



Effect of three different varieties of banana inclusion on nutritional and sensory acceptability of yogurt

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Abstract

To understand the quality attributes and acceptability of yogurt, three different varieties of *Musa sapientum* (Paranta, Saro and Williams) were used to partially fortified yogurt. Each of the banana fruit was added at different proportion (10%, 15% and 20%) to produce the yogurts. The products were analyzed for proximate, pH, brix, titratable acidity (TA), vitamin C and total phenol. Other parameters such as sensory properties and microbial loads were also determined. The results showed that protein values were between (2.9%-3.92%). The sample with 10% Paranta has the highest protein content (3.93%) which was found to be 5.76% and 36.59% higher than control and sample with 10% Saro which had the least protein respectively. The energy content was found to be between (194.03 kcal/100 g to 207.06 kcal/100 g). The sample fortified with 10% Paranta has highest energy value (207.06 kcal/100 g) which was (0.94%) and (4%) higher than control and sample with 10% Saro which had least energy content (194.03 kcal/100 g). Vitamin C ranged between (20.6 mg/100 g to 21.6 mg/100 g). The sample with 10% Paranta had the highest vitamin C concentration (21.6 mg/100 g), although not significantly different at ($p < 0.05$) compared with other samples. The total microbial count (TMC) was between (0.4×10^5 to 0.8×10^4 cfu/ml). There was no coliform detected in the entire samples. All microbial count observed were within the limit specified as acceptable counts, hence the samples were fit and safe for human consumption at the time the microbial count was done.

Keywords: *Yoghurt, banana fruits, functional food, lactic acid*

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1. Introduction

Yogurt is one of the most popular dairy products loved and consumed by different categories of age group in many parts of the world essentially due to its nutritional importance (Shi et al., 2017; and Zhi et al., 2018). Yogurt is usually made through fermentation of fresh, whole or skimmed milk by the activities of bacterial starter cultures (Falade et al., 2014; and Muniandy et al., 2016). It has been found to provide additional health benefits over its main ingredient which is milk. The conversion of milk to yoghurt through lactic acid fermentation improves the bioavailability of nutrients such as vitamin B₁₂, protein as well as dietary minerals (Gray, 2007; Dello Staffolo et al. 2017; and Tomic et al., 2017). The live bacteria in yogurt could act as probiotic, contributing to microbial balance in the host's gastrointestinal tract which is capable of providing crucial health benefits when it is consumed in sufficient quantity (Melissa and André, 2017). The regular consumption of yoghurt with live cultures (probiotics) is believed to be effective in reducing serum cholesterol levels, improves lactose digestion in case of lactose intolerance, prevention of gut infections, inflammation, diarrhea and colon cancer (Muniandy et al., 2016).

The use of different fruits to enrich yogurt has been found to improve nutritional and sensory properties (Cakmakci et al., 2012). Fruits such as strawberry, apple, watermelon, mango, and grape are rich sources of vitamins, mineral, fibers and anti-oxidants, which could be incorporated in the making of yogurt to increase their nutrients and nutritional benefits (Vahedi et al, 2008; and Erdogan and Zekai 2003). It also has the potential to boost their market distribution due to increasing demand for functional food products rich in essential nutrients and bioactive compounds with strong biological activities which in fact are available in fruits (Hati et al. 2013).

Banana fruits are among the most important food crops in the world. However, despite the fact that millions of people around the world depend on banana as a source of food and income, a significant amount are lost to poor post-harvest management, thus, the need to find more of its alternative uses. Banana is ideal food source to provide vitality; it has natural sugars as well as fiber. Children may consume it as puree or as fruit yoghurt to stimulate their intellectual coefficient due to its high content of potassium and magnesium (Shiby et al., 2013). Banana is called the health fruit as it contains vitamins C, D and E, which are powerful antioxidant factors. It also has β -carotene and vitamin A, and it is ideal for the aged for improved and glowing skin (Kumar and Bhowmik, 2012). The yellow pulp of bananas is a rich in provitamin A and other carotenoids. Carotenoid-rich foods could protect against heart disease, and certain cancers, which are serious emerging problems of large proportion in most developing countries. There is paucity in research works on inclusion of banana to develop fruit based yogurt as it is evident in scarce availability of it in our local stores and super markets. Some people still don't have yogurt compelling to drink despite its numerous nutritional benefits. Enriching it further and adding flavor to its taste with addition of banana may influence more people finding it attractive to consume. This study is aimed at developing fruit enriched yogurts using three different varieties of banana at different proportion and evaluates their properties.

