# Nutritional Composition of African Locust Bean (*Parkia biglobosa*) Pulp Composite Yoghurt

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## ABSTRACT

Yoghurt is an acidified custard-like semi-solid dairy product, produced by fermenting pasteurized milk with lactic acid bacteria. In recent times, yoghurt is also produced from non-dairy sources that are plant based such as soya beans, tiger nuts and coconuts. Yoghurt is nutritious and highly recommended for lactose sensitive individuals because it is low in lactose. The African locust's bean (*Parkia biglobosa*) pulp is yellow in colour which indicates the presence of carotenoids (an important precursor of vitamin A and vitamin C). The pulp has sweet-taste indicating the presence of natural sugars. The study was aimed at formulating composite yoghurt from the African Locust bean pulp and cow milk, and determine the nutritional and sensory quality of the produced yoghurt. Four composite yoghurt formulations were prepared as follows: control/100% milk (T1), 5% pulp: 95% milk (T2), 4% pulp: 96% milk (T3) and 3% pulp: 97% milk (T4) using Yogourmet containing *Lactobacillus bulgaricus, Streptococcus bulgaricus, Streptococcus thermophilus and Lactobacillus acidophilus*. The mean values for the proximate analysis on protein was (3.63), fat (2.95), carbohydrate (7.57), ash (0.84) and moisture content (85.0). There were however, no significant differences between proximate means at $p<0.05$. The physiochemical results ranges were pH (3.75 - 3.87), total titratable acidity (0.26 - 0.28%), total solids (14.00 -15.67%), total soluble sugar (0.07 - 0.12%) and solid non-fat (15.10±0.01 - 18.10±0.01). There were no significant differences between treatments for total solids and total titrable acidity while there were significant differences between treatments for pH, total soluble sugar at ($p>0.05$). For consumer acceptability, T1 had the highest consumer acceptability followed by T4 and T3. The pulp had the highest beta-carotene content of 3.96±1.29 followed by T1 (1.48±1.29), T3 (1.23±1.29) and T4 (0.97±1.29). Knowledge on the nutritional benefits of the composite yoghurt, especially T4 could influence consumers to patronize the African Locust bean pulp yoghurt when produced on commercial scale for the markets.

**Keywords:** African locust bean pulp, milk, yoghurt, starter culture, fortified, nutrition

## INTRODUCTION

Yoghurt is an acidified, custard-like semisolid dairy product produced by the fermentation of pasteurized milk and a starter culture (Roy *et al*., 2015). There has also been the use of non-dairy milk in the processing of yoghurt from plant sources such as coconuts, tiger nuts and soya beans.



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Functionally, *Streptococcus thermophilus* and *lactobacillus spp* have been used to alter the physical and chemical properties of yoghurt, as well as, to improve its sensory properties (Kristo *et al*., 2003). The consumption of yoghurt has increased globally due to its nutritional value, therapeutic effects and functional properties (McKinley, 2005). Yoghurt contains at about 3.25% milk fat and 8.25% milk solids non-fat (MSNF) with a titratable acidity of not less than 0.9 percent, which is converted into lactic acid (Weerathilake *et al*., 2014).

Yoghurt is mainly produced by pasteurization of cow milk and the action of two homo fermentative bacteria known; *Lactobacillus bulgaricus* and *Streptococcus salivarius*, which show a mutual relationship between each other. Also, the proto-cooperative action between these two bacteria, leads to a rapid acid development as compared to developments in a single strain culture. However, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are not the only bacterial agents that enable conversion of lactose into lactic acid (Roy *et al*., 2015). In a normal dairy processing industry, various combinations of starter cultures are selected during the production of the yoghurt to achieve a desired characteristic of the product. This also help to provide consumers with a wide range of therapeutic benefits. Based on its activity, a manufacturer normally adds 2-4 % yoghurt starter culture to the pasteurized milk (Ghadge *et al*., 2008).

Despite the nutritional value of yoghurt, some essential components of food such as vitamins are still lacking, as such the production of composite yoghurt. Composite yoghurt processing improves the nutritional, sensory and physical attributes of yoghurt. Composite yoghurt can help improve the nutritional and sensory (texture, viscosity, colour and firmness) qualities. According to Dari (2013), butternut squash composite yoghurt can be described as a healthy choice based on the proximate composition. Most composite yoghurts often possess natural colours which prevents the use of artificial colourants. The most commonly used in composite yoghurts include; fruits and vegetables, and other plant part extracts. Çakmakçi *et al*. (2012), attributed the improvement in the nutritional and sensory properties of fruit yoghurt to the usage of different fruits and additives in the



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preparation processing. Some of the fruits frequently used include peaches, cherries, apricots, papaya, cactus pear and blueberries (Arslan and Ozel, 2012). Other vegetables and plant extracts used are squash, carrots, beetroots and sweet potato.

