FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 5, October, 2023, pp 24 - 29
DOI: https://doi.org/10.33003/fjs-2023-0705-1992

QUALITY AND SUSTAINABILITY OF PRODUCTION OF YOHURT FROM SOYABEANS, TIGER NUT, AND DATE

Nakakana Hussaina, Sherifat Adeniran Misbah, Hassan Shehu Mohammed, *Abdullahi Haruna

Department of Biochemistry, Faculty of Life Sciences, Ahmadu Bello University, Zaria-Nigeria

*Corresponding authors' email: get2haruna@gmail.com

ABSTRACT

Yogurt, is also known as yoghurt, is one of the most known popularly fermented dairy products in the world, with a wide range of health benefits in addition to basic nutrition and was believed to have therapeutic powers and give long life to those who consumed it. This study aimed to evaluating the quality and suitability of production of yoghurt using blended tiger nut milk, soybeans milk and date milk. Proximate and microbial analysis was used to determine nutrient composition and quality of the produced yogurt. The study shows the mean scores ranges of proximate composition (moisture, ash, protein, fat, crude fibre and carbohydrate) of the formulated yoghurt: 75.83±1.44, 70.16±0.28, 81.00±1.73, 80.00±0.00, 0.61±0.02 – 0.76±0.02, 5.40±0.17 – 7.43±0.05, 5.33±0.03 – 6.40±0.00, 0.04±0.00 – 0.12±0.00. and for carbohydrate content, the mean score ranged from 4.27 ±1.81 – 17.16 ±0.54. The bacterial total plate count of the sample ranged from $1.6x10^2$ – $9.7x10^3$ cfu/ml. Sample A ($1.3x10^2$) had lowest growth while sample D ($9.7x10^3$) had highest growth. For appearance, the mean score ranged from 6.00±2.22 – 8.25±0.63, also for aroma, the mean score ranged from 6.45±2.41 – 7.50±0.94 and for overall acceptability, the mean score ranged from 6.40±2.37 – 8.00±0.64. This study revealed that soy milk, tiger nut milk and date palm juice produced can be effectively used for acceptable yogurt formulations..

Keywords: proximate, microbial, quality, sustainability, acceptability, sensory

INTRODUCTION

Yoghurt is a fermented milk product that evolved empirically some centuries ago by allowing naturally contaminated milk to sour at a warm temperature probably in the temperature range of 40 - 50℃ (Ihekoronye and Ngoddy, 1985). It is usually produced from whole or partially skimmed cow's (El – Batawy *et al.,* 2014). There have been a lot of improvements in the industry where starter cultures are used to ferment the milk for a specific period and desired flavours are achieved. As population keep on growing in Nigeria and there is migration of people from rural to urban areas, there is high demand of milk which the indigenous breed could not met the demand of the teaming population. There is no adequate improved breed that could burst milk production, it is largely affected by a numbers of factors such as genetics make up in term of use of improve breeds selected for milk production, a favourable nutritional environment, and improved managerial practices (Sammy et al., 2012); as such it's increases the unit price of milk resulting in increase in the cost of production which could affect the profit margin (USDA, 2017). However this as to do with the prices for milk and dairy products which are volatile and change on a weekly and monthly basis based on a number of supply and demand factors as well as government policies. Milk prices at the farm level are determined fundamentally by wholesale commodity prices for cheese, butter, nonfat dry milk, and dry whey. Wholesale prices for cheese, butter, and most dried dairy products are determined by market supply and demand factors. Wholesale prices rise when supply is short relative to demand. On the other hand, prices fall when supply grows and/or demand falls. That said, it is not always immediately clear why wholesale dairy products rise and fall in a given weekly or monthly. The prices processors charge retailers and the retail prices of milk and dairy products, generally face very little government regulation, Thus, the market place sets the so called farm-to-retail price margin. For some dairy commodities, the farm price drives the retail price (e.g., butter and fluid milk) (USDA, 2017).

Most of the animal milk used by our industry in Nigeria is dry skim milk which is mostly imported which drains our foreign exchange earnings. Alternatives for cow milk were explored by most industry produce cheap and available milk and milk like products to the teeming population. The use of extracted milk from plant sources (imitation milk) to produce yoghurt as an alternative to animal milk with certain quality attribute (taste, flavour, texture, shelf life, stability), healthy benefit and variety in diet have been study (Farinde *et al.*, 2008, Bamishaiye *et al.*, 2011). In general, yogurt is a nutrient-dense food because of its nutritional profile, and it is a high-calcium source that supplies considerable amounts of calcium in bio-available form and was believed to have therapeutic powers and give long life to those who consumed it (FSF, 2020).

