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Quality evaluation and microbial enumeration of plant based probiotic yoghurt from powdered milk and tiger nut milk

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Abstract

Some commercial yoghurt manufacturers have promoted the usage of artificial thickening and binding agents in the production of yoghurt. These substances, most of which are chemically synthesized could be dangerous. The purpose of this research is to assess the physicochemical characteristics of yogurt made from full cream milk, skimmed milk, and tiger nut milk. It also aimed to estimate the total aerobic plate count, total coliform count, and total mold count of the products for microbiological analyses. The powdered milk samples were reconstituted into liquid and the sorted-clean tiger nut was blended in order to extract the milk. Tiger nut milk proportion of 20 to 30 % was incorporated into the liquid milk before fermentation. The harvested yoghurt was assayed for sensory, physicochemical and microbial analyses. The result obtained showed a level of significant difference ($p < 0.05$). Among the samples produced, sample G has the least acceptable value 5.00 while sample C had the highest acceptable value 7.05 across the sensory scores. The values obtained from the physicochemical analysis showed that pH value ranged from 3.67 to 4.97. For TDS and titratable acidity (TA), the values ranged from 4.53 to 6.72 x 10^2 ppm and 0.62 to 0.87 respectively. None of the yoghurt samples had coliform growth on the medium after the incubation period while total viable count ranged from 78.67 to 227.33 cfu/ml and total mould count ranged from 16.67 to 56.67 sfu/ml at a dilution factor of 10^2. Tiger nut milk can be used in the production of yoghurt as a possible substitute because of its nutritional content and health advantages. Therefore, it is imperative to assert that the use of tiger nut milk in the manufacturing of yoghurt will improve the quality of yoghurt and ultimately result in a desired product.

Keywords: Yoghurt; Powdered milk; Tiger nut milk; Probiotics; Physicochemical; Total microbial count

1. Introduction

The use of synthetic binding and thickening agents in the production of yoghurt has been the major practice of some commercial yoghurt producers. Most of these thickeners are chemically synthesized and could pose a potential threat to the health status of the potential consumers. Thus, there is need to explore alternatively natural source that enhances the thickness and viscosity of yoghurt without altering the textural characteristics. Yogurt is a dairy product made from the bacterial fermentation of milk [1]. Yogurt cultures are the microorganisms that are used to manufacture yogurt. Lactic acid is produced when these bacteria ferment carbohydrates in milk, which acts on milk protein to give yogurt its distinctive acidic flavor and texture [1]. Cow's milk is the most widely utilized milk in the production of yogurt. Yogurt is also made from the milk of water buffalo, goats, ewes, mares, camels, and yaks. The milk used may or may not be homogenized. It can be pasteurized or unpasteurized. Each variety of milk yields very different outcomes. A culture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* bacteria is used to make yogurt [2]. Other lactobacilli and bifidobacteria are sometimes introduced during or after yogurt culture. To make yogurt, milk is heated to 85 °C (185 °F) to denature the milk proteins and prevent them from curdling. The milk is allowed to cool to around 45 °C (113 °F) after it has been heated [2]. The bacterial culture is added, and a warm temperature of 30 - 45 °C (86 - 113 °F) is maintained for 4 to 12 hours to allow fermentation to start; higher temperatures work faster but risk lumpy

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texture or whey separation [3]. Flavored yogurt is made by combining flavorings with plain yogurt. Set-style yogurt and Swiss-style yogurt are the two most prevalent types of yogurt seen in supermarkets. Set-style yogurt is put into individual containers to set before packing, whereas Swiss-style yogurt is stirred before packaging. Fruit may be added to either to boost sweetness [4].

