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Production and Evaluation of Yoghurt from Mixtures of Cow Milk, Milk Extract from Soybean and Tiger Nut

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Abstract: The proportions of cow milk, milk extracts from soybean and tiger nut were varied resulting in producing eight formulations. Yoghourt was produced from eight formulations and their physicochemical properties, sensory evaluation and microbial counts were determined. The fat, protein, ash and carbohydrate contents of yoghourt ranged from 1.15 – 3.26%, 2. 14 – 3.56%, 0.22 – 0.68% and 3.77 – 9.27%, respectively. Cow – Soy (50:50) yoghourt had the highest ($P<0.05$) fat content, whereas the highest ($P<0.05$) protein content were recorded by Cow – Soy (50:50), Cow milk (100%) and Cow – Soy (20:80) yoghourts. Consistency of cow milk (100%) yoghourt was most preferred ($P<0.05$). Flavour of Cow – soy (50:50), cow milk (100%) and cow – tiger (50:50) yoghourts were Preferred ($P<0.05$). Colour and texture of cow – soy (50:50) and cow milk (100%) yoghourts were significantly preferred ($P<0.05$). Generally, yoghourts from cow milk (100%) and cow – soy (50:50) were most accepted ($P<0.05$). Total bacterial plate count of yoghurt formulations ranged from 1.3×10^5 - 10.5×10^5 CFU/ml and mould plate count from 2.4×10^5 - 8.7×10^5 CFU/ml. pH of yoghurt formulations ranged from 3.97 - 4.75, whereas titratable acidity ranged from 0.09 - 1.13%. Therefore, yoghourt can be produced by partial substitution of cow milk with either soymilk or tiger nut.

Key words: Imitation milk · Starter culture · Sensory attributes · Titratable acidity · Flour

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°C [1]. It is usually produced from whole or partially skimmed cow's or buffalo's milk [2]. 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 cities, there is high demand of milk which the indigenous breed could not meet the demand of the teaming population. There is no adequate improved breed that could burst milk production; as such this increases the unit price of milk resulting in increase in the cost of production which could affect the profit margin. 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 to 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 yoghourt as an alternative to animal milk with certain quality attribute (taste, flavour, texture, shelf life stability), health benefit and variety in diet have been investigated [3, 4]. Recent studies have been carried out in an effort to improve the nutritional quality and need of consumers. In such case, protein from other rich plant sources is used to improve other deficient diets for nutritional and economic reasons.

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Several researches have attempted to produce imitation milk from legumes and other plant sources. Akoma *et al*. [5] produced yoghourt from coconut and tiger nuts which improved the protein value. Proximate and amino acid composition of extracts of two varieties of tiger nut (Cyperus esculentus) have been studied [6]. Natural tiger nut milk, pasteurized tiger nut milk, fermented tiger nut milk, sterilized tiger nut milk, ultra-high temperature tiger nut milk and concentrated and condensed milk was produced by Ukwuru and Ogbodo [7]. Fermentation increased the protein content of the product. Similarly, Nwobosi *et al*. [8] studied the influence of pasteurization and use of natural tropical preservatives on the quality attributes of tiger nut drink during storage and the study revealed that preserved tiger nut extract is rich in nutrient and can be produced in a moderate cheap means which can be sold at a considerate rate and give better option to soft drink. Ukwuru *et al*. [9] developed new product from tiger nut and had good proximate composition values and microbiologically wholesome. Sterilized whole tiger nut milk and other high temperature processed tiger nut milk did not show microbial growth during storage. Composition, products, uses, economics and nutritional/health benefits of tiger nut and its derivatives have been reviewed by Bamishaiye and Bamishaiue [4], Chima *et al*. [10] and Gambo and Da'u [11]. Adgidzi *et al*. [12] studied the effects of hot water and steam blanching on the quality of aqueous extract from tiger nuts (Cyperus esculentus).

Other studies in recent times indicated that milk prepared from tiger nut and soybean could be used as a beverage for both the young and old persons due to the high nutrient contents [13]. Researchers in Cameroon determined the influence of soaking on biochemical components of tiger nut (*Cyperus esculentus*) tubers. The study revealed some information that could benefit public health officials in sub-Saharan Africa in advising local populations about influence of treatment on the nutrient value of various spontaneous edible plants that grow in the region [14]. In other studies, Imam *et al*. [15] and Musa and Hamza [16] did preliminary phytochemical screening; elemental and proximate composition of two varies of *Cyperus esculentus* (tiger nut) and reported that the plant has high fibre content. Therefore, the consumption of significant quantities of *Cyperus esculentus* would not constitute a risk factor to some pathogenic stages that is diabetic mellitus, obesity and coronary heart disease. Notwithstanding, good hygiene practice need to be adopted during preparation since *Escherichia coli* and *Staphylococcus aureus* have been isolated from tiger nut extract consumed by students of Kaduna state University, Kaduna-Nigeria [16].

