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PRODUCTION AND EVALUATION OF YOGHURT FLAVOURED WITH SOLAR-DRIED BUSH MANGO (*Irvingia gabonensis*) PULP

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ABSTRACT
Bush mango (Irvingia gabonensis) pulp was subjected to oven-drying, sun-drying and solar-drying to ascertain the best drying technique. The bush mango samples were milled and different concentrations (0.80, 1.60, 2.40, 3.20, 4.00 and 4.80%) were used to formulate flavoured yoghurt. Formulated products were assessed chemically, microbiologically and organoleptically using standard methods. The storage stability of the formulated products at 28^oC for 0-21 days was also analyzed. Stored samples were withdrawn at 7 days interval and analyzed to assess the effect of storage on the products quality. Results showed that solar-drying was the best drying method. Solar - dried bush mango pulp had reduced moisture content and microbial load relative to the sundried and ovendried samples. Addition of 0.08% solar-dried bush mango in the formulated yoghurt significantly ($p < 0.05$) increased the ash and Vitamin C contents but reduced the moisture and phosphorus. The colour, flavour, mouthfeel, aftertaste and overall acceptability of the formulated flavoured yoghurt products were enhanced by the addition of 0.80% concentration of the solar-dried bush mango. Shelf life projection studies suggested that the bush mango flavoured yoghurt might be stored beyond 21 days at 28 ^oC with no mould or coliform growth.

Key words: Yoghurt, Solar-drying, Bush mango, (*Irvingia gabonensis Solar dryimg*

INTRODUCTION

Yoghurt is a food obtained by controlled fermentation of milk by a mixed culture of lactic acid bacteria selected to produce a flavour and typical aroma (Schmidt, 1992). The milk sugar (lactose) is fermented to lactic acid and it causes the characteristic curd to form. According to Bystron and Molenda (2004), fermentation ensures not only increased shelf life and microbial safety but also makes food more digestible. Preservation by fermentation depends on the anaerobic enzymatic conversion of organic acids to ethyl alcohol and carbon IV. Oxide. Schmidt (1992) stated that standard quality yoghurt should be fat-free, low in milk solids, total solids and free from added sugar with some body, mouth feel, creaminess and flavour. Traditional yoghurt is thick creamy and are sold plain. In a wide assortment of flavours, typically fruit flavours such as strawberry or blue-berry and more recently cream pie and chocolate flavours are used. However, in the processing of flavoured yoghurt, natural fruits could be used. Nigerian Industrial Standard (2004) defined flavored yoghurt as yoghurt to which has been added flavoring food or other flavouring agents (like fruits). Although fruits may be taken in their fresh forms, because of their outstanding perishable and seasonal nature, a lot of fruits are processed traditionally in regions where a food processing culture exists. Apart from the use of fresh fruits for natural flavouring, canned, quick frozen and powdered fruits, fruit puree, fruit pulp, jam, fruit juice, chocolate, cocoa, nuts, coffee, spices and other natural flavouring ingredients from temperate fruits (grapes, berries, drupes and pomes) have been utilized.

Certain locally available or commonly consumed fruits with flavourants include pineapple, star fruit, mangoes and bush mango among others. These tropical fruits undergo post-harvest losses because of poor storage condition, handling, pest attack, disease and deterioration. According to Okaka (2005), processing reduces post-harvest losses and spread the availability throughout the year. Fruit processing involves indispensable steps to achieve best quality products of longer shelf life, wholesome and sensory acceptable products at affordable prices. These fruits which are prone to post-harvest losses could be dried to extend their shelf life. Drying is an efficient way to preserve fruits (foods) and the use of the solar dryer is an appropriate food preservation technology for a sustainable world (David and Whitfield, 2008). Solar-drying, as a heat treatment reduces the flavour intensity of fruit preparation according to Tamime and Robinson (2008).