Tiger nut is a perennial crop grown mostly in tropical and subtropical places across the world, as well as substantially in Africa, Asia, and certain European nations for its sweetish tubers. Fresh tubers are consumed as a vegetable, and dried tubers are utilized as a sweet snack [5]. They are also ground into flour and used as a thickening in bread and cakes, as well as blended with water to make a drink. Because of their great nutritional features and ability to prevent heart disease and thrombosis, the tubers are frequently referred to as "health" foods. Tiger nut has been shown to increase blood circulation, lower the risk of colon cancer and diabetes, and aid in weight reduction [5]. Tiger nut has aphrodisiac, carminative, diuretic, emmenagogue, stimulant, and tonic properties, as well as medical purposes such as treatment of flatulence, indigestion, diarrhea, dysentery, and excessive thirst [6]. Tiger nut flour is high in carbohydrate, oil, and minerals like iron and calcium, which are essential for body growth and development [7, 8]. Three color variants have been recorded, including yellow, black, and brown varieties [8]. Tiger nut is high in carbs, fiber, lipids, and oleic acid [5, 9]. Despite its enormous potentials, the tiger nut is underused [7]. The aim of this research is to evaluate the qualities of yogurt produced from full cream milk, skimmed milk and tiger nut milk in terms of physical and chemical parameters and also to estimate the total aerobic plate count, total coliform count and total mold count of the products for microbiological analyses.

2. Material and methods

This research was conducted in the Microbiology Quality Control Laboratory, Department of Food Technology, School of Applied Sciences and Technology, The Federal Polytechnic Offa, Offa, Kwara State, Nigeria.

2.1. Sample collection

All raw materials used (sachet full cream and skimmed milk, tiger nuts, muslin cloth, sugar, packaging plastic bottles) were purchased from the major market within Offa metropolis, Kwara State and were transferred to the Food Technology Microbiology Laboratory of the institution. All apparatus used were washed thoroughly and disinfected to reduce the level of microbial contamination and high level of personal hygiene was maintained in the production of the yoghurt. The equipment and chemicals used were sourced from Food Technology Chemistry Laboratory of the institution.

2.2. Preparation of Tiger nut milk

Tiger nuts were picked to remove the bad nuts and other foreign materials that may affect the quality of the tiger nuts milk and washed thoroughly with tap water, it was soaked for 3 days while interchanging the water. Five hundred (500) g of the soaked tiger nuts was weighed and blended in 1 litre of clean tap water using 2.5 liter capacity blender (Model: 10500, Multi function 32000 RPM 4000W 220 – 240V – 50/60Hz). The slurry was filtered using muslin cloth to extract the milk [10]. The resultant tiger nut milk was thoroughly mixed and allowed to stand for 30 minutes so as to allow the starch molecules to settle out to prevent gelatinization during pasteurization. The supernatant (tiger nut milk) was decanted and pasteurized at 85 °C for 15 minutes and allowed to cool down.

2.3. Preparation of powdered milk solution

One (1) kilogram of powdered milk was weighed and reconstituted into 2 litre distilled water. The solution was thoroughly mixed together to have a homogeneous milk solution. The milk solution was also pasteurized at 85 °C for 15 minutes and allowed to cool [11].

2.4. Preparation of the blends of powdered milk-tiger nut milk

Full cream milk, skimmed milk and tiger nut milk were prepared in the following ratio 100:0:0 F-S-T, 0:100:0 F-S-T, 80:20 F-T, 80:20 S-T, 40:40:20 F-S-T, 70:30 F-T, 70-30 S-T vol. / vol. Each blend was prepared into a previously sterilized jar for pasteurization at 85 °C for 15 minutes in a thermostatically controlled water bath.

Table 1 Formulations of powdered milk and tiger nut milk solution

Samples	Skimmed milk (ml)	Full cream milk (ml)	Tiger nut milk (ml)
A	100	0	0
B	0	100	0
C	80	0	20
D	0	80	20
E	40	40	20
F	0	70	30
G	70	0	30

Keys: A = 100% Skimmed milk; B = 100% Full cream milk; C = 80% Skimmed milk and 20% tiger nut milk; D = 80% Full cream milk and 20% tiger nut milk; E = 40% Full cream milk, 40% skimmed milk and 20% tiger nut milk; F = 70% Full cream milk and 30% tiger nut milk; G = 70% Skimmed milk and 30% tiger nut milk

2.5. Production of yoghurt from the mix

The pasteurized jars containing the milk solution was allowed to cool to 42 °C and then inoculated with a mixed culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (yogourmet). The inoculated samples were allowed to ferment in an incubator preset at 42 °C for 12 hours. Thereafter, the samples were allowed to cool down, stirred and kept under refrigerated condition at 4 °C for further analysis.