Studies have been carried out in an effort to improve the nutritional quality and need of consumers (Amanze and Amanze, 2011). In such case, protein from other rich plant sources is used to improve other deficient diet for nutritional and economic reasons. Yoghurt from imitation milk extracted from soybeans, tigernut and milk extract from other plant sources recorded only few successes. Even when a good imitation milk is produced from these sources, it has never yielded desired good quantity yoghurts and even if a good one is produced, it has to carry a lot food additives such as preservatives, flavours, colours, and thickeners (Chap et al., 2019). Which is not the same as yoghourt from cow's milk. The need to add cow's milk to imitation milk to incorporate the flavour characteristics of yghourt from cow's milk cannot be over emphasized (Amanze and Amanze, 2011).

Soybean is another locally available material that can be used as alternative to cow milk in the production of yoghurt. It is a member of the Leguminosae family, the Papilionoideae subfamily, and the genus Glycine, L. Soybean (Glycine max), a plant protein which is cheaper and could also serve as an alternative to cow milk (Amin et al., 2015). Consumption of fermented soymilk improves the intestinal ecosystem by increasing the number of probiotics. Soybean protein content is approximately twice that of other pulses, four times that of wheat, six times that of rice grain, and four times that of egg (Joel et al., 2011). Soybean contains 3% lecithin, which is beneficial to brain development (Kim, 2021). It also contains calcium, phosphorus, and vitamins A, B, C, and D (Barbara et al., 2022).

Tiger nut (Cyperus esculentum) is a perennial plant abundantly cultivated in Nigeria (Oke, 2019). Tiger nut is Akiausa in Igbo, Ofio in Yoruba and Aya in Hausa. The tubers are about the size of peanuts and are available in Nigeria as fresh, semi-dried, and dried forms in the markets where they are sold locally. Milk extracted from tiger nut, apart from being nutritious (Oke, 2019), has been recommended for persons that do not tolerate gluten or are allergic to cow milk and its derivatives (Belewu and Abodurin, 2006). The abundant availability of tiger nuts in Nigeria and the unique qualities of tiger nut milk necessitates further exploration of the milk as a potential resource for cheaper production of yoghurt of acceptable quality.

Dates are consumed fresh or in the dried form. Besides being a rich source of carbohydrates, dietary fibers, some essential vitamins, and minerals, and a variety of phytochemicals, e.g., phenolics, carotenoids, anthocyanins, and flavonoids. Even date pits are an excellent source of dietary fiber, minerals, lipids, and protein. In addition to their pharmacological properties, phytochemicals also contribute to nutritional and sensorial properties of dates. In date producing countries, this fruit has been used for centuries to treat a variety of ailments in the various traditional systems of medicine. In recent years, research to assess the health benefits of dates has interfiled and a number of studies have reported on the positive contribution dates to human health (Jasim et al., 2014).

A study revealed that over the years that yoghurt is being produced from milk gotten from diary product (Kim, 2021). However, milk is expensive that is not easily affordable and fat from animal are more highly saturated which can raise level of the total blood cholesterol; lipoprotein is associated with an increased risk of developing cardiovascular disease. It was also reported that, production of yoghurt from mixtures of cow milk extract from tigernut is under reported in its environment (Amanze and Amanze, 2011). Food based approaches have been recognized as the principal way of combating these nutritional problems although some other forms of intervention could serve as a complement. Adequate processing and judicious blending of locally available foods could result in improved intake of nutrients to prevent malnutrition problems. Therefore, there is need to produce yoghurt from milk extracts of soybeans, tigernut, and date compared with that of cow milk.

MATERIALS AND METHODS

Materials

The materials used for the production of yoghurt include: Tiger nut, soybeans, date, MacConkey agar/nutrient agar, Potato dextrose agar, 10% tartaric acid, sterilized ringer's solution. Ringer's solution, plate count agar, measuring cylinder and weighing balance, atomic absorption spectrophotometer (AAS) and starter culture.

