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# Utilization of Sorrel/Roselle (*Hibiscus sabdariffa* L.) Nectar in Stirred Yoghurts: Physicochemical and Sensory Quality

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**Abstract:** This first study investigated the effects of sorrel/roselle (*Hibiscus sabdariffa* L.) nectar on physicochemical and sensory quality of stirred yoghurts. Sorrel calyces were hot-water processed at 60°C for 3.5 h, cooled treated with pectolase for puree and processed into nectar. To plain yoghurt, nectar of 60°Brix or 67°Brix was added at 27 and 33% level (v/v). Focus groups guided product development. Yoghurt with 33% of sorrel 60°Brix nectar with 0.6% sorrel flavor extract was rated as liked moderately to very much in overall acceptability. This hedonic scoring of yoghurt with 33% of sorrel was not influenced by the reading of an extract on the nutritional and health benefits of sorrel by panelists. Yoghurt had 'L' 59.00, 'C' 10.56, hue° 14.24, pH 3.81, 23.00°Brix, 0.19% lactic acid and consistency 0.56 mm $sec^{-1}$. On storage at 4°C for 4 weeks, yoghurt became less red and chromatic, more viscous and acidic and had higher microbial growth. A yoghurt serving was a good source of protein.

**Key words:** Sorrel, *Hibiscus sabdariffa* L., yoghurt, nectar, physicochemical, nutritional

## INTRODUCTION

Yoghurt is an acid gel made from the fermentation of a standardised mix by *Streptococcus thermophilis* and *Lactobacillus delbrueckii* subsp. bulgaricus (FDA., 1998). Culturing or fermenting dairy foods is a method of preservation as well as improving taste, digestibility and increasing the nutrition and variety of dairy foods available (Wang, 1986; Kurman *et al*., 1992 and Campbell-Plat, 1994).

Sorrel has medicinal and health benefits (Du and Francis, 1973). The brilliant red pigments in red calyces of sorrel contain anthocyanins (Du and Francis, 1973; Mazza and Miniati, 2001). Anthocyanins as phytochemical com-pounds in plants have been recognized in disease prevention properties of the plant foods, possibly through their effects on oxidative damage (Prior and Cao, 2000; Porter *et al*., 2001). In the West Indies, tropical Africa, Philippines and Indonesia, sorrel calyces are utilized in refreshing drinks, tea, syrups, puddings, condiments, colorants, sauces and wines (Esselen and Sammy, 1973, 1975; Clydesolale, 1979; Heureux-Calix and Badrie, 2004; Mounigan and Badrie, 2006, 2006b).

To the authors' knowledge, there has been no published study on utilization of sorrel nectar in stirred yoghurts. Therefore, our objectives were to:

- To utilize extracted pectolase-treated sorrel (*H. sabdariffa* L.) puree in nectar processing for incorporation in stirred yoghurts
- To incorporate sorrel nectar of two total soluble solids content at two levels of incorporation for stirred yoghurt in the investigation of changes in physicochemical and sensory quality
- To determine the nutritional composition of the most sensory acceptable yoghurt and conduct shelf life testing

## MATERIALS AND METHODS

**Yogurt production:** Ultra-High Temperature (UHT)-treated 100 % full cream cow's milk (Nestlé Trinidad ltd, Valsayn, Trinidad, West Indies) was fortified with 6% w/v commercial instant low fat fortified milk powder (Kerrygold, Multifoods Corporation, Diego Martin, Trinidad, West Indies). The total soluble solid was increased from 11.8°Brix in UHT cow's milk to 15.0°Brix in milk blend with skim milk powder. The best yoghurt was made from milk with TSS of 15-16 g 100 $g^{-1}$ total solids (Tamin and Robinson, 1999). The pH of the milk blend was 4.28±0.01. The milk blend was inoculated with 0.5% Yoghurt Culture (YC-180Yo-flex freeze-dried lactic culture, Christian Hansen, Inc, Milwaukee, USA) and incubated at

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39°C for 14 hrs to pH 4.2±0.1. The plain yoghurt was stored at 4°C for later addition with sorrel nectar.