In Nigeria, two varieties of the bush, mango [*Irvingia gabonensis]* (the sweet variety) and *Irvinga wombulu* (the bitter variety) exist according to Ladipo *et al.* (1996). The sweet variety, commonly known as *"Ugiri"* in Igbo has a juicy fruit pulp which is rich in vitamin C and is widely reported to be consumed as a desert fruit or snack (Ejiofor, 1994; Leakey and Newton, 1994; Vivien and Faure, 1996; Vabi and Tchamou, 1997). The pulp had been processed into jam, jelly and juice (Okolo, 1994) to reduce the high losses of this marketable fruit. According to Joseph and Aworh (1991; 1992), the fresh fruits of *Irvingia gabonensis* have a shelf life of less than 2 days if picked when ripe and not more than 10 days if harvested at the mature green stage due to high respiration rate, moisture loss and microbial attack. Joseph and Aworh (1991) prolonged the shelflife of the mature fruits by refrigeration at 12-15^{o}C to delay ripening.

Meanwhile, the ripe fruit pulp of *Var. gabonensis* is not just consumed for its nutrients, flavour and aroma but also for its medicinal value. It has been claimed that consumption of bush mango whitens the teeth (Umoh, 1998). The bark of *Irvingia gabonensis* when mixed with palm oil is used in the treatment of diarrhoea and to shorten the breast feeding period of women (Ndoye and Tchamou, 1994). According to Okolo *et al.* (1995), the bark was administered against colic dysentery while Ayuk *et al.* (1999) stated that the bark was used to cure hernia, yellow fever and as an anti-poison. Also, the bark had been reported to have antibiotic properties for the treatment of scabby skin and as pain reliever for toothache (when administered boiled). The seeds could be used as laxatives enhance bowel movement leading to more gradual absorption of dietary sugar and reduce the blood sugar level typically after a meal (Cesa *et al.*, 1990).

The aim of this research was to diversify the use of the sweet variety bush mango by evaluating its performance as a flavorant in yoghurt.

MATERIALS AND METHODS

Three hundred and eighty kilogram (380kg) of sweet variety of bush mango (*Irvingia gabonensis*) fruits were procured from Ogige market, Nsukka. The fruits were subjected to preliminary investigation to determine the optimum drying technique and best concentration to be used in the formulation of the flavoured yoghurt.

Determination of the Optimum Drying Technique and Conditions

The fresh bush mango fruit was sorted, cleaned, washed, peeled, sliced sulphited for 10 minutes (using 0.02g of sodium metabisulphite in one litre of water ≡ 100ppm of SO_2); dried using sun, solar and hot air oven (Fulton NYC – 101) at 55^{o}C until the sliced fruits became flaky or pliable.

Determination of the Best Flavour Concentration for Formulated Flavoured Yoghurt

The best flavour concentration for the formulated flavoured yoghurt was determined using sensory evaluation (9-point hedonic scale) by 20-member trained panelists consisting of staff and students from the Faculty of Agriculture, University of Nigeria, Nsukka who were conversant with yoghurt intake.

Preparation of Solar-Dried Bush Mango Pulp

The ripe bush mango fruits were collected during fruiting season and processed according to Mircea (1995) with slight modification. The fruits were sorted, washed, peeled, sliced and treated with the preservative (0.02g of sodium metabisulphite in one litre of water equivalent to 100ppm of sulphur oxide) for 10 minutes. The pulp (mesocarp) was solar-dried until fruits were pliable. (Thomas and Berry, 1997). The dried slices were milled using hammer mill and sieved through 0.59mm sieve.

Production of Yoghurt

In accordance with the procedure by Schmidt (1992), yoghurt was processed. The milk mix was pasteurized at 85^{o}C for 20-30 minutes to inactivate the pathogens in a water bath and homogenized at pasteurization temperature. Subsequently, the milk was cooled to inoculation temperature of 43^{o}C $\pm$ 1^{o}C and then inoculated with 10% yoghurt starter culture (Yoghurmet) consisting of *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and *Lactobacillus acidophilus*. The yoghurt was fermented for 12 hours at room temperature after which it was homogenized, smoothened and flavoured. A part of the formulated flavoured yoghurt was packaged in plastic bottles, chilled in a refrigerator, stored and presented for sensory evaluation.

Analysis

The freshly prepared flavoured yoghurt samples were analysed for pH, total titrable acidity (TTA), proximate composition, some selected micronutrient composition and microbiological assessment to ascertain the safety and sensory characteristics.