Methodology

Sample preparation (Soyabean)

Wet extraction of milk from soybean: whole soybeans was first sorted and washed to remove contaminant. It was soaked in clean water for overnight and were dehulled in between two palms. This was further washed and drained repeatedly until the seed coats were removed. The wet soybean bran was milled with milling machine and mixed in clean water and was strained through mushin cloth to obtain the soymilk (Bamishaiye and Bamishaiye, 2011)

Preparation of Samples (Tiger nut)

Wet extraction of milk from tiger nut: Whole tiger nuts were also sorted and wash to remove contaminants. It was soaked in clean water overnight. The wet tiger nuts were drained and wet mill with milling machine and then strained through muslin cloth to obtain the tiger nut milk (Bamishaiye and Bamishaiye, 2011).

Sample Preparation (Date Juice)

The whole of the fruit flesh was obtained by splitting the fruit open to remove the seed. The date flesh was soaked for 2hours and then blended with small water to a fine juice (Bamishaiye and Bamishaiye, 2011).

Sample Formulation

Table 1: Blend formulation of Soyabeans, Tiger nut, and Date

Materials	A(%)	B(%)	C(%)	D(%)
Soybean	30	30	40	-
Tiger nut	40	50	40	-
Date	20	20	20	-
Control	-	-	-	100

Proximate Analysis

The samples were evaluated for proximate analysis. It was analysed for moisture content, fat, crude protein, crude fibre, ash, carbohydrate and energy content as describe in the method of (AOAC, 1990).

Microbiological Analysis

Preparation of sample

Well mixed samples of 10 mls was measured and poured into a sterilized blended jar and 90 mls of sterilized ringer's solution was added. It was blended at a speed of 1500-2000 rpm for not more than 2.5 minutes.

Dilution: The sample was mixed by shaking and 1.0 ml was pipette into a tube containing 9 ml of the sterilized ringer's solution. The sample was mixed with a pipette carefully by aspirating 10 times. The sample (2 ml) was transferred from the first dilution with the same pipette to the second dilution tube containing 9 ml of the sterilized ringer's solution. The sample was mixed and repeated using a third and fourth tube, all dilutions was shaken carefully.

Pour plating

Plate count agar (PCA), eosin methylene blue agar (EMBA), potato dextrose agar (PDA) (15 ml) was poured into the petri-dish each. (kept at 45ºc + 1ºc in a water bath) within 15 minutes of the time of original dilution and 14 ml, 10% tartaric acid was added to potato dextrose agar (PDA) before pouring to inhibit/ destroy microbes present in the medium. The sample dilution and agar medium was mixed thoroughly and uniformly and allowed to solidify.

Preparation of formulated yogurt blended from tigernut milk, soymilk and date juice homogenate
The sample (10 mls) which is well mixed was weighed into a sterilized blended jar and 90 mls of sterilized ringer's solution was added. It was blended at a speed of 1500-2000 rpm for 2 minutes in a blender for 20 minutes.

Dilution
The sample homogenate was mixed by shaking and 1.0 ml was pipette into a tube containing 9 mls of the sterilized ringer's solution. The pipette was used to mixed the sample carefully by aspirating it 10 times. 1 ml was transferred from the first dilution with the same pipette to the 2nd dilution tube containing 9 mls of the sterilized ringer's solution, it was mixed with a pipette and repeated using the 3rd-4th tube or more until the required number of dilution is made, all dilutions were shaken carefully. The sample (1 ml) homogenate was pipette and each dilution of the homogenate was transferred into each of the appropriately marked duplicate dishes. Plate count agar, eosin methylene blue agar, potato dextrose agar (15 ml) was poured into a petri dish each (kept at 45ºC + 10ºC in a water bath) within 15 minutes of the time of original dilution. The sample dilution was smeared in the agar medium thoroughly and uniformly and was allowed to solidify.

Counting of Colonies
Count all colonies that have greenish metallic sheen, dark or even black centre in transmitted light and those that appear grey-brown centre without metallic sheen in the transmitted light. If no MacConkey agar count colonies that appear large, rod, surrounded by turbid zone and large, pink mucoid colonies

Preparation of sample homogenate
A well-mixed sample (10 mls) was weighed ascetically into a sterilized blended jar and 90 mls of sterilized ringer's solution was added.

Dilution
The food homogenate was mixed by shaking and 1.0 ml pipette into a tube containing 9 mls of the ringer's solution. It was mixed with a pipette carefully by aspirating 10 times. A dilution of the sample (1 ml) was transferred with the same pipette into the 2nd sample containing 9 ml of the sterilized ringer's solution. It was then mixed with a pipette and then repeated using a 3rd-4th tube, dilution was shaken carefully.