2.6. Sensory evaluation

All the samples were evaluated for sensory characteristics such as colour, creaminess, sweetness, flavor, mouth-feel, sourness, viscosity and overall acceptability using twenty (20) semi-trained panelists recruited from the Food Technology Department, The Federal Polytechnic, Offa. Yoghurt samples were coded with the alphabetical arrangements and presented to the panelists in a random manner. A nine-point hedonic scale ranging from 9 (like extremely) and 1 (dislike extremely) was used to grade the samples. The overall acceptability of the samples was determined as the average scores for sensory characteristics.

2.7. Physicochemical analyses

The samples of yoghurt spread were also analyzed for pH, acidity and total dissolved solids (TDS) after 24 hours of production. Every experiment was performed in triplicate for control as well as other formulations and average values were documented.

2.8. Determination of pH

Hydrogen ion concentration (pH) of the yoghurt samples was determined using mobile hand pH meter [12]. The pH meter was standardized following the standard operating procedures (SOPs) and inserted in the beaker containing sample. Reading displayed on the digital screen was cautiously documented.

2.9. Determination of acidity (%)

With the help of Pasteur pipette 20 ml sample, 99.5% ethyl alcohol, sulphuric acid and 2-3 drops of 1% phenolphthalein indicator were transferred into Erlenmeyer flask and mixed gently. Titration was carried out with titrant 0.1 N NaOH until colour of solution changed to pink [13]. Volume used for titration was multiplied with acidity factor accordingly.

Acidity (%) = (Volume of titrant used X normality of titrant X equivalent factor (90))/(grams of sample) X 100

2.10. Determination of total dissolved solid (TDS)

Total Dissolved Solids was measured by digital hand Multi-Parameter (Eutech PCSTestrTM 35-01X441506/Oakton 35425-10). Before using the Multi-Parameter, it was calibrated by distilled water and well cleaned. An adequate amount of sample was placed in a beaker and the Multi-Parameter was inserted until a stable reading was achieved. The procedure was repeated and triplicate readings were recorded.

2.11. Microbial analysis

The samples produced were kept under refrigeration temperature at 4 °C. Microbial analyses of the sample were carried out using pour plate method. The nutrient agar (NA), McConkey agar (MCA) and Potato Dextrose Agar (PDA) were used for total aerobic bacterial count, total coliform count and total mould count respectively and they were prepared according to the manufacturer's instructions and this was carried out 24 hours after the production of the yoghurt.

2.12. Experimental design

Complete Randomized Block Design was used in this study which involved the use of equal number of response on the yoghurt samples provided.

2.13. Statistical analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using the Statistical Package for Social Sciences (IBM SPSS VERSION 25). Duncan Multiple Range Test (DMRT) was used to separate the means where significance differences existed. All analyses were done at 95% confidence level ($p < 0.05$).

3. Results

This chapter interprets the values generated from the statistical analysis data and the mean ± SD values are presented in tables, charts and figures. The result also indicated the significant difference ($p < 0.05$) obtained from the post-hoc test. Table 1 showed the mean sensory score of the yoghurt produced. The values ranged from 4.55 ± 0.69 to 6.90 ± 0.72 for colour, 4.85 ± 0.37 to 6.95 ± 0.51 for creaminess, 4.60 ± 0.75 to 6.95 ± 0.39 for sweetness, 4.75 ± 0.55 to 7.00 ± 0.46 for flavour, 4.50 ± 0.51 to 6.75 ± 0.55 for smoothness, 4.70 ± 0.57 to 6.70 ± 0.66 for sourness, 5.00 ± 0.56 to 7.40 ± 0.60 for viscosity and 5.00 ± 0.32 to 7.05 ± 0.39 for overall acceptability. It was observed that from the samples produced, sample G has the least acceptable values while sample C had the highest acceptable values across the sensory scores.

The values obtained from the physicochemical analysis presented in Figure 1 showed that sample A had the highest pH value 4.97 ± 0.02 while sample F had the lowest pH value 3.67 ± 0.01. For TDS and acidity, the values ranged from 4.53 ± 0.01 to 6.72 ± 0.01 ppm and 0.62 ± 0.08 to 0.87 ± 0.06 respectively. Sample C was seen to have the highest TDS and sample F had the lowest TDS while sample D had the highest acidity and sample E had the lowest acidity.