**Processing of sorrel nectar:** Fresh red sorrel was bought from public market in Trinidad, West Indies. The calyces were removed from the seeds by making an incision around the tough base of the calyx below the bracts to free the attached seed capsule as described by (Morton, 1987). and were frozen at -18°C. Fig 1. shows the processing of sorrel nectar and the steps in the production of stirred sorrel yoghurt. Thawed sorrel calyces in distilled water (ratio: 0.5: 1.0) were hot water processed at 60°C for 3.5 h (Wong *et al*., 2003) with 0.4% allspice (*Pimenta dioica*) and 0.6% nutmeg (*Myristica fragans*). The calyces were blended in an Oster blender (model # 889 16R, New Hartford, Connecticut, US).To the cooled pulp (~38°C) 0.5% w/w pectolase enzyme (Young's Home Brew and Allied Products Ltd, Bilston, West Midlands MV) was added at 20°C for 24 h to break down the cell structure of calyces. The enzymatic-treated calyces were sieved through a No.10 sieve (USA Standard Testing Sieve A.S.T.M E-11 Spec 2 mm 0787) for sorrel puree and refrigerated at 4°C.

Sorrel puree (6°Brix) was processed into nectars of 60°Brix or 67°Brix. High fructose corn syrup (22.5%; Karo's high fructose corn syrup, ACH Food Company, Inc., Memphis, Tennessee, USA) was added to the sorrel puree to achieve 20°Brix. Granulated crystallised cane sugar (Caroni Ltd, Couva, Trinidad, West Indies) with 0.6% xanthan gum (CP Kelco, CA, USA) were then added and the mixture processed at 40°C to obtain sorrel nectars of 60°Brix or 67°Brix. Stirred yoghurts were stored at 4°C for analysis.

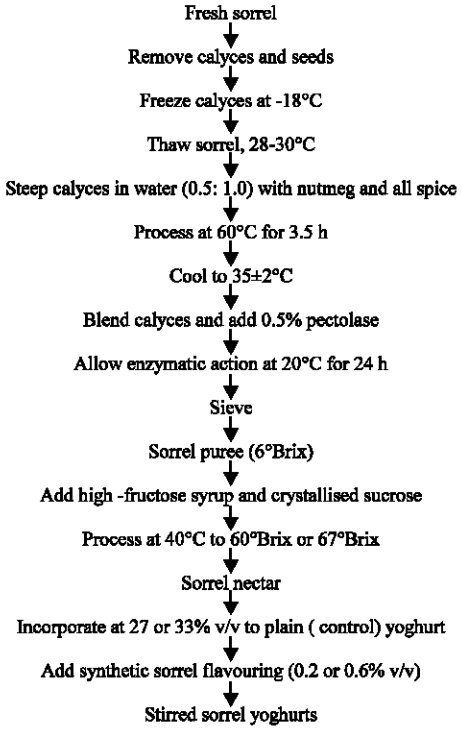


Fig. 1: Processing of stirred sorrel yoghurt

**Focus group evaluation:** The focus group method was used to give an early assessment of the prototypes (stirred sorrel yoghurts in reference to plain (control) yoghurt (0% sorrel nectar) (ASTM, 1979).Focus groups provided an insight into consumer's preference and defined the critical attributes of a product (Galvez and Resurreccion, 1992). Five stirred yoghurt treatments were presented to panelists (2 sorrel nectars of 60°Brix or 67°Brix×2 levels of addition 29 and 33% v/v) and one plain (control) yoghurt (0% sorrel nectar) and served in 3 oz transparent cups coded with 3-digit numbers. The focus group method utilized small groups of 8-12 consumers to obtain reactions, both positive and negative to products (IFT/SED, 1981). Hence two groups of 8 panelists served as focus groups. These panelists were regular consumers of yoghurts and were willing participants. The moderator facilitated the discussion and the information was transcribed and used in the modification of the formulation of stirred sorrel yoghurt.