Pour plating
Tartaric acid (14 ml) of 10% was added into 1-liter potato dextrose agar (PDA) and kept at 44-45ºc, just before pouring 15 ml amounts into plates containing 1 ml serial diluted samples approximately. The dishes were gently rubbed clockwise and anti-clockwise to thoroughly mix the sample agar and was allowed to set and solidify.

Counting of colonies
All colonies that have greenish metallic sheen, dark or even black centre in transmitted light were counted. If no MacConkey agar count colonies that appear large, rod surrounded by turbid and large, pink mucoid colonies

Sensory Evaluation
Sensory evaluation of the sample was carried out for consumer acceptance using 20 untrained judges at random selection with a 9-point hedonic scale according to Larmond (1997). The panelists were given samples to assess the quality attributes in terms of colour, taste, texture, flavor and overall acceptability.

Statistical Analysis
All values were expressed as mean +SD. Data was subjected to analysis of variance (ANOVA) and Duncan's new multiple range test was used to assess the significance difference among mean (<0.05).

Proximate Composition of Yoghurt from Blended Soymilk, Tiger nut Milk and Date Palm Juice
The Proximate Composition of yoghurt from blended soymilk, tiger nut milk and date palm juice were determined and presented in ± standard deviation as shown in the table 1.

Table 1: Proximate Composition of yoghurt from blended soymilk, tiger nut milk and date palm juice

SAMPLES	MOISTURE	ASH	PROTEIN	FAT	C/FIBRE	CARBOHYDRATES
A	75.83 ± 1.44^{b}	0.71 ± 0.02^{bc}	7.00 ± 0.03^{c}	5.66 ± 0.23^{b}	0.09 ± 0.00^{c}	10.71 ± 1.69^{b}
B	70.16 ± 0.28^{a}	0.66 ± 0.00^{b}	6.30 ± 0.17^{b}	5.63 ± 0.0^{ab}	0.07 ± 0.00^{b}	17.16 ± 0.54^{c}
C	81.00 ± 1.73^{c}	0.76 ± 0.02^{c}	7.43 ± 0.05^{d}	6.40 ± 0.00^{a}	0.12 ± 0.00^{d}	4.27 ± 1.81^{a}
D	80.00 ± 0.00^{c}	0.61 ± 0.02^{a}	5.40 ± 0.17^{a}	5.33 ± 0.05^{a}	0.04 ± 0.00^{a}	8.60 ± 0.26^{b}

Mean of samples in the same column with same superscripts are not significantly (p>0.05) different.
Key Word:
Sample A: 50% Soybeans, 30% tiger nut, 20% date palm
Sample B: 30% Soybeans, 50% tiger nut, 20% date palm
Sample C: 40% Soybeans, 40% tiger nut, 20% date palm
Sample D: control (diary yogurt)

Table 2: Microbial analysis of yoghurt from blended soymilk, tiger nut milk and date palm juice

SAMPLE	COLONIES COUNTED	CFU/ML	GRAM STAINING	ORGANISM ISOLATED
A	$16x10^{-1}$	$1.6x10^{-2}$	Gram +ve shining light yellow	Bacillus species
B	$42x10^{-1}$	$4.2x10^{-2}$	Gram +ve white shining	Staphylococci species
C	$94x10^{-1}$	$9.4x10^{-2}$	Gram +ve white shining	Staphylococci species
D	$97x10^{-1}$	$9.7x10^{-3}$	Gram +ve white shining	Staphylococci species

Table 3: Coliform count

SAMPLE	COLONIES COUNTED	CFU/ML	GRAM STAINING	ORGANISM ISOLATED
A	Nil	Nil	Nil	Nil
B	Nil	Nil	Nil	Nil
C	Nil	Nil	Nil	Nil
D	Nil	Nil	Nil	Nil

Table 4: Yeasts and Mould count of yoghurt from blended soymilk, tiger nut milk and date palm juice

SAMPLE	COLONIES COUNTED	CFU/ML	GRAM STAINING	SPECIES ISOLATED
A	$19x10^{-1}$	$1.9x10^{-2}$	Gram +ve fibric white	Mould species
B	$27x10^{-1}$	$2.7x10^{-2}$	Gram +ve fibric white	Mould species
C	$55x10^{-1}$	$5.5x10^{-2}$	Gram +ve fibric white	Mould species
D	$79x10^{-1}$	$7.9x10^{-3}$	Gram +ve fibric white	Mould species

