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Assessment of the Nutritional Profile of Variable Graded Levels of Julie Mango Fruit Juice Flavoured Yoghurt and Plain Yoghurt

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Abstract:- Plain yoghurt, 5%, 10% and 15% flavoured yoghurt samples were analysed for their proximate compositions, physico-chemical compositions, vitamin and mineral contents. The protein, moisture, fat and ash contents of the yoghurt samples decreased with significance (p<0.05) difference as the addition of Julie mango fruit juice increased. The carbohydrate, total solids, total solids non-fat, titrable acidity, vitamin C, and Calcium contents increased with significance (p<0.05) difference as the addition of Julie mango fruit juice increased. The pH on the other hand increased with no significance (p<0.05) difference between the yoghurt samples. All the formulated yoghurt samples in this study met the standard requirement for yoghurt production, hence could be hitherto modified to suit customers/consumers appeal for industrial mass production.

***Keywords**:- Yoghurt, Plain Yoghurt, Flavoured Yoghurt, Julie Mango Juice, Nutritional Profile.*

I. INTRODUCTION

Yoghurt is a fermentation product resulting from milk with a mixed starter culture (bacterial enzymes) consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. Bulgaricus*, by breaking down the sugar compound lactose into glucose and galactose under anaerobic conditions [1, 2]. When the starter culture produces sufficient lactic acid, the lactic acid lowers the pH, making it tart (a characteristic sour flavour), causing the coagulation or thickening of the milk protein [3] This action acts as a preservative inhibiting the growth of pathogenic bacteria as they cannot grow in acid environment as well as maintains the yoghurt quality during storage and packaging [4]. The partial digestion of the milk when these bacteria ferment milk makes yoghurt easily digestible and helps those consumers with lactose intolerance [5]

The use of fruit in yoghurt improves the Aesthetic value of the product (making it more pleasing) and delicious, retaining the health benefits of yoghurt and the refreshing flavour of the fruits [6, 7]. The nutritional and therapeutic benefits of yoghurt has increased its popularity around the world, fruit flavouring of yoghurt has hitherto increased its nutritional profile and sensory acceptability by the consumers. To improve certain nutrients of yoghurt, flavours and fruit flavours are added to yoghurt during the production process to modify/improve the therapeutic and organoleptic properties. Presently, only flavoured yoghurts from fruits such as raspberry, banana, peach, vanilla, and strawberry are commercially available [4]

However, some of these highly rated fruits could be replaced with some underutilized ones such as; Julie mango which was adjudged to be the consumer's choice from the varieties of mango owing to its nutritional profile, great taste, aroma and sensory acceptability [8, 9]

Furthermore, most Nigerian fruits like Julie mango are seasonal and due to poor storage condition, handling, disease, deterioration most of them are unfortunately wasted or lost either to spoilage or pests. Processing these fruits will reduce post-harvest losses and spread their availability throughout the year [8] To avoid these postharvest losses, these fruits (like Julie mango) could be formulated with yoghurt as flavouring agent as well as to enhance diversification, domestication and spread the availability of Julie mango juice throughout the year.

There have been various studies on yoghurt and flavoured yoghurt, but no study on the flavouring of yoghurt with Julie mango has been recorded in Nigeria to the authors' knowledge. Hence, the objectives of this study are; (i) to produce plain yoghurt from fresh cow milk and flavour the plain yoghurt with Julie mango fruit juice at variable percentages. (ii) to evaluate the nutritional profile of the plain and flavoured yoghurt.

II. MATERIALS AND METHODS

2.1 Materials

2.1.1 Sample Collection

Fresh cow milk was obtained from the local traders in Wadata market, Makurdi. Starter Culture, *S. thermophilus and L. bulgaricus* (yógourmet) was obtained from modern market, Makurdi. Julie mango fruits of appreciably even level of ripening were bought from the local traders in Wurukum Market, Makurdi. Dangote Sugar was bought from Wurukum market, Makurdi.

2.1.2 Sample Preservation:

The samples were preserved in a thermostatic refrigerator at 4°C for further use.