**Experimental design:** In the first stage of processing, sorrel nectar (60° Brix or 67°Brix) was incorporated at 29 and 33% v/v and a control (0% sorrel nectar) to plain yoghurt and presented along with a control stirred yoghurt (0% sorrel nectar) to focus groups in two sessions.

Based on feedback from focus group evaluation, the yoghurt was reformulated. Hence, stirred sorrel yoghurts with 33% sorrel nectar of 60°Brix and with 0.2 or 0.6% sorrel synthetic flavoring (Taste Makers Ltd, Abercromby, Port-of-Spain, Trinidad, West Indies) were analyzed on physicochemical and sensory (hedonic) quality. The shelf-life of the yoghurt was evaluated at 4°C for 4 weeks.

**Hedonic testing:** The consumer acceptance test is a small panel test, usually involving only 50-100 panelists (Resurreccion, 1998). Sensory evaluation was replicated using 50 panelists (22 males and 28 females) for each session. The panelists comprised staff and students of the University of the West Indies, St. Augustine, who had reported to be in good health (self-report). Most of the panelists were between 17-34 year (81%), 35-44 year (12%) and over 44 year (7%). These panelists were

recruited by adver-tisements placed on the University's notice boards. Recruitment criteria included consumers of yoghurt who were older than 17 years. Also the panelists were asked to fill out a demographic questionnaire, which requested their gender, age category, consumption of the popular sorrel drink, forms of utilization of sorrel (eg., sauces, preserves, jams, drinks, liqueur or other) and frequency of consuming yoghurt (once a week, more than once a week, once a month, more than once a month or other).

Hedonic testing was conducted in two stages. The re-formulated stirred sorrel yoghurts (~ 30 mL) (33% addition of 60°Brix sorrel nectar v/v with either 0.2 or 0.6% synthetic sorrel synthetic flavoring) were coded with random three digit numbers and served in 3-oz transparent plastic cups. They were evaluated on appearance, aroma, flavor, body/mouthfeel, acidity, sweetness and overall acceptability on a 9-point hedonic scale (Peryam and Pilgrim, 1957) where 9-liked extremely, 8-liked very much, 7-liked moderately, 6-liked slightly, 5-neither liked nor disliked, 4-disliked slightly, 3-disliked moderately, 2-disliked very much and 1-disliked extremely.

In the second stage of hedonic testing, the same panelists were used as in the first stage of hedonic testing. The panelists were given a 10 min break between the first and second sessions of hedonic testing and were provided with water for cleansing of the palate. They were given an abstract on the nutritive and health benefits of sorrel to read and were presented with the same reformulated stirred sorrel yoghurt treatment (i.e., 33% 60°Brix sorrel nectar v/v with 0.6% synthetic sorrel synthetic flavoring) as in the first stage of hedonic testing. This yoghurt was coded with a different random three-digit numbers from the first stage of hedonic testing. The same procedure was applied for hedonic testing as in the first stage of sensory evaluation. The presented information on the health and nutrition information on sorrel was: 'Recent advances in medicine and a greater understanding of human nutrition have led researchers to recognize the existence of a number of substances occurring in plants, known as phytochemicals. The brilliant red pigments in red calyces of sorrel are anthocyanins (Du and Fraqncis, 1973; Maqzza and Miniati, 2000). Sorrel calyces contain a group of compounds called 'flavonoids' which are recognized as powerful antioxidant which scavenges the body of free oxygen radicals that can cause deadly diseases if not removed from the body (SRC, 2002).

**Physical analysis:** Total Soluble Solids (TSS) expressed as °Brix was determined for sorrel puree, sorrel nectar and for stirred sorrel yoghurts on a refractometer (Atago Hand Refractometer: ATC-1E 0-30° Brix, Bellingham and Stanley eclipse Code 45-08, serial no. 023447. Model N-4E, Vee Gee Scientific, Washington, USA).