2. Material and methods

2.1. Collection of materials

Three varieties of fully matured banana fruits namely Paranta, Saro, and Williams were obtained from National Horticultural Research Institute (NIHORT) experimental field. A Dano powder milk, sugar and starter culture was purchased from store.

2.2. Yogurt preparation

The yogurt was prepared based on the method as described by Bertolino et al. (2015). About 20% powder milk was reconstituted by dissolving 200 g of milk in 1 liter of water (200 g/L). The slurry of the three varieties of banana was prepared by blending the banana pulp thoroughly in electrical blender until smooth slurry was obtained which were added to constant quantity of pasteurized milk at different concentration (10%, 15% and 20%) respectively. The mixtures were allowed to boil (pasteurization 85 °C for 15min), and thereafter allowed to cool to temperature (42-43°C). It was inoculated with starter culture (*Streptococcus thermophiles* and *Lactobacillus delbrueckii* subspecies *Bulgaricus*) and incubated for 9 h. The process was stopped by cooling down in a bath of ice water and subsequently packaged in sterilized plastic bottles for analysis.

Table 1: The summary of the yogurt formulations partially fortified w w with different variety of banana

Samples	Composition
A ₁₀	10% Paranta + pasteurized milk
A ₁₅	15% Paranta + pasteurized milk
A ₂₀	20% Paranta + pasteurized milk
B ₁₀	10% Saro + pasteurized milk
B ₁₅	15% Saro + pasteurized milk
B ₂₀	20% Saro + pasteurized milk
C ₁₀	10% Williams + pasteurized milk
C ₁₅	15% Williams + pasteurized milk
C ₂₀	20% Williams + pasteurized milk
D	Control + pasteurized milk