2.1.3 Sample Preparation

2.1.3.1 Julie Mango Fruit Juice Preparation

Five fully matured ripe Julie mango fruits were carefully sorted to remove bad ones and thoroughly washed in warm water to remove gummy sap or other materials. The peels, pulp and seed (kernel) of the mango fruits were removed aseptically with the aid of a sharp knife. The Julie mango fruit juice was extracted with the aid of a juice extractor (Gift King). The extracted juice was subsequently pasteurized at 85 °C for 3 minutes. The juice was then cooled for further use [10].

2.1.3.2 Production of Julie Mango Fruit Flavoured Yoghurt

Fresh cow milk was used for the production of the yoghurt. Foreign matters were removed via filtration of the milk. The milk was subsequently pasteurized at 85 °C (with constant stirring) for 30 minutes to reduce/kill off pathogenic microorganisms. The temperature was subsequently cooled to 43 – 45 °C which is the ideal growth temperature of the starter culture [11]. Starter culture (yógourmet) was inoculated to the pasteurized milk at 2 % V/V after which the milk was divided into four equal portions. The Julie mango fruit juice that was previously pasteurized was then incorporated into the yoghurt at 5 %, 10 % and 15 % level in different (pre washed) cups leaving one cup as the plain yoghurt and 12% of sugar was added to the flavoured yoghurt [12]. Fermentation was then carried out for 10-12 hours after which the yoghurt samples were set. The samples were stored at 4 °C in a thermostatic refrigerator until further use.

2.2 Methods

2.2.1 Determination of Proximate Compositions

2.2.1.1 Determination of Moisture Content

Each of the samples (2 cm^3) were put in a washed, dried and pre-weighed crucibles and placed in an oven at 70-80 °C for 2 hours and at 100-105 ^{0}C to obtain a constant weight. The samples were cooled in a desiccator and weighed [13]. The weight loss was then calculated as the moisture content.

2.2.1.2 Determination of Ash Content

The ash content of the samples was determined by the method recommended by AOAC 2010. A silica dish was heated to about 60 ^{0}C and allowed to cool in a desiccator and weighed. The samples (5 cm^3) were put in the crucible and transferred to the furnace. The temperature of the furnace was allowed to reach about 525 ^{0}C after placing the dishes in it. The temperature was maintained until whitish-grey colour was observed indicating the destruction of all organic matter in the samples. The dishes were then brought out from the furnace and cooled in the desiccator and re-weighed [11].

2.2.1.3 Determination of Fat content

Petroleum ether was used for the extraction. The flasks were washed with the solvent, dried, cooled and weighed. The samples (5 cm^3 each) were weighed into a conical flask. The flasks were swirled for several times, covered (to prevent evaporation of the solvent) and allowed to stand for extraction to take place for 12 hours. After the extraction, the solvent together with the oil were decanted and the solvent was dried up on heating. The weight of the flasks with oil was recorded [14]. The difference in weight of empty flasks and the flasks with oil content was calculated as the fat content.

2.2.1.4 Determination of Protein Content

The crude protein of the samples was determined by the semi-micro Kjeldahl technique described by AOAC (2010). Firstly, 1 cm^3 of the samples each was put in Kjeldahl flasks, anhydrous sodium sulphate (3 g) and 1 g of hydrated copper sulphate (catalyst) was added into the flasks. Then, the samples were digested under heat with 20 cm^3 of concentrated tetraoxosulphate (IV) acid (H_2SO_4) until a clear solution was observed. The clear solutions were then cooled and about 5 cm^3 of the digests was collected for distillation and made up to 100 cm^3 with distilled water. Sodium hydroxide (5 cm^3 of 60 %) was added and distillation was allowed to take place for some minutes. The ammonia distilled off was absorbed by 50 cm^3 boric acid with indicator (bromocrysol methyl red) and this was titrated with 0.01 M hydrochloric acid (HCl). The titre value of the end point at which the colour changed from green to pink was then taken [4, 15].