Determination of pH of bush mango and formulated flavoured yoghurt

A standard pH meter (Model 20 pH conductivity meter, Denver Instrument, United Nations Inventory Database) was used for the determination. The pH meter was standardized using a buffer solution pH 4.0-9.0. After a few minutes of standardization, the pH readings for the samples were taken.

Determination of Titrable Acidity of Bush Mango and Formulated Flavoured Yoghurt

The total titrable acidity was determined by the AOAC (1995) method. About 20ml of the sample at 25^{o}C was measured into a flask and diluted to twice its volume with distilled water. About 2ml of phenolphthalein indicator was added the sample and titrated with 0.1N NaOH to the first permanent pink colour. Acidity was reported as percentage lactic acid by weight.

$$\%\ \text{Total acid (as lactic acid)} = \frac{1.0\ \text{X equivalent of X N (of NaOH)}}{\text{Weight of sample}}$$

Determination of Lactose Content of Formulated Flavoured Yoghurt

The percentage lactose was determined by yoghurt sample calculation. The total weight of fat, protein and ash was subtracted from the weight of the total solid (FAO, 1986).

% Lactose=Total solid –(% fat +%Ash +% protein)

Determination of Total Solids of Formulated Flavoured Yoghurt

The total solid content of the formulated flavoured yoghurt samples was determined by drying 5g of the sample to constant weight in a hot air oven (Gallenkamp) at 130^{o}C. The total solid content was obtained as percentage (%) total solids(AOAC,1995).

$$\%\ \text{Total solids} = \frac{\text{Weight of dried sample}}{\text{Weight of sample}} \times \frac{100}{1}$$

Proximate Composition of Bush Mango and Formulated Flavoured Yoghurt

The moisture, crude protein (N x 6.25), crude fat, crude ash and crude fibre contents were determined using standard AOAC (1995) and Pearson (1991) methods. The total carbohydrate content was calculated by difference (Oyenuga, 1968).

Determination of Some Selected Micronutrient Contents of the Formulated Yoghurt And Bush Mango

(i) **Vitamin C Content Determination**

Vitamin C content was determined according to the method described by Onwuka (2005). About 5g of the sample and 2.5ml of 20% metaphosphoric acid (as a stabilizing agent) was diluted with distilled water and weighed into a 100ml volumetric flask. Ten millilitres of the solution was mixed with 2.5ml acetone and homogenized. The absorbance reading at 264nm wavelength using UV spectrophotometer gave the Vitamin C content.

(ii) **Vitamin A Content Determination**

Vitamin A content was determined according to Prentice and Langridge (1992) procedure. The sample was first saponified using an alcoholic solution of potassium hydroxide in the presence of pyrogallol. This freed the vitamins from the food matrix and converted any retinyl ester to retinol. The unsaponified matter containing vitamin A was extracted using a mixture of diethyl ether and petroleum spirit. The extract was evaporated under nitrogen and the residue was dissolved in methanol. The extract was chromatographed using a reverse phase ODS column with the mobile phase consisting of 95% acetonitrile with 5% water. The separated retinol was then quantified using a UV absorbance detector at 328nm.

Phosphorus Content Determination

Phosphorus in the sample was determined according to Onwuka (2005) by molybdate method using hydroquinone as a reducing agent. A mixture of 1.0ml ammonium molybdate, 1.0ml sodium sulphate, 1.0ml hydroquinone and 0.5ml of the mineral digest was agitated and allowed to stand for 30 minutes. The blue colour developed was quantified using a colorimeter at 660nm against a standard.

Calcium Content Determination

The calcium content was determined by titration method according to Pearson (1991) procedure. About 10ml of the sample was pipetted into 250ml conical flask and 25ml of KOH with a pinch of calcine indicator were added. The mixture was titrated against EDTA (ethylenediamine tetraacetate) solution to get an end point. The volume of EDTA is the equivalent volume of calcium in the sample.

Microbial Enumeration of the Solar Dried Bush Mango Flavour and Formulated Flavoured Yoghurt

According to Oxoid (1982), the selective media were prepared, de Man, Rogosa, Sharpe (MRS) agar for lactic acid bacteria, Sabourand Dextrose agar (SDA) for mould count, MacConkey agar for coliforms and Nutrient agar (NA) for total viable count.