The quality attributes of yoghurt such as appearance and flavour are mostly determined by the nature and composition of the yoghurt as well as the culture used. A yoghurt sample has a distinctive flavour which is due to the production of lactic acid, carbon dioxide, acetic acid and acetaldehyde and several other components from the milk fermentation process. According to Coisson *et al*. (2005), a high priority has been provided to maintaining yogurt of excellent quality, bearing in mind that even a minute contamination can cause health problems for customers. Sensory attributes such as mouthfeel, taste and viscosity of yoghurt help determine consumer acceptance. These attributes nowadays are accompanied with certain health benefits (Behare *et al*., 2010).

The African Locust (*Parkia biglobosa*) plant is indigenous owing its popularity to the fermented beans known as "Dawadawa" in Ghana. "Dawadawa" is a condiment with numerous health benefits (Akubor, 2017). The bean of the African locust fruit has a yellowish pulp that has a sweet taste, which suggests the existence of natural sugars that make it a potential source of energy. The appealing yellow colour suggests the existence of carotenoids (a significant forerunner of vitamin A), while the sour taste implies the existence of vitamin C (Akoma *et al.*, 2001).

Carotenoids are natural pigments and constituents of foods found in plants, and mostly abundant in fruits and vegetables. Some carotenoids are precursors of vitamin A. The most common types of carotenoids include alpha carotene, beta carotene, beta cryptoxanthin, lutein, zeaxanthin and lycopene. Vitamin C is a strong antioxidant that can boost blood antioxidant levels and could help reducing the risk of chronic diseases. Beta carotene (β-carotene) is a red-orange pigment found in the locust bean pulp which can fortify the composite yoghurt since carotenoids are absent in yoghurt and milk in general.


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## MATERTIALS AND METHODS

### Sample collection

The experiment was conducted at the Food Laboratory of the Department of Family and Consumer Science, University for Development Studies, Nyankpala Campus in the Northern Region of Ghana. All the ingredients used were purchased from the Tamale market except the yoghurt culture.

### Yoghurt Starter Culture Preparation

Freeze-dried yoghurt starter culture containing *Lactobacillus bulgaricus, Streptococcus bulgaricus, Streptococcus thermophilus* and *Lactobacillus acidophilus was* used according to the manufacturer's instructions (Yogourmet). Milk was pasteurised at 82°C and a holding duration of one minute, and allowed to cool. Five (5) g of starter culture was used per litre of milk by dissolving in a small quantity of lukewarm milk in a cup. The solution was poured and mixed with 1litre of lukewarm (42°C) milk (inoculated), and incubated for 8 h. Firmed yoghurt culture was stirred, packed and refrigerated to stop incubation.

### Composite Yoghurt Preparation

Sixteen (16) litres of fresh cow milk and 220 grams of African locust bean pulp was used. This was measured into different proportions which served as treatments. Treatment one (T1) was 100% milk which served as the control; treatment two (T2) was 5% pulp:95% milk; treatment three (T3) was 4% pulp:96% milk and treatment four (T4) was 3% pulp:97%. milk. Milk was pasteurised at 82°C and a holding duration of one minute for the control. Milk for treatments two to four was however, pasteurised at 82°C and the locusts' bean pulp mixed in and held for a duration of five minutes. For all treatments, 4 l each of pasteurised milk was cooled to 42 °C and inoculated with 300 ml of the prepared starter culture and incubated for 8 h. Formed and firmed yoghurt was stirred, packed and refrigerated for laboratory analysis.



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**Physicochemical Analysis**

Samples were analysed for pH, total titratable acidity (TTA), total soluble sugar, total solid non-fat (SNF), total solids (TS) and beta carotene content using the methods of Analysis of the Association of Official Analytical Chemists (AOAC, 1990), 15th edition.

**pH Determination**

A digital pH meter (CRISON pH meter basic 20) was used to determine the pH of analytical samples. Approximately 20 ml of the sample was measured into a plastic container. The pH was then determined by inserting the electrode of pH meter into the sample and the readings recorded (AOAC, 1990).

**Determination of Total Titratable Acidity (TTA)**

A 2.5 g of each sample was weighed into a clean beaker. Amounts of 50 ml of deionised water and three drops of phenolphthalein were added respectively, and mixed thoroughly at each step. The mixture was then titrated against 0.1sodium hydroxide (NaOH) solution until the endpoint (pink colour) was observed (AOAC, 1990).