2.2.1.5 Determination of Carbohydrate Content

Carbohydrate was obtained using the method described by Hossain *et al.* (2012). Percentage carbohydrate was calculated by simply subtracting other food components from one hundred.

2.2.2 Determination of Physico-chemical compositions

2.2.2.1 Determination of Total Titrable Acidity (TTA)

Acidity of the yoghurt samples were assayed by simple titration method also known as Total Titrable Acidity (TTA), described by AOAC (2010). TTA is measured as free and bound hydrogen ions by titration with 0.1 N NaOH expressed in g/L. The samples (10 cm^3 each) was measured into a conical flask and about 3 drops of phenolphthalein indicator was added to the samples and titrated with 0.1 N sodium hydroxide (NaOH) until colour change was observed [4]. The end points were taken and the TTA expressed as % lactic acid (CH_3-CHOH-COOH, MW = 90).

2.2.2.2 Determination of Total Solid content.

The samples (5 cm^3 each) were dried to constant weight in a hot oven at 130 °C. The total solid obtained is expressed as the percentage total solids [13].

2.2.2.3 Total Solids-non-Fat Content

Total solids-non-fat was determined by the difference between percentage total solids and the percentage fat content [16].

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2.2.2.4 Determination of pH

The pH values were obtained by dipping the electrode of the pH meter in 5 cm^3 of the samples each (one at a time) and the pH recorded [13].

2.2.3 Determination of Vitamin and Mineral

2.2.3.1 Determination of Vitamin C

To determine the ascorbic acid content of the samples, 100 cm^3 of distilled water was added to 2 cm^3 of each of the samples. The mixtures (of the samples) were then filtered to obtain a clear solution. The clear solution (10 cm^3) was pipetted into a small flask and 1 cm^3 of starch indicator solution was added. The solution was titrated with 0.005 M iodine solution to get a dark blue colour change [17].

2.2.3.2 Determination of Calcium Content

The calcium content was determined by titration method. The ashed samples (5 cm^3 each) were diluted with 3 cm^3 of distilled water, and 1 cm^3 of 50 % ammonium oxalate was added. One drop each of methyl red indicator, ammonia and glacial acetic acid were added until the colour changes to pink. The samples were stood for 4 hours and centrifuged for 5 minutes and subsequently decanted. Distilled water (4 cm^3) and 1 cm^3 of hydrogen sulphate were added to the supernatant and boiled. Thereafter, the solutions were titrated with 0.02 N potassium permanganate solutions [18].

2.2.5 Statistical Analysis

The results in this study are reported as mean of duplicate analysis, using one way analysis of variance (ANOVA), to determine the difference between the mean scores at 95 % confidence interval for mean. The significant means were separated by Duncan's multiple range tests. Significance was accepted at $P \leq 0.05$ using IBM SPSS version 23.

III. RESULTS AND DISCUSSION

3.1 Results

Table 3.1: Proximate composition (%) of Julie mango flavoured yoghurt samples.

Sample	Protein	Fat	Moisture	Ash	carbohydrate
C(100:0)	3.58 ± 0.02^a	2.50 ± 0.02^a	84.50 ± 0.04^a	1.80 ± 0.03^a	7.62 ± 0.06^a
CM_1(95:5)	3.41 ± 0.01^b	1.50 ± 0.01^b	84.00 ± 0.03^b	1.60 ± 0.02^b	9.49 ± 0.01^b
CM_2(90:10)	3.33 ± 0.01^c	1.00 ± 0.01^c	83.00 ± 0.01^c	1.20 ± 0.00^c	11.47 ± 0.04^c
CM_3(85:15)	3.24 ± 0.00^d	0.50 ± 0.01^d	82.50 ± 0.00^d	1.00 ± 0.00^d	12.76 ± 0.01^d

Values are mean ± standard deviation in duplicate readings. Means on the same column with different superscripts are significantly different ($p \leq 0.05$). C = plain yoghurt, CM_1= 5 % Julie mango fruit flavoured yoghurt, CM_2 = 10 % Julie mango fruit flavoured yoghurt, and CM_3 = 15 % Julie mango fruit flavoured yoghurt.