Table 5: Sensory Evaluation of yoghurt from blended soymilk, tiger nut milk and date palm juice

Sample	TASTE	TEXTURE	FLAVOUR	APPEARANCE	OVERALL ACCEPTABILITY
A	8.10 ± 0.64^{a}	7.65 ± 0.81^{a}	8.00 ± 0.86^{ab}	8.15 ± 0.75^{a}	8.45 ± 0.69^{b}
B	8.20 ± 0.77^{a}	7.95 ± 0.89^{a}	8.35 ± 0.59^{b}	7.90 ± 0.97^{a}	8.40 ± 0.75^{b}
C	7.65 ± 0.81^{a}	7.95 ± 0.76^{a}	7.55 ± 0.94^{a}	7.80 ± 0.89^{a}	8.05 ± 0.76^{ab}
D (Control)	7.90 ± 0.64^{a}	7.85 ± 0.75^{a}	7.65 ± 0.67^{a}	7.85 ± 0.81^{a}	7.75 ± 0.64^{a}

Mean of samples with the same superscript in the same column do not differ significantly (P<0.05).

Key Word:

Sample A: 50% Soybeans, 30% tiger nut, 20% date palm
Sample B: 30% Soybeans, 50% tiger nut, 20% date palm
Sample C: 40% Soybeans, 40% tiger nut, 20% date palm

RESULTS AND DISCUSSION

The findings of the proximate composition of the yoghurt samples in this study revealed that the range of the moisture content ranges between 70.16±0.28 and 81.00±1.73. The sample with the lowest moisture content was sample B (30% Soybeans, 50% tiger nut, 20% date palm), while the highest was sample C (40% Soybeans, 40% tiger nut, 20% date palm). The result clearly indicates that yoghurt from sample B (30% Soybeans, 50% tiger nut, 20% date palm) will have superior solidity (in terms of firmness) since it had the lowest moisture content. Food quality, preservation, and resistance to degradation are the primary concerns associated with the moisture content of food (Nielsen, 2010). The texture of the yoghurt is significantly influenced by this key factor (moisture). For instance, if the moisture content is low, the yoghurt's firmness will increase. This agreed with the study done by (Igbabul et al., 2014), who revealed that the moisture content of yoghurt ranged between 78.62 to 82.41%, suggesting that the moisture content of all plant-based yoghurts was on the normal level. According to (Matela et al., 2019), yoghurt's moisture level should be less than 84%, as higher moisture contents impair the texture and mouth feel. The entire amounts of minerals, including sodium, potassium, magnesium, calcium, zinc and iron, are represented by the ash content (Lakshmipathy and Sarada, 2013). The ash content of all the samples from this work ranged from 0.61 – 0.76, with sample C (40% Soybeans, 40% tiger nut, 20% date palm) having the highest value, suggesting that this sample may contain more minerals than other samples. The lowest value was sample D (control). The ash content of the formulated yoghurt was lower than the ash content of 1.5% as reported by (Ukwuru et al., 2011). Ash indicates the measure of minerals in a food commodity. The variation in ash content may be due to variation in inorganic compounds especially calcium and iron present in milk extracted from soybeans. With regard to crude protein content in this research, the values were significantly (p>0.05) different from each other, highlighting the nutritional value of plant-based milk. Yoghurt formulation from 40% Soybeans, 40% tiger nut, 20% date palm sample had the highest crude protein content whereas sample D (control) had the lowest (5.40) value. The protein content of the formulated yoghurt was higher than the protein content of 2.45 – 3.64% reported by (Awonorin and Udeozor 2014) in a study "Chemical Properties of Tiger nut – Soy milk Extract". The result also was higher than the report of (Belewu et al., 2005; Belewu et al., 2010).