As can be seen, blends of milk extract from tiger nut and those of other plant sources for yoghourt production have been investigated extensively. Similar studies in substituting animal milk with other food grade materials have been carried out in Egypt by Awad *et al*. [17] and Ismael *et al*. [18]. Yoghourt has been produced from coconut and tiger nuts by Akoma *et al*. [5]. In other studies, Udeze *et al*. [19] and Adedokun et al. [20] examined the mineral composition, proximate composition, fibre qualities and consumer acceptability of bambara–tiger nut–coconut beverage blends, Udeozor and Awonorin [21] made comparative microbial analysis and storage of tiger nut–soy milk and Wakil *et al*. [22] determined the microbiological and nutritional assessment of starter-developed fermented tiger nut milk. The results obtained in these studies were awesome in terms of economical, nutritional and health benefits.

Yoghourt from imitation milk extracted from soybeans, tiger nut 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 quality yoghurts and even if a good one is produced, it has to carry a lot of food additives such as preservatives, flavours, colours and thickeners [23- 26] and never same as yoghourt from cow's milk. The need to add cow's milk to imitation milk to incorporate the flavour characteristics of yoghourt from cow's milk cannot be over emphasized. Amanze and Amanze [27] reported the production of yoghourt from mixtures of cow milk and soymilk but that from mixture of cow milk and milk extract from tiger nut is under reported in this environment. Therefore, there is the need to produce yoghourt from milk extracts of tiger nuts and soybeans and compared with that of cow milk. The objectives of this study were to produce yoghurt from mixtures of cow's milk; milk extracts from soybeans and tiger nut and determine their physicochemical properties, sensory attributes and microbiological load.

MATERIALS AND METHODS

Sources of Materials: Soybeans (yar-Jalingo) was procured from Maiduguri Monday market, Borno state, Nigeria, while tiger nut (yar-Girei) and fresh cow milk and 'kindirmo' starter culture, an indigenous yoghourt composed of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* [28] were procured from Girei, Girei Local Government Area of Nigeria.

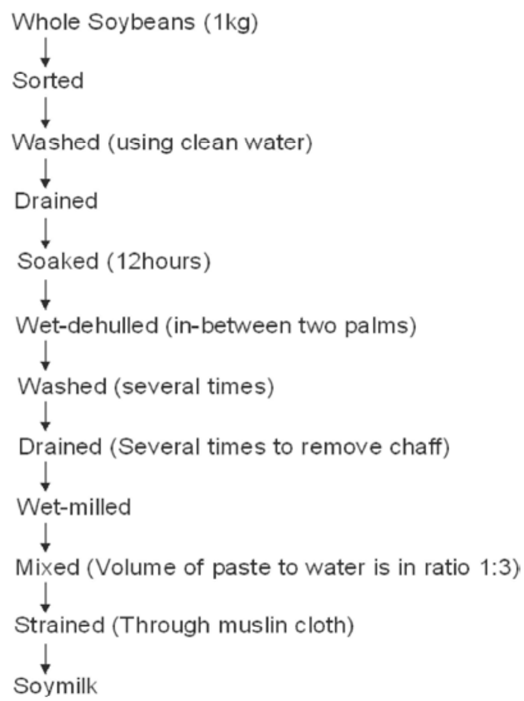

Fig. 1: Flowchart for Wet-Extraction of Milk from Soybeans Adopted with modification [4, 24]

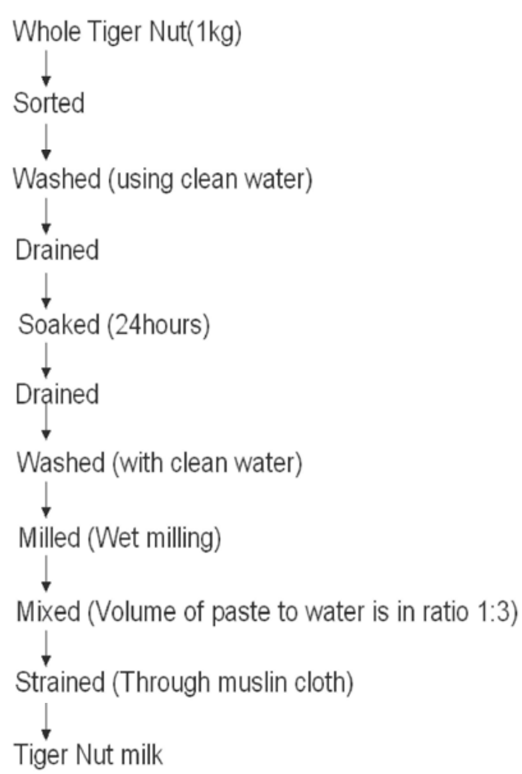

Fig. 2: Flowchart for Wet-Extraction of Milk from Tiger Nut Adopted with modification from Bamishaiye and Bamishaiye [4]

Wet Extraction of Milk from Soybeans: Whole soybeans (1 kg) was first sorted and washed to remove contaminant. It was soaked inside clean water for 12 hours and was then dehulled in-between two palms (rubbed abrasively between two palms). This was further washed and drained repeatedly until the seed coats were removed. The wet soybean bran was then wet milled with Premier A-1 disc mill (Yamaha Motor Company Ltd, Iwata, Japan), mixed in a ratio of 1:3 volume of clean water and was strained through muslin cloth to obtain the soymilk (Figure 1).