Table 3.2: Physico-chemical properties of Julie mango fruit flavoured yoghurt

Sample	PH	TTA	Total Solids	Total Solids non-fat
C(100:0)	3.60 ± 0.14^a	1.00 ± 0.03^a	15.50 ± 0.04^a	13.00 ± 0.06^a
CM_1(95:5)	3.70 ± 0.14^a	0.90 ± 0.01^b	16.00 ± 0.03^b	14.50 ± 0.02^b
CM_2(90:10)	3.80 ± 0.28^a	0.85 ± 0.03^c	17.00 ± 0.01^c	16.00 ± 0.00^c
CM_3(85:15)	3.80 ± 0.42^a	0.77 ± 0.01^d	17.50 ± 0.00^d	17.00 ± 0.01^d

Values are mean ± standard deviation in duplicate readings. Means on the same column with different superscripts are significantly different ($p \leq 0.05$). C = plain yoghurt, CM_1 = 5 % Julie mango fruit flavoured yoghurt, CM_2 = 10 % Julie mango fruit flavoured yoghurt, and CM_3 = 15 % Julie mango fruit flavoured yoghurt.

Table 3.3: Levels of vitamin and mineral elements in Julie mango fruit juice flavoured yoghurt (mg/100 g)

Sample	Vitamin C	Calcium
C(100:0)	18.50 ± 0.02^a	57.06 ± 0.01^a
CM_1(95:5)	19.50 ± 0.01^b	50.72 ± 0.01^b
CM_2(90:10)	15.00 ± 0.00^c	38.04 ± 0.01^c
CM_3(85:15)	24.00 ± 0.00^d	25.36 ± 0.01^d

Values are mean ± standard deviation in duplicate readings. Means on the same column with different superscripts are significantly different (p≤0.05). C = plain yoghurt, CM_1= 5 % Julie mango fruit flavoured yoghurt, CM_2 = 10 % Julie mango fruit flavoured yoghurt, and CM_3 = 15 % Julie mango fruit flavoured yoghurt.

3.2 Discussion

3.2.1 Proximate Compositions

3.2.1.1 Protein Content

The crude protein content of the flavoured yoghurt ranged between 3.58-3.24 % as shown in Table 3.1. The plain yoghurt(C) recorded the highest value and 15 % formulation recorded the lowest. Statistically there was significant (p≤0.0.5) difference in the protein contents of the yoghurt samples. The protein content decreased with an increase in the level of the Julie mango juice added. This decrease was as a result of the low protein content in mango compared to milk. The values reported for the crude protein content agreed with the range (3.44 – 3.80) reported in the study of fruit flavored yoghurt: chemical, functional and rheological properties in Saudi Arabia [19]. The results are higher than the range of values (1.62-2.37) reported in the study carried out on the physicochemical properties and sensory evaluation of yogurt nutritionally enriched with papaya [20].

3.2.1.2 Crude Fat

The percentage crude fat ranged between 2.50-0.05 % as shown in Table 3.1; with the plain yoghurt (100:0) having the highest value of 2.50 % and the flavoured yoghurt (85:15) recorded the lowest value (0-5 %). There was significant (p≤0.0.5) difference between the yoghurt samples. The crude fat values reported decreased with increase in the addition of Julie mango juice. The fat content of yoghurt is dependent on the type of yoghurt produced, be it full fat yoghurt containing ≥3 % fat content, low/reduced fat yoghurt containing 0.5-2.5 % fat content or non fat yoghurt containing <0.5 % [21]. Hence the formulated Julie mango juice flavoured yoghurt which had a fat content ranging between 2.50-0.5 % could be referred to as low/reduced fat yoghurt. The values recorded vary slightly from the range of values (1.16 – 3.50) recorded in the study of some yoghurt samples in Maseru, Lesotho [22] but far lower than the range of values (9.8-9.6) recorded in the production of fruity yoghurt with banana flavor [23].