Determination of Organoleptic Properties of the Formulated Flavoured Yoghurt

The sensory evaluation was done according to Ihekoronye and Ngoddy (1985) using a 20-man semi-trained panel from the Faculty of Agriculture, University of Nigeria, Nsukka. The panelists were instructed to indicate their preference of the samples. According to Iwe (2002), a nine-point hedonic scale, where 9 was the highest score and I was the lowest score for each characteristic such as colour, flavour, mouthfeel, aftertaste and overall acceptability was used to evaluate the products organoleptically. The interpretation of the consumer response depicts the level of acceptance of the product.

STATISTICAL ANALYSIS

The data obtained were subjected to one-way analysis of variance (ANOVA) according to Obi (2002). The means were separated using the least significant difference (LSD) at the significance level of P > 0.05 using SPSS version 13 computer statistical package.

RESULTS AND DISCUSSION

The sun dried samples had high microbial load but the solar-dried samples had an edge over these other drying techniques since it had lower moisture content (Table 1) as well as low microbial load after drying. Fruit pulps that were not completely dried became mouldy outside the refrigerator by the next day. Desired dried fruit pulp colour was better obtained from bush mango fruits at mature green stage than from soft ripe fruits in agreement with Duckworth (1966) report.

Table 1: Moisture content and drying rate of solar-dried bush mango pulp

Drying time (days)	Moisture content (%)	Drying rate (g/min)
0	90.48	2.51
1	65.70	2.30
2	25.46	0.67
3	11.01	0.30

Drying rate = (initial weight - final weight)/time interval
Moisture content (%) = (initial weight - final weight x 100)/initial weight

Composition of Formulated Yoghurt Flavoured with Varying Concentrations of Solar-dried bush mango.

Table 2: Titrable Acidity, pH and total solids of formulated yoghurt

Samples	Titrable Acidity	pH	Total solids
A(3.20%)	1.80±0.00	3.90±0.00	21.125±0.03
B(0.80%)	4.50±0.13	4.00±0.00	16.93±0.00
E(1.60%)	2.70±0.14	3.90±0.00	19.44±0.01
F(0.00%)	2.97±0.00	4.10±0.00	15.028±0.00
H(control)	4.32±0.00	4.00±0.00	13.09±0.01
FPu(Fresh pulp)	-	6.18±0.00	9.51±0.01
SoPu(Solar dried pulp)	-	5.27±0.00	88.29±0.01

* Values are mean ± standard deviation of triplicate determinations.
- = Not determined

Table 2 shows that the titrable acidity values (1.80-4.32) and pH values (3.90- 4.10) of all the samples were higher than the minimum standards for yoghurt manufactured in the United States (Romanowski, 2008). This may be attributed to over fermentation and/or acidity imparted by the bush mango. Addition of 0.80%, 1.60% and 3.20% bush mango flavour gave the titrable acidity values of 4.50, 1.80 and 2.70.respectively. When compared to sample without bush mango flavour, the presence of bush mango (at the levels used) depressed the production of lactic acid. This result is in agreement with the observation of Alakali *et al.* (2008). The low acid production could be attributed to the formation of highly viscous systems which caused diffusion resistance that reduced mobility of reactants resulting in reduction of the rate at which the yoghurt culture organisms and lactose came together for fermentation to occur.

Table 2 contains data on the pH of the formulated yoghurt samples. The results showed that as the pH decreased the total solids increased with increase in concentration of the bush mango flavour. The pH of the formulated yoghurt without any bush mango (control) was 4.10. It was evident that using bush mango flavour at concentrations beyond 1.60% was not necessary since the lowest pH was produced at 1.60% concentration else a thicker product with more organic acid content is obtained. Samples H (positive control) and B showed comparable pH and titrable acidity values implying that both samples had comparable characteristics. Samples with higher titrable acidity had corresponding higher pH values, suggesting that the pH depended not only on the amount of acid in the yoghurt systems. The total solids of the positive control sample was lower than the values reported by Muhammad *et al.* (2005). The observed lower total solids may be due to period of fermentation.