Wet Extraction of Milk from Tiger nuts: Similarly, 1 kg of whole Tiger nuts was sorted and washed to remove contaminants. It was soaked in clean water for 24 hours. The wet tiger nuts were drained, washed again, wet milled with Premier A-1 disc mill (Yamaha Motor Company Ltd, Iwata, Japan) and mixed in ratio 1:3 volume of water. This was then strained through muslin cloth to obtain the tiger nut milk (Figure 2).

Dehulling, Roasting and Milling of Soybeans: Soybeans were first sorted, washed and soaked for five hours in a clean water of three times its weight by volume until the coat became soaked and wet to assist in removal of some soluble anti-nutrients and to facilitate dehulling. The soybeans were further washed, drained and partially sun-dried. The soybeans were then roasted at surface temperature of 180 ± 5 °C for 30 minutes in an open thick aluminium pot [25]. It was milled into fine flour with hammer mill (Gibbons Electric, Essex, U.K.) and let to pass through a 0.8μm mesh size screen and later packaged in a plastic container and stored in iron cupboard (30 ± 2 °C) until when needed for use [29].

Roasting and Milling of Tiger Nuts: Tiger nut was first sorted, washed with clean water and drained. It was roasted at surface temperature of 180 ± 5°C for 30 minutes in an open thick aluminium pot [25, 29]. It was milled into fine flour with hammer mill (Gibbons Electric, Essex, U.K.) and let to pass through a 0.8 μm mesh size screen and later packaged in a plastic container and was stored in iron cupboard at ambient temperature (30 ± 2 °C) until when needed for use [29].

Particle Size Determination: The particle size determination of flours where done using laboratory test sieve (Endecotts l.t.d London, England) in the Department of Civil Engineering Laboratory, Adamawa State Ministry of Works, Yola as described by Chen *et al*. [30].

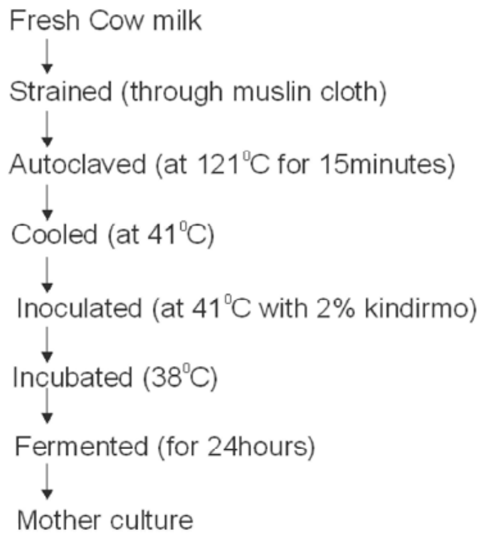

Fig. 3: Flowchart for preparation of Mother Starter Culture Adopted with modification from Sukumar [23]

Preparation of Mother Starter Culture: Fresh raw cow milk was first strained through a clean muslin cloth and was autoclaved at 121°C for 15 minutes [24, 31and 32]. It was cooled to 41°C and was inculcated with 2% 'kindirmo'. The inoculated milk was incubated at 38°C and was allowed to ferment for 24 hours [24] (Fig. 3).

Dry Extraction of Milk from Soybeans: The soybean flour weighing 1 kg was constituted with 6 litres of clean water, strained through muslin cloth. The soy milk was then pasteurized at 95°C for 7 minutes [32, 33], cooled to 41°C and inoculated with 2% mother starter culture. This was allowed to ferment at room temperature (37± 3°C) for 24 hours [32].

Dry Extraction of Milk from Tiger Nuts: Similarly, Figure 4 shows the dry extraction of milk from the tiger nut flour. The tiger nut flour weighing 1 kg was mixed thoroughly with 8 litres of clean water and strained with