3.2.1.3 Moisture Content

Table 3.1 showed the moisture content of the samples ranging between 82.50-84.50 %. The high moisture content recorded signifies the low shelf life of the yoghurt [9]. There was significant (p≤0.0.5) difference between the mean of the yoghurt samples in this study. The moisture content of the samples decreased with increase in the addition of Julie mango fruit juice. By implication, the yoghurt should be stored in a cool condition to avoid microbial spoilage [25, 26]. The moisture content recorded in this study agrees with the range (≤84.67) reported in the study of yoghurt using carrot, pineapple and spiced yoghurt using ginger and pepper fruit [26] but higher than the range (77.63-76.81) reported in the analysis of the proximate composition, acceptability and stability of probiotic dairy yoghurt containing cooking banana/*matooke* puree and *lactobacillus rhamnosus* yoba [27].

3.2.1.4 Ash Content

The ash content, as shown in Table 3.1, ranged between 1.80-1.00 %. These values decreased with significant (p≤0.0.5) difference as the addition of variable levels of Julie mango fruit juice increased. This could be ascribed to the substitution of milk with Julie mango fruit juice. Milk is rich in minerals, which some are not present in mango, hence, could have informed the decrease in the ash content with the addition of Julie mango fruit juice [4].The ash content reported in this study is similar to the results (1.98 – 1.30) reported in the study of stirred yoghurt flavoured with African star apple pulp [28] and higher than the value (0.357) recorded for groundnut yoghurt [29].

3.2.1.5 Carbohydrate Content

The carbohydrate content of the yoghurt samples ranged between 7.62 % in plain yoghurt, C (100:0) to 12.76 % in M_3 (100:15) as presented in Table 3.1. There was significant (p≤0.0.5) difference between the yoghurt samples. The increase in the carbohydrate content is associated with increase/addition of Julie mango fruit juice. This is because Julie mango fruits have high carbohydrate content of 19.78 g/mg [23]. These results are similar to the results (7.20 – 10.96) reported in the study of yoghurt manufactured with Cow milk and Goat milk [30] but lower than the value (18.2) reported for low fat yoghurt in the study of Strawberry-Flavored Yogurts and Whey Beverages [31].

3.2.2 Physico-chemical Compositions

3.2.2.1 pH

The plain yoghurt, C (100:0) recorded the least value (3.60) for pH, while the formulated yoghurts, CM_3 (85:15) and CM_2 (90:10) both recorded the highest (3.80) values as shown in Table 3.2. There was no significant (p≤0.0.5) difference between the yoghurt samples. The pH of the samples increased with addition of Julie mango fruit juice. This trend falls within the range of value (4.34 – 1.40) recorded in the study carried out on various types of yoghurt in Kano-Nigeria [32] and also lower than the range of value (5.10-5.00) recorded in the study of Apple and Banana blend yoghurt [6].

3.2.2.2 Total Titrable Acidity (TTA)

Statistical analysis of the yoghurt samples showed that there was significant (p≤0.0.5) difference between the mean of the plain yoghurt and the variable formulated/flavoured yoghurts. Table 3.2 recorded an increase in acidity as the addition of Julie mango fruit juice increased. The plain yoghurt C (100:0), recorded the highest value 1.00 ± 0.03, while the flavoured yoghurt CM_3 (85:15) recorded the least value, 0.77 ± 0.01. The addition of Julie mango fruits juice increased the pH but decreased the acidity of the yoghurt.

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This can be ascribed to the fact that the ascorbic acid of fruits decreases as they ripen [4]. This trend differ slightly from the range (0.64 – 0.85) reported in the comparative study of Mango and Pawpaw flavoured yoghurt in Ethiopia [33] but similar to the range of values (1.08 – 0.70) recorded in the quality evaluation and acceptability of soy-yoghurt with different colours and fruit flavours [34].

3.2.2.3 Total Solids.

Table 3.2 showed an increase in the total solid content as the addition of Julie mango fruit juice increased. There was significant (p≤0.0.5) difference between the mean of the yoghurt samples. The plain yoghurt, C (100:0), had the least value of 15.50±0.04 while CM_3 (85:15) had the highest value (17.50 ±0.00). However, the values are lower than the value (26.51) recorded in the study of coconut yoghurt [35].