Table 3 shows the proximate composition of the formulated yoghurt. The moisture content of the bush mango flavoured samples decreased with increase in concentration of the flavour. This could be attributed to the ability of the dry pulp (11.01%) to mop up the free moisture in the yoghurt. The moisture content of the negative control, (84.96%) was high since it contained no added flavour but it did not differ significantly (p>0.05) from 85.00-89.01% reported by Awaziem (2007). The high moisture content of the positive control (86.91%) could be as result of alteration with water and the volume of vanilla flavour added.

Ash content of the yoghurt samples increased with increase in the concentration of the added bush mango flavour when compared with the yoghurt samples without bush mango flavours. Sample SoPu had higher ash content (2.29%) than FPu (1.40%) which could be as a result of high mineral content as suggested by Awaziem (2007). This suggests that the drier the bush mango pulp, the higher the ash content. The ash content of formulated yoghurt was higher than the literature value 0.43% reported by Tamime and Robinson (1989). However, Muhammad *et al*. (2005) noted that ash content may be influenced by processing. There was no difference in fibre content of the yoghurt samples at different solar-dried bush mango pulp concentrations. This agreed with the report by Awaziem (2007).This could probably be due to fermentation effect. The fat content ranged from between 2.90% and 4.16% at 0.80% and 3.20% concentration of the solar-dried bush mango pulp which was within the range obtained by other researchers but higher than that of commercial yoghurt (F). The fat content increased with increase in concentration of bush mango flavour. The fat content of the yoghurt sample without bush mango flavour (1.91%) was within the range reported by Muhammad *et al*. (2005) who stated that fat content has no effect on titrable acidity. This is attributed to the fat content (3.20%) of the solar-dried bush mango pulp. The protein content and total solids of the yoghurt samples follow a similar trend to the fat content. The result revealed that the yoghurt samples without bush mango flavour (negative control), had protein content of 3.48% which agreed with that (3.44 -3.53%) reported by Jiancai and Mingruo (2006) and above that obtained by Muhammad *et al*. (2005). The protein content (0.50%), ash content (0.86%), crude fat (0.86%) and total carbohydrate (4.37%) of the fresh bush mango pulp as reported by Belonwu, (2007) were lower while that obtained by Elemo, *et al.* (2001) were higher than that obtained in this study. The results also showed that the drier the bush mango pulp, the higher the carbohydrate content which was in agreement with the report by Herringshaw (1997). The higher fat content of the solar-dried bush mango pulp (3.20%) to the fresh pulp (2.20%) may be due to concentration of the fat as a large quantity of water was lost.

Table 4 shows the effect of Bush Mango flavour on micronutrients and lactose content of formulated Yoghurt. The phosphorus content of yoghurt without bush mango flavour (control) was higher than that containing 1.90mg/100g, 1.20mg/100g and 1.364mg/100g at 3.20%, 0.80% and 1.60% respectively. This indicates that their phosphorus content reduced with the addition of the bush mango flavour. The calcium content remained unchanged in all the formulated yoghurt samples while their vitamin A and vitamin C content (0.04-0.14mg/100g) increased with increase in concentration of solar-dried bush mango pulp and the vitamin C content range (0.04-0.14mg/100g) was within the range (0.037-0.095mg/100mg) obtained by Awaziem (2007).

Table 3: Proximate composition of formulated yoghurt flavored with solar-dried bush mango pulp

Samples	Moisture content (%)	Ash content (%)	Crude Fibre (%)	Crude fat (%)	Crude Protein (%)	Total Carbohydrate (%)
A(3.20%)	78.83±0.04	2.46±0.04	Trace	4.15±0.07	6.57±0.01	7.84±0.24
B(0.80%)	83.04±0.04	0.71±0.01	Trace	2.90±1.56	6.13±0.00	7.22±3.22
E(1.60%)	80.45±0.09	2.00±0.00	Trace	3.20±0.00	6.14±0.00	8.21±0.18
F(0.00%)	84.96±0.01	0.70±0.00	Trace	1.91±0.02	3.48±0.00	9.01±0.06
H(control)	86.91±0.01	0.61±0.01	Trace	1.20±0.00	6.56±0.00	4.72±0.00
FPu(Fresh pulp)	90.47±0.01	1.41±0.01	4.91±0.01	2.20±0.00	4.37±0.02	4.65±1.08
SoPu(Solar-dried pulp)	11.01±0.00	2.30±0.01	6.32±0.02	3.20±0.00	1.78±0.03	79.13±0.00
SuPu(Sun-dried pulp)	11.70±0.01	-	-	-	-	-

*Values are mean ± standard deviation of triplicate determinations.