Consistency was measured as the flow rate of sorrel yoghurt on a Bostwick consistometer (Cenco Brand, Redman Scientific Company, San Francisco, USA).The sorrel yoghurt was poured into the holding compartment and leveled off. The gate was opened to release the trigger and the rate of flow as cm 30 $sec^{-1}$ was recorded (Gould, 1978).

Color of sorrel puree, sorrel nectar and sorrel yoghurt were m easured on a Minolta chroma meter (model CR-200b) portable tristimulus colorimeter. Before measurement, the chromameter was calibrated using a white tile (Minolta calibration plate CR-A43) as a standard. Fruit chromaticity was measured in 'L' 'a' 'b' co-ordinates where 'L' represents lightness of color, with larger 'L' values representing lightness, 'a' is negative for green and positive for red, 'b' is negative for blue and positive for yellow. Hue angle was measured as described by (Francis, 1989).Values of 0, 45, 90, 180 and 270 would indicate bluish red, orange, yellow, green and blue colors, respectively.

The pH of sorrel, sorrel puree and sorrel yoghurt was measured on an Orion pH meter (520A with data plate, digital hotplate with stirrer PMC 720 series, New York).

Total Titratable Acidity (TTA) expressed as % lactic acid for sorrel flavored yoghurt and as % citric acid for fresh sorrel, sorrel puree and sorrel nectar was determined by titrimetric method No. 985.29 (AOAC, 1985). A sample (25 g) was blended with 100 mL distilled water and centrifuged (Sorvall RC 50-Plus-Dupoint,Global Medical Instrumentation Ltd., Ramsey Minnesota, USA) at 1000g for 10 min.

**Nutritional analyses:** Sorrel nectar yoghurt (incorporation of 33% sorrel nectar 60° Brix with 0.6% sorrel synthetic flavoring extract) was analyzed for total solids, crude fat, crude protein, potassium, sodium and phosphorus. Using the AOAC methods (AOAC, 1985), total solids was determined by the air-oven method of drying the sample at 105±1°C for 48 h, crude fat by the soxhlet extraction method, crude fat by the Kjeldahl method and ash for mineral analysis by the muffle furnace method at 600°C for 6 h. The ash was digested [5] and potassium and sodium determined by flame emission spectroscopy and phosphorus by the spectrometric method (Analytical Methods, 1989). Nutrition information on percentage daily value was guided by the US Nutrition Labeling and Education Act (NLEA, 1990).

**Microbiological analyses:** Total aerobic mesophilic count, lactobacilli, *Escherichia coli*, yeast and moulds, *Streptococcus thermophilus* and staphylococci were

Table 1: Physicochemical changes on processing of stirred sorrel yoghurt

| Physicochemical attributes | Fresh sorrel | Sorrel puree | Sorrel nectar | *Sorrel nectar yoghurt | LSD | p |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| L | 24.10±0.17 | 23.02±0.46 | 19.96±0.33 | 57.58±0.73 | 3.98 | 0.01 |
| C | 9.72±0.77 | 11.11±0.53 | 3.34±0.10 | 10.56±0.33 | 1.50 | 0.01 |
| H° | 10.72±0.67 | 11.85±0.53 | 8.39±1.25 | 14.24±2.14 | 2.50 | 0.05 |
| pH | 2.63±0.01 | 2.62±0.02 | 2.59±0.03 | 3.81±0.01 | 0.70 | 0.01 |
| TTS, °Brix | 6.00±0.01 | 6.00±0.01 | 60.00±0.02 | 23.00±2.00 | 7.00 | 0.01 |
| TTA, % citric acid | 0.46±0.01 | 0.38±0.01 | 0.20±0.01 | *0.19±0.01 | 0.04 | 0.01 |