Represented in Figure 2 is the microbial load of the yoghurt produced from the powdered milk and tiger nut milk. It was observed that none of the yoghurt samples had coliform on the medium after the incubation period. The total viable count ranged from 78.67 ± 11.02 to 227.33 ± 20.40 x 10^2 cfu/ml while that of the total mould count ranged from 16.67 ± 2.08 to 56.67 ± 10.02 x 10^2 sfu/ml. Among all the samples, sample F had the highest TVC while sample C had the least TVC count. Also in TMC, sample B had the least mould count while sample G had the highest mould count. All values showed statistically significant difference at 95% confidence interval.

4. Discussion

Several plant-based dairy products have a long tradition in both Eastern and Western cultures and available widely in the market [14]. Although some plant milk products contain low protein and calcium, plant milk substitutes are used to replace cow's milk in the diet because of low allergy and intolerance issues, lactose-free, cholesterol-free, and low-calorie [15]. This may lead to increased consumer awareness and subsequently a rise in purchase levels [16]. In addition, previous studies have reported a therapeutic relationship between vegetable milk and diseases such as cancer, atherosclerosis, and inflammatory diseases with a good source of antioxidants [15]. The fermentation of plant-based products is one of the most traditional methods for food preservation.

Non-conventional dairy substitutes of plant origin have been developed including tiger nut, soybean, almond, oat, coconut, rice, hemp, peanut, and cashew [17].

The sensory characteristics are depicted in Table 1. The result indicated that the addition of tiger nut to the milk sample impacted the colour. There is a regressive decrease in the colour of the yoghurt as the quantity of the tiger nut milk increases. This must have resulted from the colour intensity of the tiger nut milk from deep cream which diluted the whitish colour of the milk. Sample D (5.60 ± 0.60) was seen to be the least affected by the tiger nut milk when compared with the control sample whereas sample G (4.55 ± 0.69) was the most affected.

The addition of the tiger nut milk also showed a significant effect on the creaminess of the yoghurt. As the volume of the tiger nut milk in the yoghurt increased the creaminess reduced. Sample G (4.85 ± 0.37) also showed the lowest significant level of creaminess in the yoghurt produced. Although the addition of 20% tiger nut milk greatly increased the creaminess of the skimmed milk yoghurt (sample C) while that of the full cream milk yoghurt was reduced (sample D).

The incorporation of tiger nut milk is seen to significantly increase the sweetness of the skimmed milk yoghurt at a concentration which does not affect the ability of the microorganism to act on the lactose content present in milk. This must have resulted from the natural sugar present in tiger nut milk which must have enhanced the sweetness of the sample. A significant decrease was also observed in the full cream milk yoghurt. This could be responsible for the potential reduction in some of the nutritional compositions of the yoghurt. But as the volume of the tiger nut increased above the desired level the effect was obvious on the sample and the sweetness was reduced. Aside the addition of commercially available flavour, the introduction of the tiger nut milk also influenced the flavour of the skimmed milk yoghurt. When eaten, tiger nut has a natural sweetness in the mouth which was observed during the processing of the tiger nut milk. The study of Gambo and Da'u [18] revealed that tiger nut can also be used as an aroma in ice cream and cookies for its particular sweetness. There was no much significant difference observed in the smoothness of the yoghurt upon the addition of the tiger nut milk. At 30% addition of tiger nut milk to the skimmed milk and full cream milk yoghurt, no significant difference was observed in samples E and F. Although a noticeable effect was observed in samples C and D. Thus the incorporation of tiger nut milk in yoghurt production may likely not affect the smoothness and textural quality on the yoghurt if the tiger nut milk is well filtered to avoid the shaft being transferred into yoghurt.

