± 0.07	1.3 ± 0.07	14.0 ± 0.07
B_7	7.70	± 0.14	0.47 ± 0.01	33.0 ± 0.00	1.2 ± 0.07	14.0 ± 0.07
B_8	8.18	± 0.59	0.17 ± 0.00	63.0 ± 0.07	1.6 ± 0.14	15.0 ± 0.07

Values are means ± standard deviation of duplicate determinations

Physiochemical Composition of Beetroot Flavoured Yoghurt

Table 3 shows the range of total solid, pH, titrable acidity and lactose. Total solids increased with increase concentration of the beetroot juice flavour in yoghurt. Furthermore, moisture content in the table decreased with increase total solids. For example, sample G_5 has the lowest moisture content and the highest total solid content. Lactose content increased with increase in beetroot juice content in yoghurt, and this could be compared with Anyanwu . The pH ranged between 6.5-7.8, while titrable acidity ranged between 0.0-7.2 on Table 3. The pH range was higher when compared with brands of commercial yoghurt which ranged between 4.0-4.45 reported by Orakwue [24]. This could be due to acidity impacted by beetroot juice . There were no titrable acidity content in samples (B_0 and B_6) this could be as the result of the fact that sample B_0 was the control and it contained no beetroot juice, while sample B_6 contained no beetroot juice also and it was thermized. Titrable acidity decreased with increase in pH as seen in Table 3. The pH of sample B_4 was 7.8 while the titrable acidity of sample B_4 was 0.0. However, the pH decreased with increase in total solid in samples and with increase of the beetroot juice content. This could be compared with the report of Anyanwu.

Table 3 Physicochemical composition of the beetroot flavoured yoghurt.

Samples	Total solids (%)		pH value	Titrable acidity	Lactose (%)	
B_0	17.03	± 0.9	7.8 ± 0.6	0.0 ± 0.0	10.00	± 0.6
B_1	15.03	± 0.3	6.8 ± 0.6	4.2 ± 0.7	15.55	± 0.6
B_2	13.06	± 0.4	7.6 ± 0.6	1.9 ± 0.7	17.22	± 0.59
B_3	15.06	± 0.2	6.8 ± 0.4	3.2 ± 1.4	18.26	± 0.47
B4	15.08	± 0.28	6.8 ± 0.6	3.7 ± 0.9	20.07	± 0.8
B_5	21.04	± 0.32	9.8 ± 0.2	7.2 ± 1.4	25.65	± 0.8
B_6	17.01	± 0.42	6.5 ± 0.6	0.0 ± 0.0	15.57	± 0.6
B_7	15.03	± 0.32	6.6 ± 0.5	1.9 ± 0.7	16.20	± 0.58
B_8	16.04	± 0.32	7.8 ± 0.6	3.2 ± 1.4	18.20	± 0.45

Values are mean ± standard deviation of duplicate determinations;

Proximate Composition of Beetroot Flavoured Yoghurt

Table 4 showed that the moisture content ranged between 60.09%-90.08%. Sample B_5 had the lowest moisture content while sample B_8 had the highest moisture content. This showed that moisture increased with decrease in the concentration of the juice added. Hiroya reported that the moisture content of skimmed sweet yoghurt is 80% and this could be compared with B_1. The crude protein ranged from 2.15%-9.25% with sample G_0 having the highest value and sample G_5 having the lowest value of crude protein. This showed that increase in concentration of the beetroot juice in the product reduced the protein content. Oberman reported protein content of yoghurt to be ranged between 4.6%. The values obtained below were more than these ranges probably because of the milk used. Sample G_3 was almost close to the range reported by Oberman. The fat content obtained in the Table 4 below was low compared to the brands of commercial yoghurt reported by Orakwue, whose fat content ranged from 2.6%-3.24%. Sample B_0 had the highest fat content while sample B_5 had the lowest fat content. Yoghurt flavoured with sweetened juice reduced fat level.

Ash content ranged from 0.94%-1.49% and this could be compared with the range given by Mbaeyi as 0.49%-0.98%. The ash content could have been enhanced by the added juice. Carbohydrate content ranged from 22.22%-10.15%. The concentration of carbohydrate content increased with decreased concentration of the juice in the product.

Table 4 Proximate composition (%) of the beetroot flavoured yoghurt

Samples	Moisture content	Crude protein	Fat content	Ash content	Carbohydrate	Fibre content
B_0	77.22 ± 0.7	9.23 ± 0.05	1.54 ± 0.04	0.945± 0.05	11.15 ± 0.60	ND
B_1	81.92 ± 0.1	9.21 ± 0.05	1.46 ± 0.04	0.96 ± 0.05	13.03 ± 0.60	ND
B_2	86.09 ± 0.7	6.48 ± 0.05	1.38 ± 0.03	0.97 ± 0.05	18.34 ± 0.71	ND
B_3	87.05 ± 0.7	3.31 ± 0.04	1.25 ± 0.04	0.97 ± 0.04	19.37 ± 0.75	ND
B_4	86.22 ± 0.1	2.85 ± 0.04	1.27 ± 0.03	0.97 ± 0.05	21.22 ± 0.74	ND
B_5	62.09 ± 0.4	2.13 ± 0.04	0.17 ± 0.04	0.97 ± 0.04	23.06 ± 0.65	ND
B_6	76.20 ± 0.5	9.26 ± 0.05	1.54 ± 0.04	1.07 ± 0.05	12.17 ± 0.80	ND
B7	83.89 ± 0.9	9.22 ± 0.05	1.42 ± 0.03	1.48 ± 0.05	14.05 ± 0.80	ND
B_8	91.08 ± 1.6	6.42 ± 0.05	1.27 ± 0.03	1.48 ± 0.05	19.36 ± 0.75	ND

Values are mean ± standard deviation of duplicate determinations ND= Not Detected

Sensory Analysis

From the sensory scores on Tables 5, 6, it showed that there were no significant differences (P> 0.05) between the samples and the control. Therefore the samples that were used for analysis were selected randomly from the sensory evaluation result which is samples (B_0-B_5). From the Table 5, colour and acceptance decreased with increase in the proportion of the beetroot juice. This may be as the result of the red colour of beetroot juice. Flavouring the yoghurt with different concentration of beetroot juice improved the flavour, colour, taste, mouthfeel, aftertaste and the overall acceptability of the products.