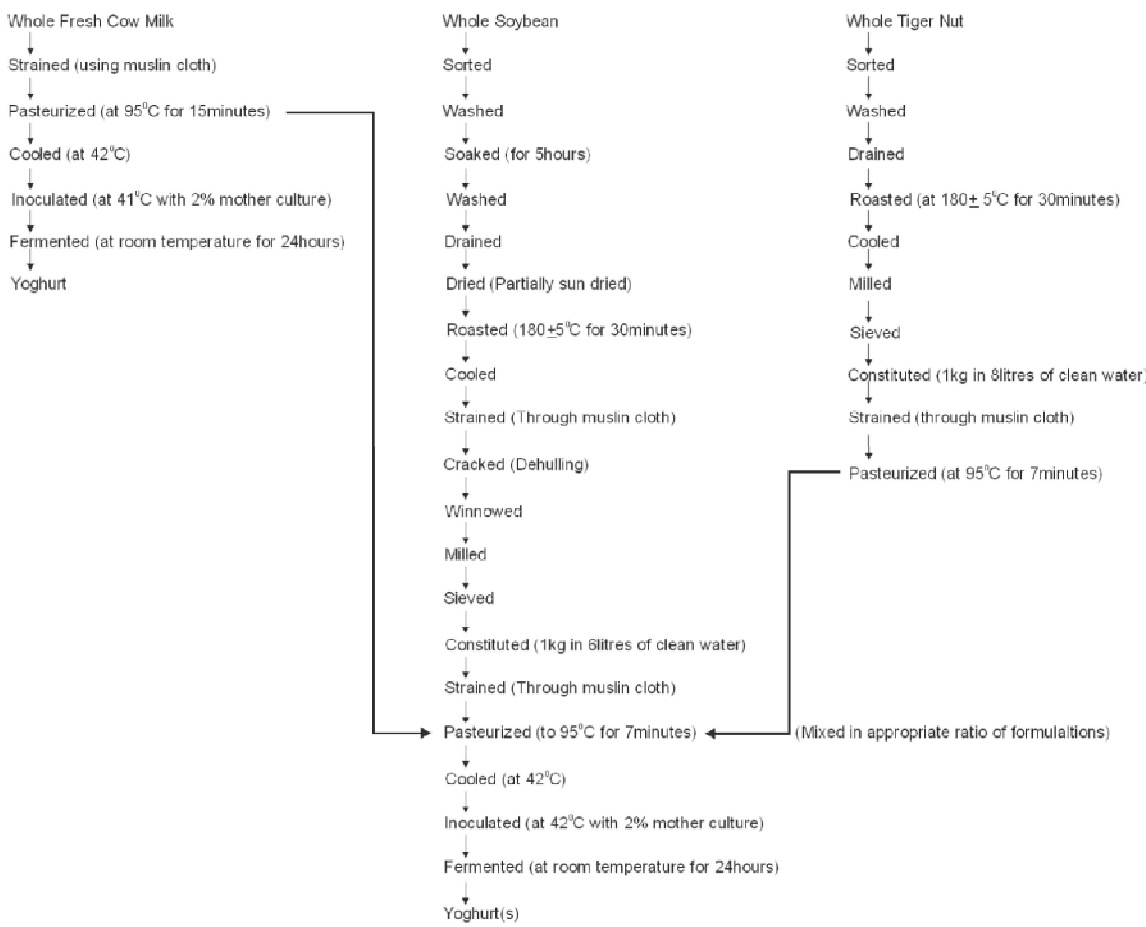

Fig. 4: Flowchart for yoghurt production
Source: Adopted with modification from Bristone [32].

Table 1: Yoghourt formulations from cow milk, milk extracts from soybean and tiger nut

	Formulations							
Types of milk	I	II	III	IV	V	VI	VII	VIII
Soymilk	-	50	-	80	-	50	20	80
Cow milk	100	50	50	20	20	-	-	-
Tiger nut milk	-	-	50	-	80	50	80	20
Total	100	100	100	100	100	100	100	100

muslin cloth to obtain Tiger nut milk. This milk was pasteurized at 95°C for 7 minutes [32, 33], cooled at 41°C and was inoculated with 2% mother starter culture. This was incubated at room temperature (37± 3°C) for 24 hours [32].

Yoghurt Formulation: Eight yoghourt formulations were produced by varying the proportions of cow milk, soymilk and tiger nut milk. Formulation I that had 100% cow milk was used as a control (Table 1).

Yoghurt Production: Fresh cow milk was strained through muslin cloth. It was pasteurized at 85°C for 15 minutes [27], cooled to 41°C and was inoculated at that temperature with 2% 'kindirmo' mother starter culture. This was then fermented at room temperature (37 ± 3°C) for 24 hours [32].

Wet extracted soymilk (Figure 1) was pasteurized at 85°C for 15 minutes [27], cooled to 41°C and was the fermented at 37 ± 3 °C for 24 hours [32].

Wet extracted tiger nut milk was also pasteurized at 95°C for 15 minutes but precipitation started at come up temperature of 50 °C which was discarded (flow chart not shown).

Dry extracted milk from soybean and tiger nuts were reconstituted with water in the ratio of 1:6 and 1:8 w/v, respectively; pasteurized at temperature of 95 °C for 7 minutes, inoculated with 2% 'kindirmo' starter culture and fermented at temperature of 37 ± 3 °C for 24 hours [32, 33] as shown in Figure 4.

Physicochemical Analysis: Physicochemical analyses were carried out on the fresh milk and yoghourt from cow milk, milk extracts from soybean and tiger nuts as described by AOAC [34]. Moisture, ash, protein, lipid and carbohydrate (calculated by difference) contents were determined. The pH and Titratable acidity of fresh milk and yoghourt from cow milk, milk extracts from soybean and tiger nuts were also determined [34].

Particle Size and Functional Properties: Particle size of soybean and tiger nut flours were determined as reported by Chen *et al*. [30] while functional properties such as bulk density, percentage dispersibility and water absorption capacity were also determined [26, 35].

Microbial Analysis: The total plate and mould counts of the ingredients and yoghourt formulations were determined using aseptic technique as described by Collins and Lyne [36], Harrigan and McCance [37] and Nkama *et al*. [38] and Badau *et al*. [39, 40and 41].