*% lactic acid, * % lactic acid of yoghurt, * combined mean for stirred sorrel yoghurt with 33% of 60°Brix nectar with addition of 0.2 or 0.6% sorrel flavor extract

enumerated on Plate Count Agar (PCA, Oxoid, Basingstoke, England) Tomato Juice Agar (TJA, Oxoid), Eosin Methylene Blue Agar (EMBA, Oxoid), Potato Dextrose Agar (PDA, Oxoid), Lee's Agar (LA, Oxoid) and Mannitol Salt Agar (MSA, Oxoid), respectively (Venderzant and splittstoesser, 1992). Spread plate was applied by transferring 0.1mL of serial dilutions to EMB, MSA and LA media petri plates. Pour plate methods were applied to PCA, TJA and PCA. LA plated were incubated in anaerobic jars. All petri dishes were incubated at 36±1°C for 48 hrs, while PDA plates were at 23±2°C for 48-72 h. The microbial counts were expressed as cfu $mL^{-1}$ and converted to $\log_{10} mL^{-1}$

**Shelf life:** Microbiological and physicochemical analyses were conducted every week from week 0 to week 4 on sorrel nectar yoghurt (incorporation of 33% sorrel nectar 60° Brix with 0.6% sorrel synthetic flavoring).

**Statistical analysis:** The general linear model program using Minitab (Minitab version 12, Minitab Inc, 1991 Enterprise State College, PA) tested the physicochemical changes on processing of stirred yoghurt using fresh sorrel and the effects of storage effect on physicochemical and microbiological quality. Where mean values were significant, they were separated by Fisher's Least Significant Difference (LSD) at $p<0.05$ level of significance Paired t-test was used to determine whether the presentation of nutritional and health benefits on sorrel had influenced ($p<0.05$) the hedonic scores given by panelists for sorrel nectar yoghurt.

## RESULTS AND DISCUSSION

**Focus group:** All stirred sorrel yoghurts were preferred over the plain yoghurt (control yoghurt; 0% sorrel nectar). By consensus of panelists, the most acceptable stirred yoghurt was with the addition of 33.% of 60°Brix sorrel nectar. Stirred yoghurts with 67°Brix sorrel nectar were found to be too sweet at both levels of incorporation. However, it was found that the natural sorrel flavor was not pronounced in all stirred yoghurts. The re-formulated yoghurt included the addition (0.2 and 0.6 %v/v) of sorrel synthetic flavor extract (Taste Makers Ltd, Abercromby, Port-of-Spain, Trinidad, West Indies). All yoghurts were described as having custard-like gel. The solid-not-fat component of the milk should be raised to 12% or higher for this type of texture (Nauth, 2004). Also, in a study, showed that higher the sorrel puree content in wines, higher were the assigned acceptable flavor scores (Mounigan and badrie, 2006b).

**Physicochemical changes:** Significant physicochemical quality differences were noted on processing of stirred sorrel yoghurts (Table 1). The stirred sorrel yoghurts were less dark, red and acidic than fresh sorrel, sorrel puree and sorrel nectar. Also, the pH was significantly ($p<0.01$) higher in the stirred sorrel yoghurt. These yoghurts had 0.19±0.00% lactic acid (data not shown). The pH has a marked influence on color of anthocyanins in aqueous media (Briuillard, 1982; Mazza and Briuillard, 1985). BAcidic pH favors the appearance of the colored forms: the flavyium cation AH = is red (Delgado, *et al*., 2003). Temperature is an important factor and pigment degradation is exponential (Francis, 1989). Initially, chalcones, uncolored forms are formed and further degraded to brown products. Anthocyanins extracted by hot-water extraction were relatively stable at 60°C for 3.5 h (Wong *et al*., 2003). Hot water extraction, was found to be the most effective method as sorrel juice had high anthocyanins and ascorbic acid contents of 43 g $L^{-1}$ (as delphinidin -3-glucoside and 2.34 g $kg^{-1}$, respectively.