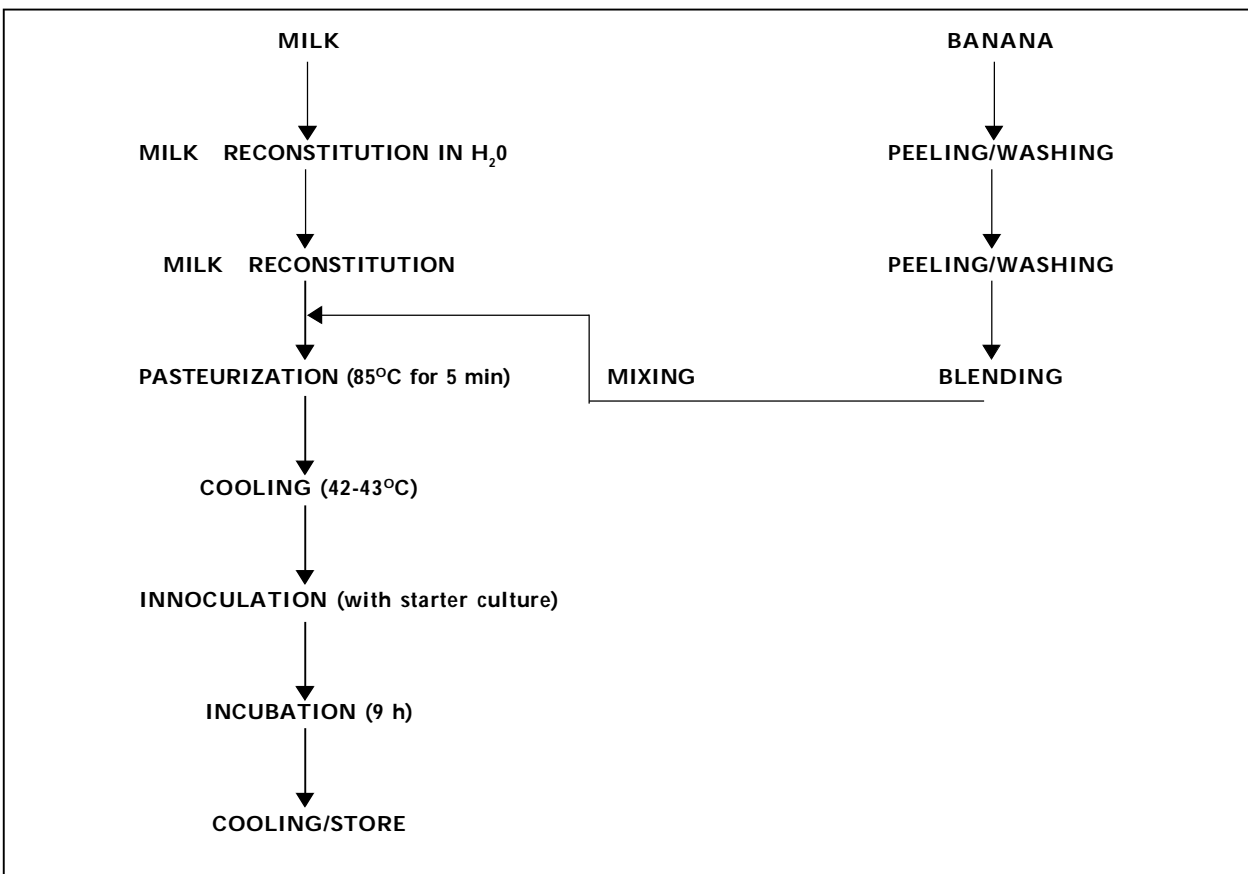


Figure 1: Flow chart showing the production of yogurt

2.3. Analysis

2.3.1. Determination of proximate properties of the yoghurt samples

Moisture, fat and ash content were determined using AOAC methods (AOAC, 2005). The protein content was determined by Kjeldahl method ($N \times 6.25$). Total carbohydrate was calculated by difference as Carbohydrate = 100 – (Moisture + Ash + Fat + Protein).

The energy value in kilocalorie (Kcal) was calculated using a converting factor thus

$$\text{Energy (kcal)} = [\text{protein} \times 4] + [\text{CHO} \times 4] + [\text{fat} \times 9].$$

2.3.2. Determination of pH and TSS (%brix) values

The physical properties of yoghurt like pH, and TSS (%brix) were determined. The pH analysis was carried out using a pH meter (Hanna HI 8314, Hannalnc., Italy) and refractometer was used for total soluble solid (%brix).

2.3.3. Determination of Vitamin C

Vitamin C was determined through titration method using 2, 6-dichlorophenol-indophenol (Ranganna, 1986);

2.3.4. Determination of total phenols

Phenolic compounds were determined using the method described by Gülçin, (2012) with some modifications. Briefly, 1 mL of aqueous extract of yogurt, obtained as described above, was added to 1 mL of Folin Ciocalteu reagent diluted 1:2 with water. After 3 min, 2 mL of 10% Na₂CO₃ was added and the samples were incubated for 15 min at room temperature. At the end of this step, the absorbance was measured at 750 nm. A calibration curve was performed with gallic acid and the results were expressed as micrograms of gallic acid equivalents per 100 mL of sample (GAE).

2.4. Determination of sensory Properties

The product samples were evaluated by 17 panelists randomly selected from staff of National Horticultural Research Institute (NIHORT) Ibadan, using seven-point hedonic scale where 7 represent like very much and 1 dislike very much. The panels were served coded samples to score the samples for color, taste, and aroma and overall- acceptability.