- = Not determined

Table 4: Micronutrients and lactose content of formulated yoghurt flavored with solar- dried bush mango pulp

Samples	Phosphorus content (mg/100g)	Calcium content (%)	Vitamin A Content (RE)	Vitamin C Content (mg/100g)	Lactose content (%)
A(3.20%)	1.90±0.84	0.20±0.00	175.11±0.00	0.14±0.04	14.68±0.21
B(0.80%)	1.20±0.00	0.20±0.00	44.20±2.38	0.04±0.00	13.32±3.14
E(1.60%)	1.36±0.08	0.20±0.00	70.04±0.00	0.13±0.01	14.18±0.14
F(0.00%)	9.22±0.08	0.20±0.00	35.02±0.00	0.04±0.00	13.47±1.94
H(control)	7.91±0.08	0.20±0.00	70.04±0.00	0.05±0.01	11.28±0.00
FPu(Fresh pulp)	1.42±0.00	0.60±0.00	280.18±0.00	0.04±0.00	-
SoPu(Solar-dried pulp)	1.31±0.00	0.40±0.00	140.09±0.00	0.04±0.01	-

*Values are means± standard deviation of triplicate determinations. (-)= Not determined

Table 5: Total viable count (cfu/ml) of formulated yoghurt flavoured with varying concentrations of solar-dried bush mango .

Total Viable Count (cfu/ml)/storage time (days)				
	Day 0	Day 7	Day 14	Day 21
A(3.20%)	3.60×10^{9}	5.10×10^{4}	2.91×10^{7}	4.50×10^{3}
B(0.80%)	4.95×10^{8}	4.50×10^{6}	2.84×10^{6}	1.00×10^{5}
E(1.60%)	3.15×10^{8}	4.55×10^{5}	4.05×10^{5}	2.88×10^{6}
F(0.00%)	3.83×10^{8}	4.50×10^{8}	6.10×10^{4}	2.59×10^{6}
H(Control)	4.10×10^{4}	3.65×10^{3}	1.80×10^{4}	3.50×10^{3}
FPu(Fresh pulp)	0.00×10^{3}	-	-	-
SuPu(Sun-dried pulp)	2.10×10^{3}	-	-	-
SoPu(Solar-dried pulp)	9.50×10^{2}	-	-	-

*Values are means of triplicate determinations ; (-)= not determined

There was no significant increase in the vitamin C content at 0.80% (compared with that of control) flavour concentration. The lactose content of the formulated yoghurt also increased with increase in concentration of bush mango flavour. The lactose content obtained was higher than the value (4.70%) reported by Mistry and Hassan (1992) for yoghurt made from skimmed milk fortified with nonfat dry milk.

There was no coliform growth from the zero day of storage to the twenty-first day of storage .This indicated that the products did not contain coliform bacteria and they were not contaminated during the storage. Tables 5, 6, and 7 show the total viable, lactic acid bacteria and mould counts respectively of formulated yoghurt flavoured with varying concentrations of solar dried bush mango pulp.

From Table 5, there was no particular trend followed in sample A(3.20%) during the storage period of the formulated yoghurt using varying concentrations of the solar dried bush mango pulp. However, the other samples (B,E,F)showed that the total viable count(cfu/ml) decreased as storage days increased (from 0-21 days). The total viable count decreased slightly by the 7th and 14th day storage while the pH decreased slightly during the period for all the samples. By the 21st day of storage, there was a drastic decrease in pH for all the flavoured yoghurt which resulted in a reduction of the total viable count of the samples. This could probably be due to the depletion of the nutrients and death of some survivors of the products .The pH drop created a highly acidic environment which led to the loss of viability or death of the microorganism present. In comparism with the fresh pulp, solar-dried and sundried pulps, there were no viable cells on the 0-day of storage .Also, the total viable count of the fresh ,solar dried and sundried pulps were much more lower than the flavoured yoghurt using concentrations of solar dried bush mango throughout the storage period.