**Total Soluble Sugar Determination**

The content of the soluble sugar was determined using the 0-32Brix hand refractometer which was calibrated using distilled water. Few drops of the yoghurt samples were placed on the prism and closed with the lid for 30 seconds, before the reading was taken. The instrument was then turned towards the light for the reading to be taken. The position at which the demarcation line between the light and the dark regions crossed the vertical scale gave the percentage of the readings (AOAC, 1990).


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**Determination of Total Solids (TS)**

Approximately 3 g of the samples were weighed using an analytical balance (Oahu scale). The milk sample was finally dried in a force draft air oven at 100 °C for 3 hours and the dried weight calculated for the total solids (AOAC, 1990).

**Determination of Total Solid Non-Fat (SNF)**

The total solid non-fat content of the yoghurt samples was estimated as a percentage difference between total solid content and fat percentage (AOAC, 1990).

**Determination of Beta Carotene Content**

An amount of 0.5 g of the samples were weighed into test tubes and 5 ml of acetone added, and vortex for about a minute. Petroleum ether (5 ml) was added and also vortex for a minute. The mixture was allowed to stand for 10 minutes for portioning. The optical density was measured using a spectrophotometer (AOAC, 1990).

**Proximate Analysis**

Samples were analysed for moisture, protein, fat and ash content in accordance to the methods described by AOAC (2005). The total calculated carbohydrate was by difference.

**Moisture Content Determination**

Empty porcelain crucibles were labelled and weighed. Then 3.5 g of samples were measured into crucibles using the Oahu's scale, and placed in an electric oven set at 105 °C for 4 hours to attain constant weights (AOAC, 2005).

**Ash Determination**

The weight of the empty crucible was taken, tarred and 3.5 g of the dried samples added. The crucible containing the dried samples were placed into the furnace for ashing overnight at 550 $^{o}$C. The crucible with the samples were removed from the furnace into the desiccators and the ash collected (AOAC, 2005).


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**Crude Protein Determination**

One gram of the dried samples was weighed onto a filter paper and placed into the Kjeldahl digestion tubes, then, 50 ml of sulphuric acid and 2 Khejal tablets was added to the samples. The Khejal tablets acted as a catalyst to speed up the chemical reaction. The digestion tubes were placed on the Kjeldahl digestion block and heated at 420 $^{o}$C for 5 hours. The digested samples were allowed to cool and 50 ml of distilled water was added to the clear solution and distilled using an automated distillation unit for 12 minutes. The distillates were collected with a 25 ml boric acid solution into a 250 ml conical flask and titrated against 0.1 N hydrochloric acid (HCl) (AOAC, 2005).

**Crude Fat Content Determination**

A 3.5 g of ground samples were weighed into clean thimbles. Clean fat cans were weighed and recorded. Then 50 ml of petroleum ether was measured into each of the fat cans. The thimbles were then inserted into the condensers of the Soxhlet apparatus, using thimble holder, after which the fat cans were then placed into the Soxhlet apparatus and boiled at 150 $^{o}$C for 45 minutes. The boiled sample extracts, were then rinsed for 30 minutes to evaporate the solvent from the fat extracts (AOAC, 2005).

**Sensory Evaluation of Yoghurt Samples**

The sensory attributes of the yoghurt samples were evaluated using the acceptance test of fifty panellists consisting of students who were familiar with yoghurt characteristics. The sensory attributes of the yoghurt that were evaluated included appearance, aroma, taste, mouth feel and an overall acceptability using the five-point hedonic scale where 1= dislike very, 2=dislike, 3=neither like nor dislike, 4=like and 5=like very. Yoghurt was poured into thirty millilitres plastic cups, closed and presented to panellists for evaluation.



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**Statistical Analysis**

The physicochemical parameters were subjected to one-way analysis of variance (ANOVA) using Minitab statistical software. The treatment means were separated using Turkey post Hoc option with significance at P ≤ to 0.05, Kruskal-Wallis test in XLSTAT version 2016 was used to evaluate the sensory attributes

## RESULTS AND DISCUSSION

**Proximate Composition of Samples**

From the results (Table 1), the moisture content of the raw locust bean pulp was 26.39% which was higher compared with the findings of Gernah *et al*. (2006), where moisture content was 8.41%. These differences could be due to varietal differences, geographical location of the pulp plant, the processing, method of drying, time and conditions at moisture determination. Generally, lower moisture content in dried products help maintain quality and enhance the shelf life of products during storage. The moisture content within treatments ranged from 84.33±1.07 (T4) to 86.001±1.07 (T3) and affirmed the findings by Ahmad (1994) and Dari (2013), that the maximum moisture content was 84% for yoghurt and 80% for composite yoghurt respectively. High moisture in yoghurt makes it less viscous thereby affecting texture and mouthfeel.