Samples of tiger nuts, soybeans and yoghourt formulations were taken. A prepared 1 ml of sample was transferred into a bottle containing 9 ml of distilled water to form the stock solution as described by Diliello [42]. From the stock solution 1 ml was aseptically transferred into subsequent bottles containing sterile distilled water using sterile pipette i.e. from first to second, from second to third and from third to fourth until after tenfold required serial dilution was made [42, 43]. Nutrient and Potato dextrose agars were prepared as described by the manufacturers. Plates were inoculated by pour plate technique, incubated and colonies counted and reported as colony forming unites per millilitre [29, 36- 43].

Sensory Evaluation: The cow milk, milk extracts from soybean, tiger nut and yoghurt from the eight formulations were evaluated on the basis of their quality attributes (taste, texture, colour, flavour and overall acceptability) using nine point hedonic scale [4]. Although, the panelists were not trained but their selection was based on basic requirements of a panelist, such as availability for the entire period of evaluation, interest, willing to serve, good health (not suffering from colds), not allergic or sensitive to the products evaluated [45].

Statistical Analysis: Data were subjected to analysis of variance [46, 47 and 48] where appropriate and means separated by Duncan's Multiple Range Test (DMRT) at 5% significance level [49].

RESULTS AND DISCUSSION

Proximate Composition, Functional Properties and Particle Size Distribution of Soybeans and Tiger Nut: The results of the proximate composition, functional properties and particle size distribution of soybean and tiger nut are shown in Table 2. The ash, protein, fat and carbohydrate contents of soybean differ significantly (P<0.05) from that of tiger nut. However, the moisture content of tiger nut did not differ (P>0.05) from that of soybean. More importantly, significant (P<0.05) difference occurred in cow, soybean and tiger nut milks, with higher amount of ash, protein and fat were recorded in cow milk. However, quantity of water can be regulated during constitution of flours with water to obtain similar pattern of cow milk especially in increasing the total solid. But this could affect production filtration if sieve of small aperture is used for product uniformity. It was also observed that soybean milk was in the same range with cow milk in terms of their protein. Therefore, 1 kg of soybean flour can be constituted with 6 litres of water for appropriate mixing ratio for soybean milk making.

The pH and titratable acidity of soybeans differ significantly (P<0.05) from that of tiger nut. Similarly the bulk density, percentage dispersibility and water absorption capacity of tiger nut flour were significantly (P<0.05) different from soybean flour. The soybean flour was finer than that of tiger nut flour because more flour of latter was retained at the base pan.

The proximate composition of tiger nut and soybean obtained in this study is similar to those reported by other researchers [4, 5, 11, 13 and 15]. Proximate composition is very important for compilers of food composition tables and databases that could be used by economists, agricultural planners, nutritionists, dietitians, food service managers, food and agricultural scientists, manufacturers, food technologists, home economists, teachers, epidemiologists, physicians, dentists, public health scientists, non-specialist consumers and journalists [50].

The functional property of food is an important factor in food processing operation [51]. High bulk density of food is required for easy packing, transportation, energy density, because it allows more weight of food per limited unit volume. The bulk density of 0.64 ± 0.01 for soybeans flour and 0.56 ± 0.01 for tiger nut flour in Table 2 means that high weight of soybeans flour occupied limited space than in tiger nut flour. It was also observed that both percentage dispersibility and water absorption capacity of tiger nut flour is higher than that of soybean flour.

Table 2: Physicochemical properties, functional properties and particle size distribution of soybean and tiger nut flours

Parameter	Soybean	Tiger nut
Physicochemical properties		
Moisture (%)	4.15 ± 0.14[a]	4.49 ± 0.42[a]
Ash (%)	4.95 ± 0.24[a]	2.49 ± 0.18[b]
Protein (%)	44.36 ± 0.00[a]	7.80 ± 0.26[b]
Fat (%)	20.00 ± 0.06[b]	26.26 ± 0.35[a]
Carbohydrate (%)	26.54 ± 0.38[b]	58.96 ± 0.04[a]
pH	6.48 ± 0.01[a]	5.79 ± 0.06[b]
Titratable acidity (%)	0.07 ± 0.01[a]	0.05 ± 0.00[b]
Functional properties		
Bulk density (g/ml)	0.64 ± 0.01[a]	0.56 ± 0.01[b]
Percentage dispersibility	42.00 ± 0.00[b]	62.67 ± 3.06[a]
Water absorption capacity (ml/g)	1.63 ± 0.06[b]	2.60 ± 0.00[a]
Particle size distribution		
600 µm	0.00 ± 0.00[b]	4.06 ± 0.49[a]
425 µm	5.33 ± 0.49[b]	9.29 ± 0.58[a]
300 µm	25.43 ± 0.51[a]	26.06 ± 0.93[a]
180 µm	45.37 ± 0.55[a]	33.84 ± 32.26[b]
150 µm	14.57 ± 0.51[b]	22.92 ± 2.05[a]
Base pan	9.29 ± 1.05[a]	3.83 ± 0.80[b]

Each value is a mean ± S D of triplicate determinations. Mean values in a row not sharing a common superscript letters are significantly (P< 0.05) different as assessed by Duncan multiple Range Test.