The fat content of the formulated samples and control ranged from 5.33 – 6.40%. The fat contents of the formulated samples in this work were higher than the 1.88 – 4.00% fat content reported by (Olugbuyiro and Oseh 2011) for some market yoghurt in Nigeria, but were within the fat content range of 5.1 – 9.7% reported by (Ajibade et al., (2015) for yoghurt produced from tiger nut alone and those produced from combinations of tiger nut milk with either cow milk, soy bean milk, or coconut milk. The fat content of the formulated samples were higher than the control. All the formulated fat content of the samples including the control were within the FAO standard as reported by (Omola et al., 2014). In the FAO standard, yoghurts with fat content of 3.0% are said to be the best. In terms of fat content, yoghurts can be placed into three categories. Yoghurts with less than 0.5% fat content are to be labeled 'non-fat yoghurt', those with fat content of 0.5 – 3.25% are termed 'high fat yoghurts' (USDA, 2001 as cited by Olugbuyiro and Oseh, 2011). The formulated yoghurts in this study fall within the category of high fat yoghurts. The crude fibre content obtained from this study ranged from 0.04 – 0.12. Sample C (40% Soybeans, 40% tiger nut, 20% date palm) had the highest crude fibre content. Processing, however could have affected the crude fibre content of all samples as they were very low. Although, the increase in the crude fibre content of sample C (100% coconut milk) could be due to the high fibre content present in coconut. The carbohydrate content ranged from 4.27 – 17.16%. Sample C (40% Soybeans, 40% tiger nut, 20% date palm) had the least (4.27%) carbohydrate while sample B (30% Soybeans, 50% tiger nut, 20% date palm) had the highest (17.16%) carbohydrate. The carbohydrate of sample C (40% Soybeans, 40% tiger nut, 20% date palm) and sample D (control) were within the range of 3.77 – 9.27 reported by (Bristone et al., 2015), However, according to a report from United State Department of Agriculture, yoghurt should contain carbohydrate content of 13.7 to 17.7% (USDA, 2001). This implies that only yoghurt formulation from (30% Soybeans, 50% tiger nut, 20% date palm) sample B with the carbohydrate content of 17.16% is in good agreement with this standard (USDA, 2001).

The microbial examination was to evaluate the finished product for the survival of starter organism and the presence of undesirable spoilage organisms. The microbial analyses of the formulated samples including the control in this study are shown on table 2. Result of the total plate count in this study ranged from 1.6×10^2 to 9.7×10^3 CFU/ml and for mould and yeast count, it ranged from 1.9×10^2 to 7.9×10^3CFU/ml. The sample D (control) from cow milk had the highest number of count both total count, mould and yeast count. Probably, cow milk is a good medium for microbial growth. The yoghurt formulation sample A (50% Soybeans, 30% tiger nut, 20% date palm) had the lowest total plate count, mould and yeast count. The lower microbial count observed in this study was probably due to proper handling and maintenance of good sanitary standards at all stages of the yoghurt production process, differences in fermentation time, and type of starter used. The highest count obtained from sample D (control) produced from cow milk indicated high rate of microbial activity or fermentation. The total plate count, mould and yeast count of the yoghurt produced in this study were within the acceptable safety limit ($<10^5$ and $<10^5$cfu/ml for total plate count, mould and yeast count respectively) specified by the International Commission on Microbiological Specifications for Foods (ICMSF, 1986). There were no microbial growths on the coliform count. The absence of coliform is an indication that all the samples observed were free from fecal contamination. Absence of coliform counts observed in the study showed that the yoghurt samples are of acceptable microbial quality.

Sensory evaluation of the yoghurts produced indicated that there were significant ($p<0.05$) difference in the acceptability ratings for appearance, aroma, taste, thickness and overall acceptability. Sample D (control) yoghurt was the most preferred yoghurt in terms of appearance, taste, overall acceptability and in conjunction with sample A in terms of thickness, had somewhat different findings (Akoma et al., 2000). The authors reported that yoghurt produced from tiger nut milk alone had higher appearance and taste acceptability over yoghurt produced from tiger nut + cow milk (3:2 w/v) composite. Sample C (40% Soybeans, 40% tiger nut, 20% date palm) was the most preferred yoghurt in terms of aroma acceptability. Observed differences in aroma score acceptability score were statistically ($p<0.05$) significant which implies that yoghurt aroma contribute significantly to the panelists' preference to the yoghurt produced. The finding on aroma in this study is in contrast with that of (Akoma et al., 2000) who reported non-significant differences in the aroma of yoghurt produced from cow milk, tiger nut milk, coconut milk and their composites. Sample A (50% Soybeans, 30% tiger nut, 20% date palm) and sample D (control) were the most preferred in terms of thickness acceptability. in contrast to this finding, (Akoma et al., 2000, Ajibade et al., 2015), in similar studies, reported that thickness had no significant effects on the preferences of panelists for different yoghurt products.