Table 1: Mean Proximate Composition of African Locust Bean Composite Yoghurt

| Treatments | %fat | %protein | %Ash | %moisture | % Carbohydrate |
|---|---|---|---|---|---|
| T1 | 2.440±.97[a] | 3.54±0.35[a] | 0.92±0.09[a] | 85.23±1.07[a] | 7.86±1.05[a] |
| T2 | 3.140±.97[a] | 4.08±0.35[a] | 0.77±0.09[a] | 84.461±1.07[a] | 7.56±1.05[a] |
| T3 | 2.190 ±97[a] | 3.53±0.35[a] | 0.77±0.09[a] | 86.001±1.07[a] | 7.51±1.05[a] |
| T4 | 4.040 ±97[a] | 3.37±0.35[a] | 0.91±0.09[a] | 84.33±1.07[a] | 7.35±1.05[a] |
| Pr>F | 0.232 | 0.187 | 0.148 | 0.447 | 0.983 |
| Raw pulp | 0.96 | 5.60 | 4.49 | 26.39 | 62.56 |

± standard error. Different superscripts within columns indicate significant difference between means. T1 (100% milk), T2 (5% pulp:95% milk), T3 (3% pulp:97% milk) and T4 (4% pulp:96% milk)



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The crude fat content of the African locust bean pulp was 0.96% as compared to 1.80% reported by Gernah *et al*. (2006). The maximum and minimum fat contents were in samples T4 (4.04%) and T3 (2.190) respectively, even though there were no significant differences between all treatments for fat. According to Ehirim and Onyeneke (2013), fat content in fruit pulp flavoured yoghurt should be 3.25% as it plays an important role in improving the consistency of yoghurt and also provide twice the amount of energy per the same quantity of carbohydrate and protein.

The ash content of the pulp was 4.49% as against 4.18% (Gernah *et al*., 2006). The ash content of the treatments ranged from 0.77 to 0.92 for T3 and T1 respectively. The ash value is an indication of the mineral content, which is needed for bone development, teeth formation and body functions (Trachoo and Mistry, 1998).

The raw pulp protein was 5.6%, while the protein content of the treatments ranged between 4.08% (T2) and 3.37% (T4). Protein is essential for the maintenance and repair of tissues in the body. The raw pulp carbohydrate content was 62.56%. The carbohydrate content of treatments ranged from 7.352% (T4) to 7.864% (T1). According to Ehirim and Ndimantang (2004), low carbohydrate value in yoghurt is due to the process of fermentation where lactose is converted to lactic acid. This makes yoghurt a beneficial food for lactose sensitive individuals. There were no significant differences ($p<0.05$) between all treatments.

**Physicochemical Properties of Samples**

The result of the chemical and physical properties of the yoghurt samples are as presented in Table 2. The total solids of the samples ranged from 15.67% (T4) to 14.77% (T1). This result conforms with the findings of Hofi *et al.* (1994), who stated that yoghurt should have a total solid of between 15% and 16%. According to the findings of Weaver (1993), the low percentage of total solids in yoghurt can attributed to the starter culture not performing its function. The total titratable acidity of


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treatments ranged between 0.26% - 0.28%. There was no significant difference (p>0.05) in the acidic level of yoghurt for all the treatments.

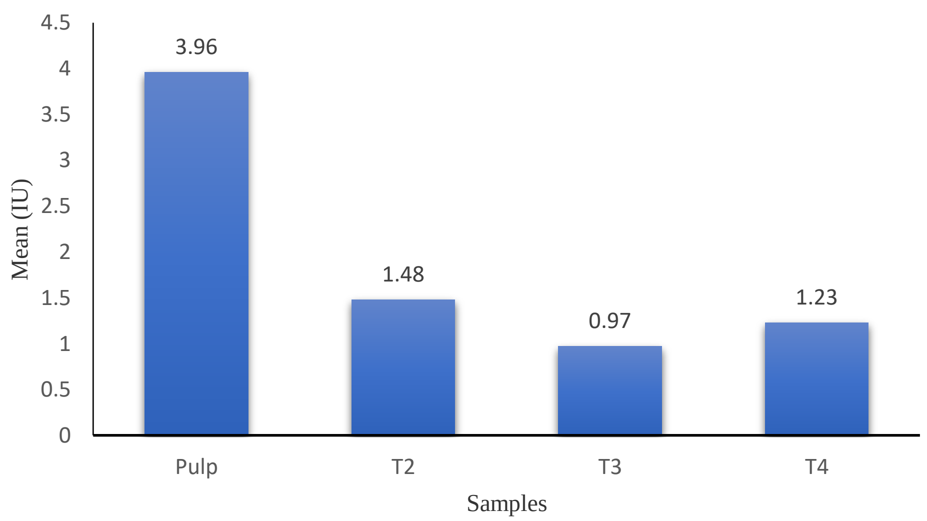
Table 2: Mean Physicochemical Characteristics of African Locust Bean Pulp Composite Yoghurt