**Hedonic scores:** There were no ($p>0.05$) significant differences in sensory attributes of appearance, aroma, flavor, body/mouthfeel, sweetness and overall acceptability between stirred sorrel yoghurts with 0.2 and 0.6% sorrel synthetic flavoring except for acidity ($p<0.01$). Stirred sorrel yoghurt with 0.2% sorrel synthetic extract was rated with a lower score 6.41 for acidity (liked slightly to moderately) than the stirred sorrel yoghurt with 0.6% sorrel flavor extract (7.22-liked moderately to very much). All other sensory attributes were rated with scores 7.0-8.0: liked moderately to very much. Flavor was rated with the highest score (7.86-8.02: liked moderately to very much). Only acidity was given a

score range 6.41-7.21, liked slightly to very much. Also, panelists were not influenced in their scoring of stirred sorrel yoghurts in the second stage of hedonic testing by reading of the abstract on the nutrition and health benefits of sorrel.

The average overall acceptability of the sorrel yoghurts was 7.82±0.16 (liked moderately to very much). In a study, it found that regular yoghurts received higher ($p<0.05$) acceptability scores than soy fortified yoghurts (Drake and Gerard, 2003). However, after consumers were informed of the health benefits of yoghurts, consumer acceptability scores were enhanced, indicating that nutritional concerns took precedence over sensory attributes. In another study, when health conscious women were provided with 27, 34, 41, 54 and 100% cranberry juice blends before and after a brief education session on the health benefits of cranberry, the researchers found that the hedonic scores for 27, 34, 41 and 54% cranberry juice increased while those for 100% cranberry juice decreased Ghazanfar and Camire, 2002). In addition the 100% blend received the lowest scores in both cases, as consumers disliked the extremely sour and bitter taste.

The most frequent consumption of yoghurt was more than once a week by 26% of panelists. Sorrel was utilized mainly in drinks (42%), jams (34%), liqueur (29%), preserves (11%) and sauces (11%). Most (88%) panelists would purchase the sorrel yoghurts if available on the market.

**Nutritional analysis of sorrel yoghurt:** Table 2 shows that a 226 serving of sorrel yoghurt provided 0.24 g total fat, 7.9 g protein, 262 mg K, 217 mg Na and 323 mg P based on daily reference value on a 8678 kJ (2000 kcal). A serving of sorrel yoghurt was high in phosphorus (320 mg: >20% or more of RDI per yoghurt serving) and a good source of protein (8 g: 10-14% of RDI per yoghurt serving) The sorrel yoghurt was reduced in sodium, not a significant source of fat as it contained less than 5 kcal from fat (21 CFR 101.9 © (1) (ii) (Summers, 2003). The sorrel yoghurt was considered a non-fat (fat-free) yoghurt (<0.5% fat, >8.25% milk solids-not-fat) (FDA., 1998). The nutritional value of yoghurt is derived from milk. Yoghurt has a higher nutrient density at 13-18% milk solids compared to milk (12.3%) Nauth, 2004).

**Shelf-life of sorrel yoghurt:** Table 3 indicated significant ($p<0.01$) changes in pH, consistency and color for stirred sorrel yoghurt on storage at 4°C for 4 weeks. The pH of stirred sorrel yoghurt dropped and the consistency increased on storage. Lactic acid bacteria ferment the lactose into lactic acid and flavor compounds such as acetaldehyde, carbon dioxide and diacetyl (Marshall, 1986).

Also, on storage, color changes were significant ($p<0.05$) as they became less chromatic (lower chroma values) and less red (higher hue°). Similarly for sorrel sauces, the color was less red ($p<0.05$) on storage at 20°C for 6 weeks (Heureux-Calix and Badrie, 2004). Instability has been a major problem with all anthocyanins in storage (Francis, 1998), even within intact tissue (Asen *et al*., 1972 and Jurd, 1972). In a study (Du and Francis, 1973), determined that the total anthocyaninc in dry sorrel calyces from Trinidad was about 1.5 g anthocyanin 100 $g^{-1}$ on a dry weight basis when expressed in terms of delphinidin-3-glucosied and cyanidin-3-glucoside were minor pigments. For Trinidad sorrel, the presence of delphinidin and cyanidin was reported (Forsyth and Simmonds, 1984). Also, the presence of flavonols quercitin and kaempferol in colorants was recorded for sorrel (Francis, 1989). The presence of delphinin is responsible for the desirable rosy red hue.