2.5. Determination of microbial loads

Microbiological tests on yoghurt products were conducted to ascertain their suitability or otherwise for human consumption after production. The *coliform* test on yoghurt was done by sample cultured on medium VRBA and counted after incubation during 48 h in 37°C. For mold and yeast tests, there was preparation of dilution (0.1 and 0.001) of yoghurt samples which were then cultured on PDA medium and counting were done after incubation for 72 h in 22°C.

2.6. Statistical analysis

The data obtained from three replications were analyzed as using the general linear model procedure of the SPSS statistical package program (SPSS, Inc., Chicago, IL). Duncan's multiple range test was used to measure the significant difference between means ($p < 0.05$).

3. Results and discussion

The proximate composition of yogurt samples partially fortified with three varieties of banana at different proportion (10%, 15% and 20%) revealed that protein content ranged between (2.93%-3.92%). The samples partially fortified with 10% paranta gave the highest protein content (3.92%). The protein in this sample with 10% paranta inclusion was (5.76%) and (36.59%) higher than the control and sample B₁₀ which has the least protein respectively as presented in (Table 2). The energy content was between (194.031 kcal-207.06 kcal/100 g). The results showed that yogurt samples incorporated with 10% paranta was with highest energy value (207.06 kcal/100 g) which was (0.94%) and (4%) higher than control and sample B₁₀ respectively which had least energy content. The addition of fruits to yogurt could play a range of modifications on its nutrient compositions, the increase in protein content of sample partially fortified with 10% over control and B₁₀ may be due to addition of banana fruit and quality of protein in paranta variety. An improvement in crude protein was observed also by Othman *et al.* (2019) in yogurt enriched with papaya. Proteins are essential nutrients in diet for human body, they are fundamental structural and functional element with every cells of body and involve in range of metabolic activities (Khan *et al.*, 2017). According to FAO/WHO (2007), adequate dietary protein is essential during human growth when new tissue proteins are being formed. Deficiency in protein in essence could precipitate multiples of clinical syndromes such as low serum cells, impaired anti-oxidative reactions, growth stunting in young children and poor cognitive development (Wolfe, 2012; and Phillips *et al.*, 2015).

Table 2: Proximate composition of partially fortified yogurt with different variety of banana

	Moisture%	Protein%	Fat%	Ash%	Fiber%	CHO%	Energy(kcal/100 g)
A ₁₀	44.32±0.0 ^g	3.92±0.01 ^a	0.53±0.10 ^f	4.25±0.15 ^{bc}	0.50±0.00 ^b	46.79±0.01 ^d	207.06±0.12 ^a
A ₁₅	45.25±0.01 ^f	3.85±0.01 ^b	0.61±0.01 ^c	4.60±0.01 ^a	0.55±0.12 ^a	46.24±0.10 ^d	205.73±0.10 ^{abc}
A ₂₀	47.20±0.01 ^{ab}	3.75±0.30 ^{bc}	0.59±0.01 ^d	4.31±0.01 ^b	0.40±0.01 ^{ef}	43.43±0.01 ^g	205.92±0.01 ^{ab}
B ₁₀	46.44±0.02 ^d	2.87±0.01 ⁱ	0.64±0.01 ^b	4.21±0.01 ^d	0.50±0.01 ^c	45.31±0.05 ^e	194.03±0.01 ^j
B ₁₅	40.54±0.00 ⁱ	2.94±0.01 ^j	0.45±0.02 ^g	4.10±0.01 ^{de}	0.49±0.01 ^d	47.90±0.01 ^b	205.92±0.02 ^{ab}
B ₂₀	45.87±0.01 ^e	2.93±0.01 ^{jh}	0.55±0.01 ^f	4.07±0.02 ^{def}	0.38±0.01 ^g	47.16±0.02 ^{bc}	203.17±0.00 ^e
C ₁₀	47.25±0.01 ^a	3.63±0.01 ^e	0.45±0.01 ^g	3.30±0.01 ^j	0.35±0.06 ^h	44.95±0.02 ^f	198.85±0.00 ^f
C ₁₅	40.28±0.02 ^j	3.56±0.01 ^f	0.67±0.01 ^a	3.41±0.05 ⁱ	0.45±0.01 ^e	50.45±0.01 ^a	196.31±0.01 ^{hi}
C ₂₀	47.07±0.01 ^c	3.18±0.01 ^g	0.59±0.01 ^{de}	3.44±0.01 ^h	0.35±0.01 ^h	45.10±0.01 ^e	198.22±0.32 ^{gh}
D	44.01±0.01 ^h	3.72±0.01 ^{bcd}	0.53±0.01 ^f	4.00±0.05 ^g	0.35±0.10 ^h	47.17±0.01 ^{bcd}	205.10±0.10 ^{cd}