| Treatments | pH% | TTA% | TSS% | TS% | SNF% |
|---|---|---|---|---|---|
| T1 | 3.84±0.05[b] | 0.26±0.02[a] | 0.07±0.02[d] | 14.77±10.7[a] | 18.10±0.01[d] |
| T2 | 3.84±0.05[ab] | 0.26±0.02[a] | 0.12±0.02[a] | 15.54±1.07[a] | 17.52±0.01[c] |
| T3 | 3.87±0.05[a] | 0.26±0.02[a] | 0.08±0.02[c] | 14.00±1.07[a] | 15.10±0.01[ab] |
| T4 | 3.75±0.05[b] | 0.28±0.02[a] | 0.09±0.02[b] | 15.67±1.07[a] | 16.06±0.01[b] |
| Pr>F | 0.038 | 0.991 | 0.000 | 0.477 | 0.02 |

± standard error. Different superscripts within columns indicate significant difference between means. TTA=Total Titratable acidity; TS=Total solids; TSS=Total soluble sugar, SNF=solid non-fat. T1 (100%milk), T2 (5% pulp:95% milk), T3 (3% pulp:97% milk) and T4 (4% pulp:96% milk)

**Beta-carotene Levels in the Pulp and Yoghurt Samples**

Results of the beta-carotene content (Figure 1) indicate the pulp recorded the highest beta-carotene content followed by T2, T4 and T3 respectively.




* T1 (100%milk), T2 (5% pulp:95% milk), T3 (3% pulp:97% milk) and T4 (4% pulp:96% milk), *IU = 0.05 µg RE (retinol equivalents)/100 g of sample (NAS-NCR, 1980).*

Figure 1: Mean beta-carotene content in samples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Beta-carotene levels in food are essential as they serve as precursors for vitamin A, an important nutrient for the human body. β-carotene and other carotenoids function as sources and activity of vitamin A, therefore the prevention of vitamin A deficiency (The National Academies 2000). A 6 to 15 mg of beta-carotene (the equivalent of 10,000 to 25,000 Units of vitamin A activity) per day is recommended for an adult as supplement (Mayoclinic, 2019).

**Sensory Evaluation Scores**

From the sensory attributes evaluated for the treatments, T1 was preferred followed by T4, T3 and T2 respectively (Table 3). Consumer preference is defined as the subjective tastes of individual consumers, measured by their satisfaction. Satisfaction is often based on familiarity, nutritional value, physical parameters and packaging of product, and cost of product.

Table 3: Mean Sensory Scores

| Treatments | Appearance | Aroma | Taste | Mouthfeel | Overall acceptability |
|---|---|---|---|---|---|
| T1 | 4.500 | 4.060 | 4.480 | 4.160 | 4.140 |
| T2 | 2.860 | 2.860 | 2.860 | 2.900 | 2.780 |
| T3 | 3.200 | 3.120 | 3.600 | 3.280 | 3.440 |
| T4 | 3.120 | 3.060 | 3.500 | 3.140 | 3.300 |

*T1 (100%milk), T2 (5% pulp:95% milk), T3 (3% pulp:97% milk) and T4 (4% pulp:96% milk)

Consumer preference could change with knowledge on the nutritional and health benefits associated with the addition of the pulp.

## CONCLUSION

From the experiment, there were no significant differences between the control and the composite samples for proximate compositions. There were however, significant differences for some



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physicochemical parameters such as total soluble sugar, total solid and solid non-fat. The composite samples also contained beta-carotene which was lacking in the control. For the consumer preference, the control (T1) was preferred above all the composite samples based on appearance, mouthfeel, aroma, taste and overall acceptability. Education on the nutritional benefits of the composite yoghurt could influence the consumer preference over time.

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