Table 6 shows the lactic acid bacterial count of the formulated yoghurt flavoured with varying concentrations of solar dried bush mango pulp. There was a remarkable decrease in the lactic acid bacteria count probably due to the varying reduction in pH. The variation in pH was lethal to the lactic acid bacteria, thereby causing the death of some viable cells .According to Prescott *et al.*(2005), lactic acid bacteria grow optimally under slightly acidic condition when the pH is between 4.5 and 6.4. However, the decrease in total viable count could probably be as a resultof the decrease in pH during storage and also storage under unsteady temperatures which might have caused post-acidification of the yoghurt during the period of storage .

Table 7 shows the mould count of the formulated yoghurt flavored with varying concentrations of solar dried bush mango pulp. The mould count of the sundried pulps was higher than the solar dried samples. There was no mould growth in the fresh pulp and the control. However, there was an evidence of very low or minimal mould probably due to the incorporation of the solar dried pulp over the period of storage. It was seen that from 0-day to 21st day recorded a remarkable reduction in the mould count.

The absence of coliform bacteria in the control samples was due to pasteurization of pre-mix prior to incubation which agreed with the report by Younus *et al.* (2002).The fluctuation in the microbial load may be as a result of fermentation and competition among microbes present and post storage contamination. The low initial lactic acid bacteria count in samples A and E may be due to competition among the microbes present.

Table 8 shows the sensory scores of the formulated yoghurt. The flavour of the formulated yoghurt containing 4.80%, and 4.00% concentration of solar-dried bush mango pulp was the least desirable with sensory scores of 4.30 and 4.50. Samples containing 0.80% concentration of solar-dried bush mango flavour was most preferred and with scores of 6.90, 7.30, 6.75 and 6.75 for colour, flavour, aftertaste and overall acceptability respectively which did not differ ($p>0.05$) significantly from the commercial yoghurt. Meanwhile, the formulated yoghurt containing 0.80% solar-dried bush mango pulp differed significantly ($p\geq0.05$) in mouthfeel (6.45) from the commercial yoghurt (7.65) and similar to formulated yoghurt of 1.60% flavour concentration (6.20).

Table 6: Lactic Acid Bacteria count (cfu/ml) of formulated yoghurt flavoured with varying concentrations of solar-dried bush mango.

Lactic acid bacteria count (cfu/ml)/storage time (days)				
	Day 0	Day 7	Day 14	Day 21
A(3.20%)	1.40×10^7	1.00×10^4	2.29×10^3	2.14×10^3
B(0.80%)	0.20×10^8	4.00×10^6	2.43×10^5	2.89×10^5
E(1.60%)	2.00×10^7	2.00×10^5	2.55×10^4	2.94×10^4
F(0.00%)	0.80×10^7	0.20×10^8	0.35×10^9	1.50×10^3
H(Control)	8.00×10^4	2.00×10^3	1.00×10^3	0.00×10^3

*Values are means of triplicate determinations; (-)= not determined

Table 7: Mould count (cfu/ml) of formulated yoghurt flavoured with varying concentrations of solar-dried bush mango.

Mould count (cfu/ml)/storage time (days)				
	Day 0	Day 7	Day 14	Day 21
A(3.20%)	0.10×10^2	0.10 x 10	0.20 x 10	0.11×10^2
B(0.80%)	0.08×10^2	1.00 x 10	0.12×10^2	0.10×10^2
E(1.60%)	0.08×10^2	2.00 x 10	1.05×10^2	0.10×10^2
F(0.00%)	0.00×10^3	0.00×10^3	0.00×10^3	0.10×10^3
H(Control)	0.00×10^3	0.00×10^3	0.00×10^3	0.10×10^3
FPu(Fresh pulp)	0.00×10^3	-	-	-
SuPu(Sun-dried pulp)	9.50 x 10	-	-	-
SoPu(Solar-dried pulp)	0.20 x 10	-	-	-

*Values are means of triplicate determinations (-) = not determined.