In terms of overall acceptability, sample D (control) was most preferred by the panelists, followed by sample C (40% Soybeans, 40% tiger nut, 20% date palm). This finding is in contrast with that of (Ajibade et al., 2015) who evaluated the nutritional qualities of yoghurt prepared from different plant milk sources. The authors reported that yoghurt produced from 50% cow – 50% soybeans composite milk had the highest overall acceptability over 100% cow milk yoghurt (diary). The result for overall acceptability in this study may be explained by the fact that people (panelists) are accustomed to the quality characteristics of commercially available yoghurts, which are typically made from 100% cow-milk. Throughout the sensory evaluation, it was found that the yoghurt formulations made from 40% Soybeans, 40% tiger nut, 20% date palm (sample C) and 50% Soybeans, 30% tiger nut, 20% date palm (sample A) scored significantly closer to the control formulation 100% cow milk (sample D) than 30% Soybeans, 50% tiger nut, 20% date palm (sample B), indicating that these two samples (A and C) may produce a plant-based yoghurt that can compete favourably with the diary yoghurt which is in similar with a study conducted by Henry-Unaeze, and Ezeugwu, (2022).

CONCLUSION

The study shown that yoghurt formulations from mixtures of soybeans milk, tiger nut milk and date palm juice have nutritional qualities similar to yogurt made entirely from cow milk and had the lowest microbial load and were within the acceptable safety ($<10^5$ and 10^5 cfu/ml for total plate count, yeast and mould respectively). This study has shown that soy milk, tiger nut milk and date palm juice produced can be effectively used for acceptable yogurt formulations.

REFERENCES

Amanze, K. O. Amanze, J. O. "Quality evaluation of yoghurt from cowmilk, soymilk and cow/soymilk", Jorind. 9(2): 44-47. 2011

AOAC. "Association of official Analyticalchemist, official method of analysis", 14 edition, the Washington D.C.35, 1990

Amin, O. I. Florence, J. Maina, Afodia, L. Kassum, Gervase, I. Agbara, Elizabeth, C. Chibuzo, Mamudu, H. Badau. Evaluation and acceptability of yoghurt "drinkprocessed from goat milk and a combination of goatand cow milks", International Journal of Biotechnology and Food ScienceVol. 3(4), pp. 41-48, July 2015ISSN: 2384-7344Research Paper, 2015

Ajibade, D. Olusegun, F. Ogunde, J. "An evaluation of the nutritional qualities of yoghurts prepared from different plant milk sources", African Journal of Agriculture and food Security, 3(5), 143-144, 2015

Akoma, O. Elekwa, U. O. Afodunrinbi, A. T. Onyeukwu, G. C. "Yoghourt from coconut and tiger nut", The Journal of Food Technology in Africa, 5: 132-134, 2000

Awonorin, S. O. Udeozor, L. O. "Chemical Properties of Tiger nut-Soy Milk Extract", IOSR Journal of Environmental Science, Toxicology and Food Technology 2014/01/01; DO I - 10.9790/2402-08318798, 2014

Belewu, M. A. Abodunrin, O. A. "Preparation of kunnu from unexploited rich food source: Tigernut (Cyperus esculentus)", World. Journal of Diary and Food Sciences, 1, 19-21, 2005

Belewu, M. A. Belewu, K. Y. "Comparative physicochemical evaluation of tiger nut, soybean and coconut milk sources", International Journal of Agriculture Biology, 9, 785-787, 2010

Bristone, C. Badau, M. H. Igwebuike, J. U. Igwegbe, A. O. "Production and evaluation of yoghurt from mixtures of cow milk, milk extract from soybean and tiger nut", World Journal of Dairy and Food Sciences, 10 (2), 159-169, 2015

Belewu, M. A. Abodunrin, O. A. "Preparation of kunnu from unexploited rich food source: Tigernut (Cyperus esculentus)", World Journal of Diary and Food Sciences, 1, 19-21, 2006

Barbara, W. René, B. Lotti, E. Reto, P. Sébastien, D. Max, H. Katrin, K. Peter, R., Otmar, Z. Rosmarie, V. Serge; R. "Comparison of nutritional composition between plant-based drinks and cow's milk" Original Research Article. Front. Nutrition., 28 October 2022. Secondary Food Chemistry. Volume 9 - 2022 | https://doi.org/10.3389/fnut.2022.988707, 2022