3.2.2.4 Total Solids non-Fat

The total solids non-fat recorded in Table 3.2 ranged between 13.00±0.06-17.00±0.01. The plain yoghurt C (100:0) recorded the highest value (13.00±0.06) while the flavoured yoghurt CM_3 (85:15) had the least value (17.00±0.01). These values are higher than the minimum requirement of 8.2 % (m/m) by NAFDAC [36] and 8.2 – 8.5 by FAO/WHO [37]. The total solids non-fat of the yoghurt increased as the addition of Julie mango fruit juice increased. There was significant (p≤0.0.5) difference between the mean of the yoghurt samples. These values are lower than the range of values (16.85 – 21.68) obtained from similar study of some yoghurt samples in Maseru, Lesotho [22] but similar to the range of values (16.82 - 15.86) recorded in the study of yoghurt fortified with Avocado pulp [38]. But it is important to state that generally, the trend is the same (upward) as the addition of the fruit flavour increased.

3.2.3 Determination of Vitamin and Mineral

3.2.3.1 Vitamin C Content

Table 3.3 shows the Vitamin C (ascorbic acid) content which ranged between 18.50±0.02-24.00±0.00 in plain yoghurt C, (100:0) and flavoured yoghurt, CM_3 (85:15) respectively. There was significant (p≤0.0.5) difference between the mean of the yoghurt samples. The Vitamin C (ascorbic acid) content of the yoghurt increased as the addition of Julie mango fruit juice increased. A study of the proximate composition and some physical attributes of three mango (Mangifera indica L.) fruit varieties recorded the Vitamin C content of Julie mango fruit to be 11.23±0.01 [24]. This finding gave the reason for the increase in the vitamin C content in the yoghurt samples. The range of Vitamin C content reported in this study varied slightly from the range (22.20 - 27.79) from similar study on the flavouring of yoghurt with African bush mango juice and pulp [4], but far less than the range (128.9 – 150.7 mg) reported in the study of chemical, physiochemical compositions of yoghurts produced from blends of cow milk and pineapple juice [39].

3.2.3.2 Calcium Content

Calcium is an important component of a healthy diet and minerals necessary for life build and to maintain strong bones and teeth and performance of other physical functions, such as muscle control and blood circulation. Milk and milk products are some of the natural and the best sources of calcium [40].

Statistical analysis showed that there was significant (p≤0.0.5) difference between the mean of the yoghurt samples. Table 3.3 showed the range (25.36±0.01 - 57.06±0.01) of the plain yoghurt, C (100:0) and the flavoured yoghurt with the highest value and flavoured yoghurt CM_3, (85:15) with the least value. The calcium content of the yoghurt samples decreased with increase in the addition of Julie mango fruit juice. This trend could be attributed to the low calcium content of Julie mango fruit juice. The results differ with the range (44.43 – 33.58) of results recorded from the Production and evaluation of yoghurt flavoured with fresh and dried cashew (*Anacardium occidentale)* apple pulp [11]. And also differ significantly from the required calcium standard for low fat yoghurt; 120 mg/100 g [41].

IV. CONCLUSION

Compared to milk, yogurt has high nutrient density and more nutritious. It is effective in the treatment of lactose intolerance (due to the fermentation of lactose), diabetes, obesity, infantic diarrhea, constipation, urogenital infections, and reduction of serum cholesterol to mention but a few [42]. The addition of a known delicious Julie mango fruit juice further boosted the health image of the yoghurt produced and the vitamin C content which is vital in the fight against iron deficiency. Although, all samples exhibited small variations in most of their proximate compositions and physiochemical properties, their values are in the acceptable ranges. But it is important to state that all the yoghurt samples in this study met yoghurt standard and acceptability index. Hence they could be hitherto modified to meet consumers' acceptability. These formulations and quality findings may be useful for yoghurt industries to produce new variety of yoghurts.

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Competing Interest

The authors have declared that no competing interest exists.

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