Note: A₁₀ = 10% Paranta, A₁₅ = 15% Paranta, A₂₀ = 20% Paranta, B₁₀ = 10% Saro, B₁₅ = 15% Saro, B₂₀ = 20% Saro, C₁₀ = 10% Williams, C₁₅ = 15% Williams, C₂₀ = 10% Williams, D = Control.

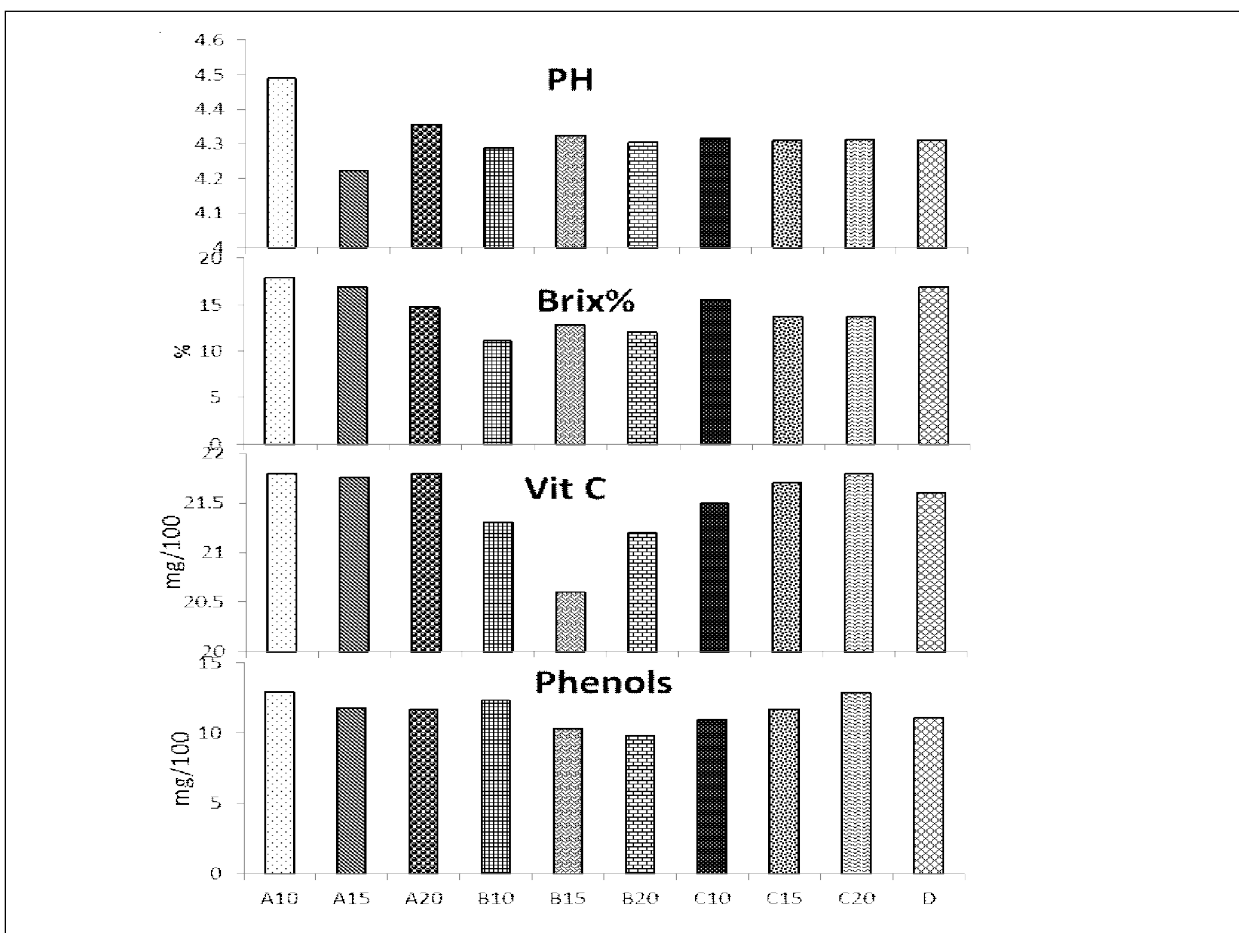


Figure 2: The physico-chemical properties of partially fortified yogurt with variety of banana

Note: A₁₀ = 10% Paranta, A₁₅ = 15% Paranta, A₂₀ = 20% Paranta, B₁₀ = 10% Saro, B₁₅ = 15% Saro, B₂₀ = 20% Saro, C₁₀ = 10% Williams, C₁₅ = 15% Williams, C₂₀ = 10% Williams, D = Control.

For daily energy requirement of a person which is averagely put at about (1,800 kcal) according to (FAO, 2014). Partial fortification of yogurt with 10% paranta could serve as energy drink that can contribute to daily energy requirement of man.

The °Brix, pH TTA, vitamin C and total phenol of the partially fortified yogurt with three varieties of banana are represented in Figure 2. The °brix value was between (11.2%-17.9%), pH (4.20-4.40), TTA (0.10-0.40), Vitamin C (20.6-21.8mg/100g), and total (9.8-12.9mg/100g).

The brix level showed that samples partially fortified with 10% paranta had highest brix value which is (5.0%) and (37.4%) higher than control and B₁₀ which had the lowest brix level. The highest pH value (4.49) was observed with the samples partially fortified with 10% paranta which although not significantly different from control (4.30) and other samples at ($p < 0.05$). These values were within the expected PH value of yogurt products. The values were similar to PH values of watermelon incorporated yoghurt as reported by (Roy et al., 2015) and enriched Probiotic yogurt incorporated with banana, papaya and sapota (Meenakshi et al., 2018). Brix level primarily represents a measure of sugar in a given sample and to large extent determines the degree of sweetness. It was observed from this study that sample with highest °brix level (17.9%) was most preferred by consumers.