Table 2 Mean values ± SD of the sensory scores of yoghurt produced from powdered milk and tiger nut milk

Samples	**Colour**	**Creaminess**	**Sweetness**	**Flavour**	**Smoothness**	**Sourness**	**Viscosity**	**Overall acceptability**
A	6.05 ± 0.83c	5.60 ± 0.75bc	5.60 ± 0.50cd	5.15 ± 0.49b	5.65 ± 0.49bc	5.30 ± 0.57b	5.70 ± 0.47b	5.85 ± 0.37cd
B	6.90 ± 0.72d	6.95 ± 0.51e	6.55 ± 0.60e	6.65 ± 0.49d	6.65 ± 0.59d	6.70 ± 0.66d	7.00 ± 0.56d	7.00 ± 0.32e
C	5.45 ± 0.51b	6.45 ± 0.69d	6.95 ± 0.39f	7.00 ± 0.46d	6.75 ± 0.55d	6.55 ± 0.60d	7.40 ± 0.60d	7.05 ± 0.39e
D	5.60 ± 0.60b	5.80 ± 0.77c	5.75 ± 0.72d	5.85 ± 0.67c	5.95 ± 0.60c	5.80 ± 0.70c	6.25 ± 0.72c	6.05 ± 0.60d
E	5.25 ± 0.79b	5.55 ± 0.60bc	5.05 ± 0.51b	5.25 ± 0.64b	5.40 ± 0.60b	5.40 ± 0.68bc	5.90 ± 0.79bc	5.50 ± 0.51b
F	5.45 ± 0.69b	5.25 ± 0.64b	5.30 ± 0.57bc	5.30 ± 0.73b	5.45 ± 0.68b	5.45 ± 0.83bc	5.75 ± 0.85b	5.70 ± 0.66bc
G	4.55 ± 0.69a	4.85 ± 0.37a	4.60 ± 0.75a	4.75 ± 0.55a	4.50 ± 0.51a	4.70 ± 0.57a	5.00 ± 0.56a	5.00 ± 0.32a

The level of sourness recorded in the yoghurt produced was greatly influenced by the addition of the tiger nut milk in both milk varieties. While there was a significant increase in the yoghurt produced from the skimmed milk sample C when compared with the control sample, alternatively, the sourness of the yoghurt produced from the full cream milk sample D reduced. It was observed that the longer incubation period also affected the end product of the yoghurt, thus a reduced incubation period is advised upon the addition of tiger nut milk.

Among all the sensory parameters considered, the effect of the tiger nut on the viscosity of the yoghurt was greatly enhanced on the skimmed milk yoghurt but not really on the full cream milk. Tiger nut is known to be rich in starch which is known to gelatinize on high heat treatment and this viscous nature could have resulted from the thickness of tiger nut milk during the pasteurization of the tiger nut milk. This might have in turn complemented the increased viscosity observed in sample C. When the volume of the tiger nut milk was increased, a resultant effect was observed in the yoghurt separating the whey from the curd and this diluted the milk samples and made it hard for the complete lactic acid fermentation to occur. Several factors could be the cause of this starting from the inadequate homogenization to the excessive dilution of the concentration of lactose present in the milk samples due the presence of starch in the tiger nut milk which made it difficult for the probiotics to fully exhibit their potential actions on the yoghurt.

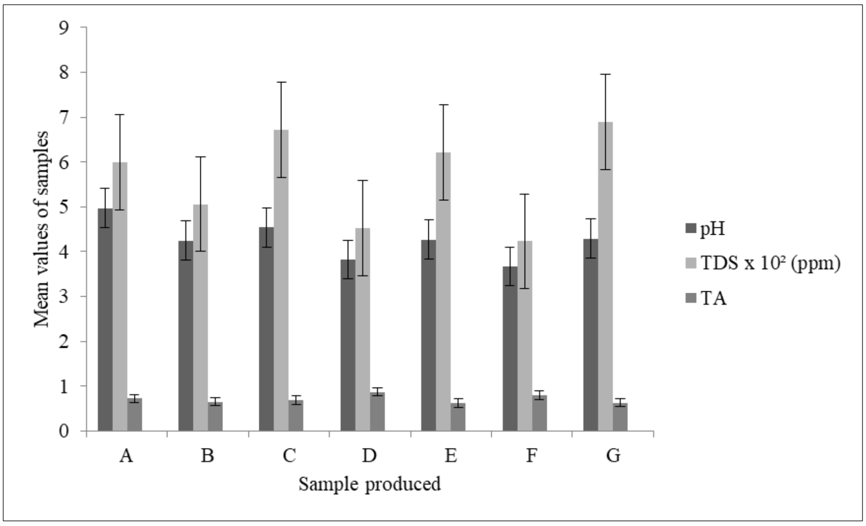

Figure 1 Mean score ± SE of the physicochemical values of the yoghurt sample produced