This mean that tiger nut flour was better constituted with water than the soybeans flour. However the pH of soybean is better in terms of milk making because it was within the standard pH of 6.4 and 6.6 of cow milk [52]. Therefore, it is better for milk making especially for the initiation of fermentation for yoghurt production if *L. bulgaricus* and *S. thermophillus* is considered as starter culture.

The result revealed that the sieve aperture used ranged from 600 µm to 150 µm. The sample size that was used in each of the determination was 40 g. The highest percentage of flour was retained on the 180 µm mesh size. A 100% of soybean flour passed through 600 µm mesh size with nothing retains. This means that the particle size of soybeans was finer than tiger nut flour even though both passed through 0.8 mm mesh screen during milling. The particle size distribution of flour is known to play an important role in its functional properties and the quality of end products [53].

Physiochemical Properties: Table 3 shows the physicochemical properties of cow milk, milk extracts from soybeans and tiger nut obtained by wet and dry extraction processes. Yoghourts produced from the eight formulations are shown in Figure 2,

Table 3: Physicochemical properties of cow milk and milk extract from soybean and tiger nut obtained by wet and dry extraction processes

		Soybean milk		Tiger nut milk	
Parameters	Cow milk	Wet extraction	Dry extraction	Wet extraction	Dry extraction
Moisture	88.34± 0.10^{e}	89.40 ± 0.64^{d}	91.36 ± 0.14^{b}	92.44 ± 0.50^{a}	90.22 ± 0.37^{c}
Fat	3.35 ± 0.23^{a}	0.85 ± 0.08^{c}	1.66 ± 0.21^{b}	0.71 ± 0.10^{c}	0.97 ± 0.06^{c}
Protein	3.08 ± 0.07^{b}	3.47 ± 0.04^{a}	3.40 ± 0.09^{a}	0.83 ± 0.03^{d}	1.74 ± 0.10^{c}
Ash	0.72 ± 0.02^{a}	0.32 ± 0.04^{c}	0.52 ± 0.04^{b}	0.20 ± 0.01^{d}	0.32 ± 0.04^{c}
Carbohydrate	4.56 ± 0.08^{c}	5.95 ± 0.63^{b}	3.06 ± 0.29^{d}	5.81 ± 0.48^{b}	6.76 ± 0.41^{a}
Total solid	11.66 ± 0.10^{a}	10.60 ± 0.64^{b}	8.64 ± 0.14^{d}	7.56 ± 0.50^{e}	9.78 ± 0.37^{c}
pH	6.44 ± 0.01^{a}	6.45 ± 0.01^{a}	6.48 ± 0.01^{a}	6.16 ± 0.01^{b}	5.79 ± 0.06^{c}
Titratable acidity	0.06 ± 0.01^{d}	0.09 ± 0.01^{b}	0.49 ± 0.37^{c}	0.10 ± 0.01^{a}	0.05 ± 0.00^{d}

Each value is a mean ± SD of triplicate determinations.

Mean values in a row not sharing a common superscript letters are significantly (P< 0.05) different as assessed by Duncan multiple Range Test.

Table 4: Physicochemical properties of yoghourt from eight formulations[1]

Formulations	Moisture	Fat	Protein	Ash	Carbohydrate	Total solid	pH	Titratable acidity
Cow-soy Yoghurt (50:50)	88.73±0.06^{c}	3.26±0.21^{a}	3.56±0.11^{a}	0.68±0.07^{a}	3.77±0.16^{e}	11.27±0.06^{b}	4.09±0.02^{e}	0.10±0.01^{b}
Cow milk yoghurt (100)	86.44±1.27^{e}	2.59±0.24^{b}	3.47±0.04^{a}	0.61±0.04^{ab}	6.90±1.03^{b}	13.56±1.27^{a}	4.06±0.01^{e}	0.09±0.01^{b}
Cow-tiger nut -yoghurt (50:50)	88.61±0.02^{c}	2.17±0.08^{c}	2.60±0.03^{c}	0.61±0.7^{ab}	6.01±0.10^{c}	11.39±0.20^{b}	3.97±0.06^{f}	1.09±0.01^{a}
Cow- soy yoghurt (20:80)	89.80±0.03^{b}	2.03±0.07^{c}	3.52±0.09^{a}	0.56±0.06^{b}	4.09±0.10^{e}	10.20±0.03^{c}	4.60±0.01^{c}	0.09±0.01^{b}
Cow-tiger nut-yoghurt (20:80)	90.52±0.02^{ab}	1.56±0.08^{d}	2.16±0.08^{d}	0.56±0.02^{b}	5.20±0.15^{d}	9.48±0.02^{cd}	3.97±0.01^{f}	1.13±0.06^{a}
Soy-tiger nut-yoghurt (50:50)	91.23±0.03^{a}	1.29±0.04^{ef}	2.63±0.06^{c}	0.42±0.03^{c}	4.43±0.03^{e}	8.50±0.44^{e}	4.65±0.02^{b}	0.09±0.01^{b}
Soy-tiger nut yoghurt (20:80)	87.23±0.06^{d}	1.15±0.05^{f}	2.14±0.06^{d}	0.22±0.04^{d}	9.27±0.10^{a}	12.77±0.06^{a}	4.49±0.02^{d}	0.01±0.01^{c}
Soy-tiger nut yoghurt (80:20)	90.83±0.03^{a}	1.50±0.02^{de}	3.13±0.05^{b}	0.44±0.03^{c}	4.10±0.04^{e}	9.17±0.03^{de}	4.75±0.02^{a}	0.11±0.01^{b}

Each value is a mean ± SD of triplicate determinations.