Table 8: Sensory scores of formulated yoghurt flavoured with varying concentrations of solar-dried bush mango.

Samples	**Colour**	**Flavour**	**Mouth feel**	**Aftertaste**	**Overall Acceptability**
A(3.20%)	5.70 ± 1.92^a	6.15 ± 1.81^a	5.05 ± 1.96^a	6.00 ± 2.08^a	5.60 ± 2.01^a
B(0.80%)	6.90 ± 1.21^b	7.30 ± 0.92^b	6.45 ± 1.67^b	6.75 ± 1.37^{ab}	6.75 ± 0.85^b
C(4.80%)	4.20 ± 2.04^c	4.30 ± 1.98^c	3.70 ± 2.00^c	4.25 ± 1.92^c	4.00 ± 2.07^c
D(2.40%)	5.45 ± 1.67^a	5.90 ± 1.59^a	5.05 ± 1.85^{ad}	5.60 ± 1.39^{ade}	5.50 ± 1.50^{ade}
E(1.60%)	6.50 ± 1.70^{ab}	6.80 ± 1.20^{ab}	6.20 ± 1.47^b	6.10 ± 1.59^{abe}	6.35 ± 1.18^{abe}
F(0.00%)	8.45 ± 0.69^d	8.35 ± 0.67^d	8.20 ± 0.62^e	8.20 ± 0.83^f	8.25 ± 0.79^f
G(4.00%)	4.30 ± 2.10^c	4.50 ± 1.84^c	4.00 ± 2.29^{acd}	4.75 ± 1.92^{cd}	4.50 ± 2.16^{cd}
H(control)	8.20 ± 1.47^{bd}	7.85 ± 1.69^{bd}	7.65 ± 1.46^e	7.50 ± 1.96^{bf}	7.55 ± 2.14^{bf}
LSD	1.03	0.95	1.07	1.04	1.04

*Values are in mean ± standard deviation of replicate determinations.
+values in the same column carrying similar superscripts are not significantly different ($p<0.05$).

The result also shows that formulated yoghurt (control) differed significantly ($p \geq 0.05$) from the yoghurt sample containing 0.80%, but similar to the commercial yoghurt (positive control) in all the sensory attributes. However, the control was preferred more than others which was expected because solar-dried bush mango pulp is a new flavour in the yoghurt market. In addition, yoghurt sample (control) was preferred to the commercial yoghurt because of its smoothness, body and mouthfeel that was very much liked (8.20). This could be attributed to the adulteration of yoghurt by commercial manufacturers to make more profit. It is probable that the thickness of the product influenced eye appeal (Alakali *et al.*, 2008). The high viscosity of the yoghurt samples is supported by Early's (1998) observation that in the UK, regular natural yoghurt has viscosity that is just pourable but that thick yoghurts have also found a place in the market generally with higher fat content. The results in this study also indicate that Nigerian consumers would prefer thicker yoghurt. Meanwhile, the main quality factors for yoghurt are the colour (appearance), taste and mouthfeel (Fellows, 1997) and formulated yoghurt flavoured with 0.80% solar-dried bush mango pulp which satisfies these quality attributes has been rated as the most desirable.

CONCLUSION

From the results obtained, the formulated yoghurt was enriched from the addition of bush mango (sweet variety). Bush mango, being nutritionally high, enabled it to act as a flavor to yoghurt and a fortificant in non-alcoholic beverages. Thus, the results showed that the addition of the solar-dried bush mango to yoghurt as a flavorant decreased the pH, titrable acidity and moisture content but increased the total solids, vitamin C, vitamin A, protein, total carbohydrate and ash contents while calcium and fibre contents were constant. Sensory properties (colour, taste, flavour and mouthfeel) were enhanced by the addition of 0.80%, solar-dried bush mango pulp followed by 1.60% and 3.20% concentration respectively. Therefore, the high vitamin A and C could aid in the combating of deficiency diseases like scurvy and night blindness respectively.

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