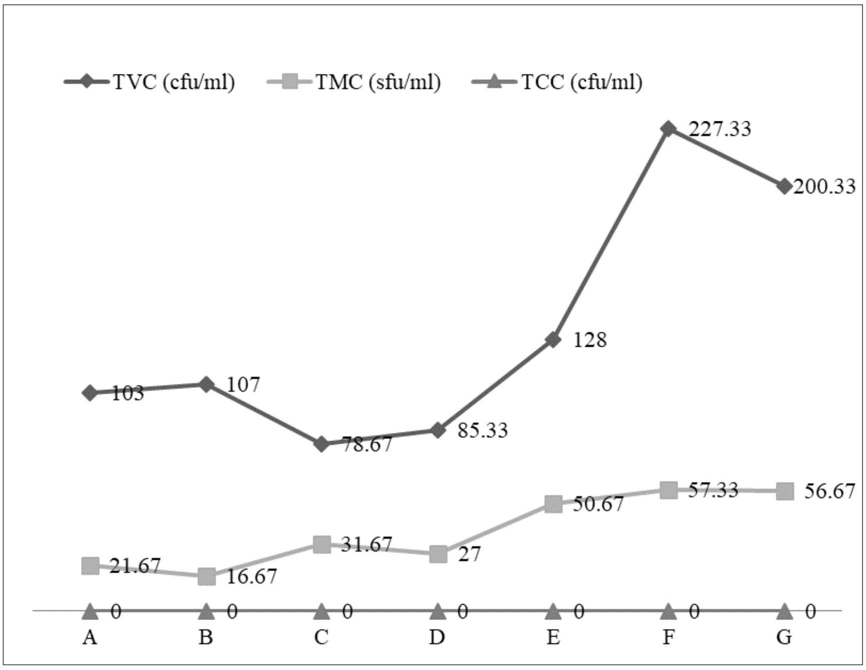

Figure 2 Mean values of the microbiological counts of different isolates from the yoghurt produced

Sample C was the most acceptable by the panelists while sample G was the least acceptable. The incorporation of tiger nut milk to the skimmed milk yoghurt provided a base substrate to improve some of the nutrients that must have lost or reduced during the processing of the skimmed milk sample. The addition of tiger nut milk to the full cream yoghurt may not have a general effect on all the sensory properties assessed but a significant effect was noticed in some of the parameters. The result of the sensory characteristics in this current research is in discordance with the result obtained by Onyimba et al. [19] where he reported that yoghurt produced from 100% tiger nut was generally acceptable while in the study of Ajibade et al. [20], yoghurt produce from 50% tiger nut and cow milk was found to be generally acceptable. In this research as against the studies of the previous authors, addition of more than 30% tiger nut could affect the sensory characteristics of the yoghurt due the inability of the probiotics to ferment the sugar present in the tiger nut milk.

The physicochemical parameters which identified the hydrogen ion concentration (pH), total dissolved solids (TDS) and titratable acidity (TA) are represented in Figure 1. The addition of the tiger nut milk reduced the pH value of the yoghurt thus increasing the acidity level of the yoghurt. Sample F (3.67 ± 0.01) had the lowest hydrogen ion concentration at 30% addition of tiger nut milk when compared with the control sample. The pH of the full cream yoghurt was the most affected by the increased concentration of the tiger nut milk. The lowest and highest pH values recorded in this research fell slightly outside the pH range (4.2 – 4.4) recorded by Makut et al. [21] but similar to the pH values (3.97 – 4.75) reported by Bristone et al. [22] for yoghurts produced from cow milk, tiger nut milk and soy bean milk.

The total dissolved solid which ranged from $4.23 \pm 0.01 \times 10^2$ to $6.72 \pm 0.01 \times 10^2$ ppm increased in the skimmed milk yoghurt when compared with the control sample while that of the full cream milk yoghurt was decreased. Obviously the addition of the tiger nut milk to the skimmed milk yoghurt increased the total dissolved solid present but the reason for the reduction observed in the full cream yoghurt could not be ascertained. The value recorded in the study was lower compared to the value recorded is the study of Salami et al. [23] where pretreated bambara groundnut was used in the production of the yoghurt.