Mean values in a row not sharing a common superscript letters are significantly (P< 0.05) different as assessed by Duncan multiple Range Test.

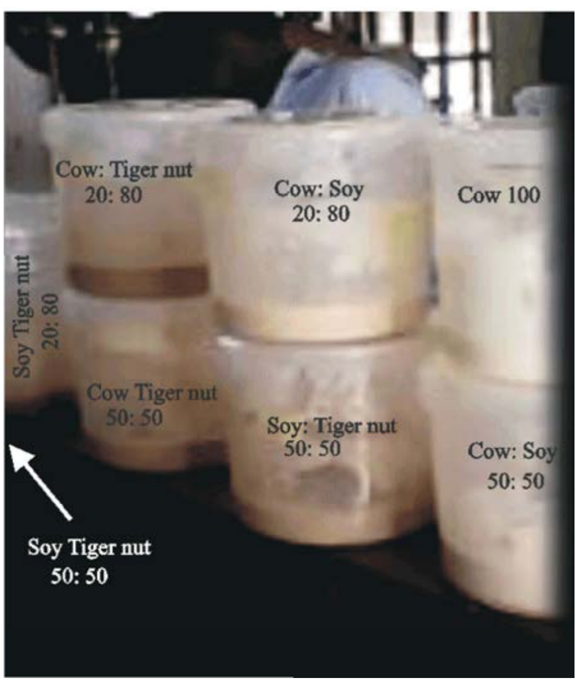

Fig. 2: Yoghourt produced from the eight formulations

while their physicochemical properties are shown in Table 4. There were significant (P< 0.05) variations among the parameters studied. Cow milk had higher (P<0.05) fat, ash and total solid than soybean and tiger nut milks. The pH of cow milk was not significantly (P>0.0) different from that of soybean milk. However, tiger nut milk had the lowest pH (P<0.95). The physicochemical properties of cow milk was significantly (P < 0.05) different to tiger nut milk than to soybeans milk. Both cow milk and soybean milk fell within the standard pH of 6.4 and 6.6, respectively [52].

Greater significant (p<0.05) difference occurred in pH of the yogurt from the various formulations, with highest pH of 4. 75 was recorded in soy-tiger nut yoghurt (80:20) and lowest pH of 3.97 recorded in cow-tiger nut yoghurt (20:80) and cow-tiger nut yoghourt (50:50) while cow milk yoghurt (100%) recorded pH of 4.06±0.01. The decrease in pH and increase in titratable acidity of yoghurt during fermentation is the desired quality characteristics of good yoghurt. The recommended titratable acidity for fresh yoghurt is 0.85 to 0.95 per cent as lactic acid and pH of 4.40 to 4.50 [52]. The moisture and the total solids are

Table 5: Total microbial count of milk types and yoghurt formulations

Parameters		Microbial Count (Cfu/ml) Total bacterial plate count	Mould Plate Count
Cow milk		1.4 x 10^5	0.5 x 10^5
Soymilk		7.5 x 10^5	4.1 x 10^5
Tiger nut milk		5.1 x 10^5	4.3 x 10^5
Cow-soy yoghurt	(50:50)	9.1 x 10^5	5.6 x 10^5
Cow milk yoghurt	(100)	10.5 x 10^5	8.7 x 10^5
Cow-tiger nut yoghurt	(50:50)	6.0 x 10^5	5.8 x 10^5
Cow-soy yoghurt	(20:80)	6.7 x 10^5	3.2 x 10^5
Cow-tiger nut yoghurt	(20:80)	7.1 x 10^5	6.3 x 10^5
Soy-tiger nut yoghurt	(50:50)	1.3 x 10^5	4.9 x 10^5
Soy-tiger nut yoghurt	(20:80)	6.6 x 10^5	2.4 x 10^5
Soy-tiger nut yoghurt	(80:20)	8.9 x 10^5	8.5 x 10^5

Each value is a mean of triplicate determinations.