Bamishaiye, E. I. Bamishaiye, O. M. "Tiger nut: as a plant, its Derivatives and benefits", African Journal of Food, Agriculture, Nutrition and Development, 11: 5157-5169, 2011

Chap, T. Y. Morya, A. U. Sonia, A. U. Sharma, P. Y. Ankit. "Food Additives and Preservatives", 2019/12/30; SP - 263: EP - 274. SN - 978-93-5274-629-3, 2019

El-Batawy,O.I. Ashous,I.S.Mehanna,N.S. " Impact of mango and pomegranate peelssupplementation on quality characteristics of yoghourt with or without whey powder". WorldJournal of Dairy and Food Sciences, 9(1): 57-65, 2014

Farinde,E.O. Obatolu,V. A. Fasoyiro, S. B. Adeniran, A. H. Agboola, E. R. "Use of alternative raw materials for yoghourt production", African Journal of Biotechnology, 7(18): 3339-3345.4, 2008

FSF. "Fact sheet foods. Vol. 1; The following resources are also helpful": www.scherjon.eu/dairy-equipment/yogurt-productio n/ www.tessadm.com/. (2020).

Ihekoronye, A. I. Ngoddy, P. O. "Integrated Food Science and Technology for Tropics. Macmillan Education Limited", London and Oxford, page: 106-112, 189-190, 343-351 , 1985

Igbabul, B. D. Bello, F. Ekeh, C. N. "Proximate composition and functional properties of wheat, sweet potato and hamburger bean flour blends", Global Advance and Research Journal of Food Science Technology;3(4):118-124, 2014

(ICMSF. "International Commission on Microbiological Specifications for Foods", 1986

Joel , N. Abdulraheem, L. O. Zakari, U. M. "Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends", African Journal of Food Science Vol. 5(8), pp. 466 - 472, August 2011 Available online http://www.academicjournals.org/ajfs ISSN 1996-0794 ©2011 Academic Journals, 2011

Jasim, A. Fahad, M. AL-Jasass, Muhammed, s. "Date fruit composition and nutrition", March 2014. In book: Dates: Postharvest Science, Processing Technology and Health Benefits (pp.261-284). Edition: 1st. DOI:10.1002/9781118292419, 2014

Kim, I. S. Cheorl-Ho, K. Woong-Suk, Y. "Physiologically Active Molecules and Functional Properties of Soybeans in Human Health", A Current Perspective. International journal of molecular science. 2021 Apr; 22(8): 4054.Published online 2021 Apr 14. doi:10.3390/ijms22084054, 2021

Lakshmipathy, R. Sarada, N. C. "Application of water melon rind as sorbent for removal of nickel and cobalt from aqueous solution", International Journal of Mineral Processing 122: 63–65, 2013

Matela, K. S. Pillai, M. K. Ranthimo, P. M. Ntakatsane, M. "Analysis of proximate compositions and physiochemical properties of some yoghurt samples from Maseru, Lesotho", Journal of Food Science and Nutrition Research, 2(3), 245-252, 2019

Nielsen. "Food Analysis", 4th Edition, Food Science Text Series, Springer, USA, 602. http://dx.doi.org/10.1007/978-1-4419-1478-1, 2010

Oke, E. K. Tijani, A. O. Abamba, R. N. Odumosu, B. O. Abiola, O. T. "Tigernut and its food application", A Review. Researcher, 11(1), 3-78, 2019

Olugbuyiro, J. A.Oseh, J. E. "Physico-chemical and sensory evaluation of market yoghurt in Nigeria", Pakistan Journal of Nutrition, 10(10), 914-918, 2011

Omola, E. M. Kawo, A. H. Shamsudden, U. "Physicochemical, sensory and microbiological qualities of yoghurt brands", European Journal of Biology and Biotechnology www.ejbio.org, 2014

Sammy, K. Kiplagat, Moses, K. Limo, Isaac, S. "Genetic Improvement of Livestock for Milk Production", Submitted: DOI: 10.5772/50761. March 2nd, 2011 Published: September 26th, 2012

Ukwuru, M. U. Ibeneme, C. L. Agbo, G. I. "New product development from tiger nut (Cyperus esculentus) and their sensory, proximate and microbiological evaluation", Pakistan Journal of Nutrition, 10: 101-105, 2011

USDA. "Dairy Risk-Management Education", Factors That Affect U.S. Farm-Gate Milk Prices. September 29, 2017