The addition of the tiger nut milk to the yoghurt also enhanced the titratable acidity of the skimmed milk yoghurt while the effect was not greatly felt in the full cream milk yoghurt. A significant correlation was therefore observed between the pH and TA values of the yoghurt samples produced. This result agrees with the study conducted by Charles et al. [24] where a significant decrease was recorded in the pH of yoghurt while the TA also increased upon the addition of 20% soy-tiger nut milk to the yoghurt. It was opined that the decrease in pH and increase in titratable acidity is a notable characteristics of good yoghurt. As lactic acid in milk is produced, there is a corresponding drop in pH. Most producers have a set point between pH 4.0 and 4.6 in which fermentation is arrested by rapid cooling. The amount of lactic acid present at this pH level is ideal for a yogurt, giving it the characteristic tartness, aiding in thickening and acting as a preservative against undesirable strains of bacteria [25].

The microbial load of the yoghurt produced is depicted in Figure 2. This predicted the level of personal and equipment hygiene employed during the processing and production of the yoghurt. To a certain extent, the microbial load was found to be lower at a percentage low enough to cause a pathogenic effect in consuming the yoghurt. The total viable count (TVC) is a quantitative estimation of microorganisms mostly bacteria present in a sample. Among all the samples, sample C had the lowest TVC count when compared to the control sample while sample F had the highest value. The concentration of the tiger nut in sample F must have affected the microbial load of the sample.

The total mould count (TMC) is an indication of the presence of fungi in the yoghurt sample including the yeast and mould species. The increased concentration of the tiger nut milk increased the TMC values observed in the samples. Sample F recorded the highest TMC value while sample E recorded the least TMC values when compared with the control samples. To assure the health benefits of fermented plant-based milk products, probiotics should meet the minimum level requirement for probiotic bacteria between 106 and 107 cfu /ml until the expiry date [26].

The result in Figure 2 also revealed that there were no coliforms present in the yoghurt sample produced after the period of incubation. This result showed that the products were free of faecal contamination.

The TVC and TMC values which ranged between 78.65 ± 11.02 – 227.33 ± 20.40 cfu/ml and 16.67 ± 2.08 – 57.33 ± 4.51 at a dilution factor of 10^2 respectively was found to be higher than the results of Onyimba et al. [19] and Wakil et al. [27] but lower than the total microbial load reported by Bristone et al. [22] where the values reported range from 6.0 – 7.1 $\times 10^5$ cfu/ml for total bacterial plate count and 5.8 – 6.3 $\times 10^5$ cfu/ml for total fungal count for yoghurts produced from two different blends of tiger nut milk and cow milk.

Today, demand for probiotic plant-based milk products is growing due to consumer's awareness of potential health benefits since probiotics enhance the balance and structure of microbiota and the protection against pathogenic species [28]. The Food and Agriculture Organization and the World Health Organization define probiotics as "live microorganisms which when ingested in enough amounts improve the health of the host [26, 29]. Natural yoghurts are characterized by unique sensory properties. A slightly sour taste and a pleasant, gentle smell provide an excellent base for creating new dairy products and improving the existing ones. In recent years, health awareness has increased the consumer demand for natural, fermented milk products, as well as products fortified with plant additives, which are a valuable source of health-promoting ingredients. Due to their nutritional value and health benefits of tiger nut milk, the incorporation of tiger nut milk in the production of yoghurt could be a potential alternative.

5. Conclusion

The findings of the research revealed that the incorporation of tiger nut milk in the production of yoghurt could go a long way in enhancing the viscosity of the product. Also the addition of tiger nut milk was found to improve the quality of the product in terms of sensory attributes since the yoghurt containing tiger nut milk was found to meet the preference of the panelists. The physicochemical properties in term of hydrogen ion concentration (pH), total dissolved solids (TDS) and titratable acidity (TA) were also influenced thereby promoting the storage period of the product. The microbial load also revealed that the yoghurt produced was not contaminated by any organism of faecal origin and the level of hygiene could be acceptable. It is therefore necessary to ascertain that the addition tiger nut milk in the production of yoghurt will enhance the quality of the yoghurt and in turn give a desirable product.

Compliance with ethical standards

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Disclosure of conflict of interest

Regarding the publishing of this work, the authors affirm that there are no competing interests.

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