Table 5 Sensory scores of beetroot flavoured yoghurt.

Sample Parameter	Color	Flavor	Mouthfeel	Taste	Aftertaste	Overall acceptability
B_0	8.75 ± 0.44^{a}	7.45 ± 1.19^{dd}	7.80 ± 0.94^{c}	7.40 ± 1.27^{c}	7.35 ± 1.18^{c}	7.85 ± 1.26^{d}
B_1	7.65 ± 1.66d^{e}	7.45 ± 1.84^{dd}	6.60 ± 1.31^{bc}	6.45 ± 1.74^{bc}	6.25 ± 1.74^{ab}	6.25 ± 2.07^{c}
B_2	6.60 ± 1.69^{cd}	6.45 ± 1.76^{cd}	5.55 ± 2.23^{ab}	5.10 ± 2.23^{ab}	5.60 ± 2.01^{ab}	5.85 ± 1.75^{bc}
B_3	5.75 ± 1.74^{bc}	6.00 ± 1.80^{bc}	5.30 ± 2.17^{a}	4.39 ± 2.51^{a}	4.80 ± 2.01^{aa}	5.00 ± 2.10^{abc}
B_4	4.65 ± 2.32^{ab}	4.90 ± 2.38^{ab}	5.30 ± 2.17^{a}	4.35 ± 2.51^{a}	4.25 ± 2.59^{a}	4.05 ± 2.68^{a}
B_5	4.30 ± 2.73^{a}	4.80 ± 2.52^{ab}	5.05 ± 2.21^{a}	4.70 ± 2.31^{a}	4.80 ± 2.35^{aa}	4.55 ± 2.62^{ab}

Values are means ± standard deviation of duplicate determinations;

Table 6 below shows the effect of thermization on the formulated yoghurt flavoured with different concentration of beetroot juice. It is observed in the table below that samples G_0, G_1 and G_3 were the most preferred. This may probably be due to their colour was not affected by the effect of thermization. There were no significant differences (P> 0.05) between the samples (B_1 and B_2) in terms of the flavour, aftertaste and overall acceptability which means they were all preferred. Similarly among the 6 samples, colour and mouth feel were the most preferred in sample G_0. This was probably due to the absence of beetroot juice in it.

Table 6 Sensory scores of Thermized yoghurt flavoured with different concentration of beetroot juice.

Sample Parameter	Color	Flavor	Mouthfeel	Taste	Aftertaste	Overall acceptability
B_0	8.25 ± 0.1^{C}	6.65 ± 1.87^{b}	6.75 ± 1.26^{b}	7.15 ± 1.26^{c}	5.65 ± 2.41^{a}	6.70 ± 2.12^{a}
B_1	7.65 ± 0.87^{C}	6.50 ± 2.009^{ab}	6.60 ± 1.93^{ab}	6.60 ± 1.81^{bc}	5.65 ± 2.23^{a}	6.65 ± 1.95^{a}
B_2	6.60 ± 1.39^{b}	6.25 ± 1.74^{ab}	5.85 ± 1.84^{ab}	6.00 ± 1.91^{bc}	5.85 ± 2.13^{a}	6.30 ±1.78^{a}
B_3	5.75 ± 1.74^{ab}	5.50 ± 1.63^{ab}	5.70 ± 1.71^{ab}	5.35 ± 1.87^{ab}	5.25 ± 1.88^{a}	6.05 ± 1.70^{a}
B_4	5.35 ± 1.81^{a}	5.80 ± 1.81^{ab}	5.35 ± 1.95^{a}	5.35 ± 2.00^{ab}	5.60 ± 2.11^{a}	5.90 ± 1.74^{a}
B_5	5.25 ± 2.31^{a}	5.15 ± 2.23^{a}	5.30 ± 1.80^{a}	4.65 ± 2.08^{a}	5.70 ± 1.41^{a}	6.15 ± 1.95^{a}

Values are means ± standard deviation of duplicate determinations

Conclusions

The result of this study showed that addition of beetroot juice to yoghurt as flavouring agent improved the physicochemical, colour and sensory properties of yoghurt, especially when added in a little quantity (5-10 mL). The addition of beetroot juice in yoghurt improved the acceptability as seen in the sensory scores obtained. Vitamin C content of the formulated product increased with increase content of the flavor. Minerals particularly Mg, Ca, K also increased in the addition of the juice. The absence of coliform showed no faecal contamination and the product was safe for consumption. Thus, the utilization of beetroot as a natural flavouring agent improved the nutritional and sensory properties of the product. Both the thermized and unthermized yoghurt lasted for about two months without spoilage. From the foregoing, there is need for further studies on other minerals (nitrites) and vitamins (vitamin A) of the beetroot flavoured with different proportion of beetroot juice. Also, more researches should be carried out on the thermization of the yoghurt.

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