The value for vitamin C was between (20.6 mg/100g-21.8 mg/100 g). The sample with 10% paranta has the highest vitamin C concentration (21.8 mg/100 g). This is (0.9%) and (5%) higher than control and B₁₅ has the least vitamin C content. Vitamin C which is also known as ascorbic acid, is an essential dietary nutrient for a variety of biological functions, it is fundamental in the biosynthesis of collagen in bones, cartilage, muscle, and blood vessels, it aids in absorption of iron. Vitamin C is a potent free radical scavenger in the plasma, protecting cells against oxidative damage. It has a strong antioxidant property attributed to its ability to reduce potentially damaging free radicals (Grosso et al., 2013). The daily recommended allowance for vitamin C is 90 mg/day for adult male and 75 mg/day for women (Zieve, 2009). Sufficient consumption of yogurt partially fortified with fruits can contribute to daily vitamin C requirement.

The total phenol content was between (9.8-12.93 mg/100 g). The yoghurt with 10% paranta has the highest phenol (12.93 mg/100 g). This value is (14.1%) and (24.2%) higher than control and B₂₀ which has the least phenol content. Phenols are the major group of dietary components in fruit and vegetables (Sergent et al., 2012). They are linked to divers of health benefits, like vitamin C, phenols are strong bioactive compound that complement functions of antioxidant vitamins and enzymes and defend the body against oxidative stress caused by excess reactive oxygen species of free radicals (Chandrasekara and Shahidi, 2010). Due to their potent antioxidant properties, plant phenols have scientifically proven to prevent various oxidative stress-related as well as chronic diseases, such as cancer, cardiovascular and neurodegenerative diseases (Dai and Mumper, 2010).