Throughout storage, microbial changes were not significant ($p>0.05$) at <1.0 $\log_{10}$ cfu $mL^{-1}$ for coliforms and staphylococci but significant ($p<0.05$) on week 2 for

Table 2: Simplified linear format of a nutrition facts for a serving of sorrel yoghurt

Nutrition Facts: Serv Size: 1 container, Amount per serving 226 g: Fat kJ (cal) 0, Total fat 0g (0% DV), Sodium 220 mg (9% DV), Potassium 260 mg (8% DV), Protein 8 g (16%DV), Percent Daily Values (DV) are based on a 8678 kJ (2,000 kcal) diet. Not a significant source of fat.

Stirred sorrel yoghurt with 33% of 60°Brix nectar and 0.6% sorrel flavour extract

Table 3: Color and pH of sorrel puree, sorrel nectar and on storage of sorrel yoghurt

| Storage, wk | pH | 'L' | 'C' | 'h°' | Consistency, mm $sec^{-1}$ |
|---|---|---|---|---|---|
| 0 | 3.83±0.02 | 59.00±0.00 | 11.68±0.06 | 9.39±0.19 | 0.56±0.01 |
| 1 | 3.83±0.02 | 56.80±0.17 | 10.74±0.00 | 12.38±0.00 | 0.53±0.01 |
| 2 | 3.76±0.02 | 55.10±0.06 | 10.03±0.06 | 12.36±1.86 | 0.47±0.01 |
| 3 | 3.79±0.00 | 58.90±0.00 | 10.56±0.12 | 15.05±0.43 | 0.42±0.01 |
| 4 | 3.76±0.00 | 58.10±0.00 | 9.79±0.06 | 22.02±0.77 | 0.40±0.01 |
| LSD | 0.03 | 0.18 | 0.15 | 0.95 | 0.02 |
| Level of significance | p<0.01 | p<0.01 | p<0.01 | p<0.01 | p<0.01 |

Stirred sorrel yoghurt with 33.3% sorrel 60°Brix and 0.6 % sorrel flavor extract

lactobacilli, streptococci and yeasts and moulds. *Lactobacillus bulgaricus* increased ($p<0.05$) from log 7.72-8.08 cfu $mL^{-1}$ for weeks 0 and 1 to more than log 8.48 cfu $mL^{-1}$ by week 2 of storage. *Streptococcus thermophilus* increased from log 7.97 cfu $mL^{-1}$ to more than 8.48 log $mL^{-1}$ by week 2 of storage. The increase in the growth of lactic acid bacteria on storage could be related to the lower pH and lower TTA in stirred sorrel yoghurts (Table 3). Milk is usually inoculated with starter culture so that the number of lactic acid bacteria so that the numbers of lactic acid bacteria are about 7 $\log_{10}$ cfu $g^{-1}$ and the final level of lactic acid bacteria in yoghurts is about 9.0 $\log_{10}$ CFU $g^{-1}$ (Fonden *et al*., 2003). Yeast and mould increased from <log 1.00 cfu $mL^{-1}$ for week 1 to log 3.65 cfu $mL^{-1}$ by week 3 of storage.

## CONCLUSION

Stirred sorrel yoghurt with overall acceptability of being liked moderately to very much was processed from 33.3% sorrel nectar of 60°Brix with 0.6% synthetic sorrel. Flavor was the most liked sensory attributes of sorrel yoghurts, while acidity was the least liked. Presentation of information on the heath and nutritional benefits of sorrel to panelists did not influence the overall sensory acceptability of the sorrel yoghurts. On storage at 4°C, yoghurts became less red and chromatic, more acidic and viscous and had higher microbial growth. Most consumers would purchase the sorrel yoghurts if available on the market. Utilization of sorrel in yoghurts could increase the value of the crop in the Caribbean and in other sorrel growing areas in the world.

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