Table 6: Sensory Scores of different types of Milk

Types of milk	Appearance	Aroma	Texture	Taste	Overall acceptability
Cow milk	7.40 ± 1.52^a	8.00 ± 1.00^a	8.00 ± 1.22^a	7.40 ± 1.14^a	7.60 ± 0.89^{ab}
Soymilk	8.60 ± 0.55^a	8.40 ± 0.55^a	8.00 ± 0.71^a	7.40 ± 1.14^a	8.40 ± 0.55^a
Tiger nut milk	4.60 ± 1.52^b	7.40 ± 1.52^a	6.60 ± 2.07^a	7.20 ± 1.79^a	6.80 ± 0.84^b

Each value is a mean ± SD scores of five panellists

Mean values in a column not sharing a common superscript letters are significantly (p<0.05) different as assessed by Duncan Multiple Range Test

Table 7: Sensory Scores of Yoghurt from eight Formulations

Formulations	Consistency	Flavour	Taste	Colour	Texture	Overall Acceptance
Cow-soy yoghurt (50:50)	7.10±1.37^b	6.80±1.62^a	6.70±2.06^{ab}	7.40±1.07^{ab}	7.30±1.57^{ab}	7.60±0.97^{ab}
Cow milk yoghurt (100)	8.50±0.97^a	7.40±2.27^a	7.80±1.03^a	8.40±1.07^a	8.20±1.14^a	8.30±0.95^a
Cow-tiger nut yoghurt (50:50)	6.90±1.66^c	6.10±1.10^{ab}	5.70±1.42^{bc}	5.80±1.48^{bcde}	6.70±2.00^{abc}	6.40±1.58^{bc}
Cow-soy yoghurt (20:80)	6.20±0.92^{bc}	4.90±1.60^{bc}	5.90±1.52^{bc}	6.50±2.07^{bc}	5.90±1.97^{bc}	5.80±2.15^{cd}
Cow-Tiger Nut yoghurt (20:80)	5.50±1.27^{cd}	4.60±2.37^{bc}	4.80±1.75^c	4.80±1.75^{dc}	5.10±1.20^c	4.70±1.89^d
Soy-Tiger Nut yoghurt (50:50)	4.90±1.10^{cd}	3.60±1.07^c	4.90±1.29^c	5.00±1.94^{cde}	5.10±2.08^c	4.70±1.16^d
Soy-Tiger Nut yoghurt (20:80)	4.40±1.51^d	3.80±1.62^c	5.10±1.79^c	4.30±2.36^e	5.10±2.18^c	4.60±1.78^d
Soy-Tiger Nut Yoghurt (80:20)	4.40±2.01^d	4.40±1.51^c	6.00±1.33^{bc}	6.30±1.34^{bcd}	5.10±2.13^c	5.20±2.30^{cd}

Each value is a mean ± SD scores of ten panellists.

Mean values in a column not sharing a common superscript letters are significantly (p<0.05) different as assessed by Ducan Multiple Range Test.

also an important factor in rating yoghurt. Moisture and total solids can be controlled by the addition of powdered milk or evaporation during pasteurization of milk for desired yoghourt [23]. The result of moisture and total solids of yoghurt formulations showed significant (p<0.05) difference, with highest total solids were recorded in cow milk yoghurt (100%) followed by soy-tiger nut yoghurt (20:80). High total solid often indicates richness of yoghurt (Table 4).

Total Microbial Count: The total microbial count of milk and yoghurt formulations is presented in Table 5. Result of the total plate count ranged from 1.3 x 10^5 to 10.5 x 10^5 CFU/ml and for the mould count ranges from 0.5 x 10^5 to 8.7 x 10^5 CFU/ml. The formulation of 100% yoghurt produced from cow milk had the highest number of count for both mould and total plate count. Probably, cow milk is a good medium for microbial growth despite the initial low count of cow milk as compared to soybean and tiger nut milk. The yoghurt formulation soy – tiger nut yoghurt (50:50), had the lowest total plate count of 1.3 x 10^5 CFU/ml. The highest count of 100% yoghurt produced from cow milk indicated high rate of microbial activity or fermentation.

Sensory Scores: The sensory score of milks is shown in Table 6. The results showed no significant (P<0.05) difference in flavour, texture and taste except for appearance and overall acceptance. The significant (P<0.05) difference in appearance and overall acceptance of milks is attributed to the much brown colour of tiger nut milk. No significant (P<0.05) difference in flavour, texture and taste, may be due to the fact that proportion of panellist naturally like or disliked cow milk flavour as some commented on the score shits.

The sensory score of yoghurt produced from the eight formulations is shown in Table 7. Significance (p<0.05) variation was observed in the formulations. Formulation Cow-soy yoghurt (50:50) showed no significant (p<0.05) difference as compared to cow milk yoghurt (100%) except for consistency. Formulation cow-tiger nut yoghurt (50:50) also showed close score to cow milk yoghurt than other formulations. Much significant variation among the formulations may be due to brown colour of soybeans and also much brown colour of tiger nut as a result of roasting. It was also observed that during this study, formulations containing tiger nut or much of tiger nut have stable storage stability than others and as the proportion of cow milk was increased in the formulations, the acceptability of the products were also increased, as observed in formulations; cow-soy yoghurt (20:80), cow-soy yoghurt (50:50), cow milk (100%) and also in formulations containing tiger nut.

CONCLUSIONS

Soybeans or tiger nut milk, if properly produced can be effectively used for acceptable yoghurt formulations. The process adopted in this study successfully produce acceptable milks and yoghurts. However, further study is recommended to enhance some quality aspects for commercial scale production, especially the wet Extraction process.

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