The sensory parameters which include color, taste, consistency, mouth-feel and overall-acceptability of yoghurt partially fortified with three different bananas varieties is summarized in (Figure 3). The seven-point (7) hedonic scale was used for ranking. The result from ranking showed that score for taste evaluation was between (3.1 -5.8). The sample with 10% paranta had the highest preference (5.8). This score was 34% and 87% preferred to control and C₁₅ which gave the least taste score (3.1). This sensory assessment indicated that samples with partially fortified with 10% paranta had the highest overall acceptability score of (6.1) among the samples. The overall acceptability of sample with 10% paranta was found to be 48% more acceptable than control sample which had over actability ranking score (4.1) out of 7.

The results of microbial load counts are presented in (Table 3). The microbial test was done to ascertain the suitability or otherwise of the products for human consumption. All counts are recorded as number of microbial colonies formed per 1 ml (cfu/ml) of sample. The Total Microbial Count (TMC) was between (0.4×10^5 cfu/ml to 0.8×10^4 cfu/ml), total fungi count (TCF) was (0.2×10^4 cfu/ml to 0.6×10^5 cfu/ml) and there was no coliform detected. The sample with 10% had (0.5×10^4) TMC which is significantly lower ($p < 0.05$) than control (0.8×10^4) and sample C₂₀ which has the highest (0.6×10^5). All counts recorded are within the limits of specified acceptable counts; hence, the samples are safe for consumption at the period when analysis was conducted.

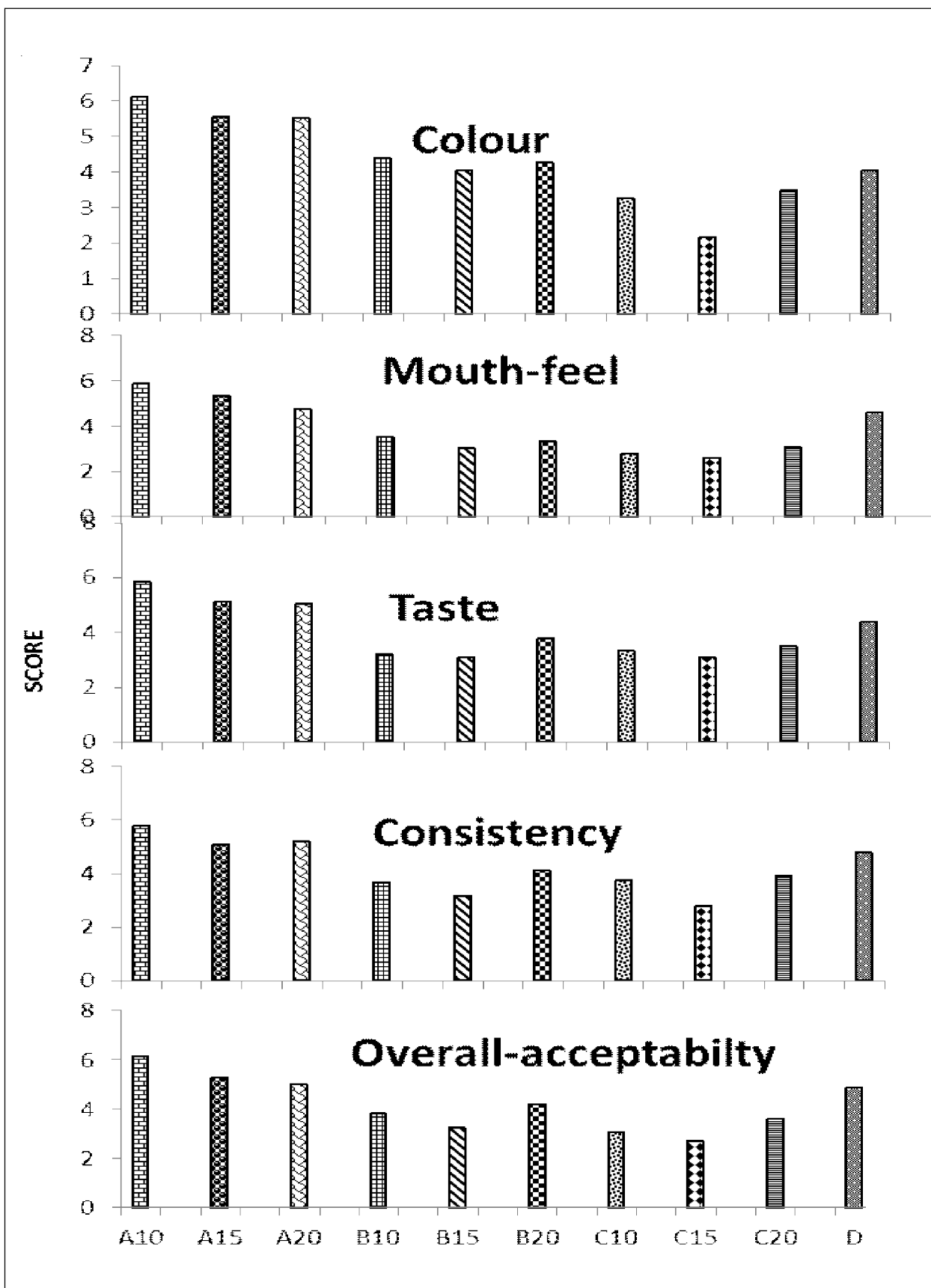


Figure 3: Sensory properties of partially fortified yogurt with variety banana

Note: A₁₀ = 10% Paranta, A₁₅ = 15% Paranta, A₂₀ = 20% Paranta, B₁₀ = 10% Saro, B₁₅ = 15% Saro, B₂₀ = 20% Saro, C₁₀ = 10% Williams, C₁₅ = 15% Williams, C₂₀ = 10% Williams, D = Control.

Table 3: Microbial load of yogurt partially fortified with different variety of banana			
Samples	Total microbial count (cfu/ml)	Total fungal count (cfu/ml)	Total coliform count (cfu/ml)
A ₁₀	0.5×10 ^{4e}	0.3×10 ^{4f}	No growth detected
A ₁₅	0.5×10 ^{4e}	0.2×10 ^{4g}	No growth detected
A ₂₀	0.5×10 ^{4e}	0.2×10 ^{4g}	No growth detected
B ₁₀	0.4×10 ^{5c}	0.4×10 ^{5e}	No growth detected
B ₁₅	0.5×10 ^{4e}	0.4×10 ^{4c}	No growth detected
B ₂₀	0.5×10 ^{5b}	0.4×10 ^{5e}	No growth detected
C ₁₀	0.6×10 ^{5a}	0.3×10 ^{5d}	No growth detected
C ₁₅	0.5×10 ^{4e}	0.4×10 ^{5c}	No growth detected
C ₂₀	0.6×10 ^{5a}	0.5×10 ^{5b}	No growth detected
D	0.8×10 ^{4d}	0.6×10 ^{5a}	No growth detected

Note: Each count is recorded as the total number of microbial colonies formed per 1 ml of yogurt sample (cfu/ml); A₁₀ = 10% Paranta, A₁₅ = 15% Paranta, A₂₀ = 20% Paranta, B₁₀ = 10% Saro, B₁₅ = 15% Saro, B₂₀ = 20% Saro, C₁₀ = 10% Williams, C₁₅ = 15% Williams, C₂₀ = 10% Williams, D = Control.

4. Conclusion

The results of this study showed, it is possible to fortified yogurt with these banana varieties (paranta, saro and Williams) to enhance nutritional profile, customer appeal and promote varieties. The (10%) fortification with paranta gave best result with respect to improvement in protein, energy content, vitamin C and overall sensory acceptability. The inclusion of banana in yogurt production is a potential and viable option at reducing post harvest losses of banana fruits.

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