Evaluation of Micronutrient and Sensory Properties of Composite Yoghurts

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Abstract
Composite yoghurt was produced from blend of cow milk, soymilk and tigernut. The proportions of cow milk, milk extracts from soybean and tiger nut were varied resulting in five formulations. Yoghurt was produced from five formulations; their micronutrient analyses and sensory evaluation was determined. Cow milk in a ratio of 100: 0%-(sample A1), Cow milk + Tiger nut milk 50:50%-(sample A_2), Cow milk +Soybean milk 50:50%- (sample A_3), Tiger nut + Soymilk-(sampleA_4), and Cow milk + Soybean milk+ Tiger nut milk50:25:25%- (sample A_5). The objective of the study was to determine the mineral and vitamin content of yoghurt prepared from extracts of tigernut and soybean milk. The 5 milk samples were analysed for minerals (Mg, Ca, Fe, K) and vitamins (A, B_{12}, C, E) using UV-visible spectroscopy. Data were subjected to analysis of variance (ANOVA) where appropriate and means separated by Duncan's multiple range test (DMRT) at 0.05% significant level. The various milk extracts used in making yoghurt were investigated in a completely randomized design model using Cow milk (A_1) as control, 50% Cow milk + 50% Tiger nut milk (A_2), 50% Cow milk + 50% Soybean milk (A_3), 50% Tiger nut + 50% Soymilk (A_4), and 50% Cow milk + 25% Soybean milk+ 25% Tiger nut milk (A_5). Sensory evaluation of the yogurt was conducted using a five-point hedonic scale. It involved the participation of 40 panellists which comprised of staff of NAERLS, Ahmadu Bello University: Zaria. Each individual evaluated seven sensory characteristics (appearance, taste, colour, flavour, consistency, sweetness and thickness). A 9-point hedonic scale was used to evaluate the organoleptic parameter of the sensory characteristics. The result of the nutrients and vitamin analysis showed that sample A_4 had the highest amount of Mg and vitamin A (40%), while sample A_5 was richest in Ca, Fe and vitamin C (30%) However, yogurt made from sample A_1 and A_3 had similar sensory qualities (60%) compared to yoghurt from other samples except samples (40%). Yoghurt prepared from sample A_2 and A_3 had the overall acceptability score (80%) as such could be successfully used in production of yoghurt characterized for good health and nutritional properties. The result of the study observed that the enriched yoghurt with soybean milk produced is sweeter and nutritionally superior in all the quality attributes than the conventional yoghurt. Thus, this enriched yoghurt can be used to produce yogurt which would be acceptable in the market.

Key words: **Yoghurt, Soymilk, Tigernut Milk, Vitamins, Minerals, Cow Milk**

Introduction

Yoghurt is a fermented product that evolved some centuries ago by allowing naturally contaminated milk to sour at a warm temperature, probably the temperature range of 40-50°C . It is produced from whole or partially skimmed cow's or buffalo's milk . 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.

One way of meeting the demands of the people for dairy and dairy products is to encourage the production of milk and milk products locally. Since local production of milk is low and a lot of money is used to import milk and dairy products, there is an urgent need to develop dairy products from other alternatives like tiger nuts and soya beans which we have in abundance. 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. According to Mason (2008), tiger-nuts have long been recognized for its health benefits as they are high in fibre, protein and natural sugars. They have a high content of soluble glucose and oleic acid, along with high energy content (starch, fats, sugars and proteins), they are rich in minerals such as phosphorous and potassium and in vitamins E and C.

The study is to determine the mineral /vitamin analysis and sensory evaluation of the composite yoghurt that helps in reducing the cost of yoghurt in the market.

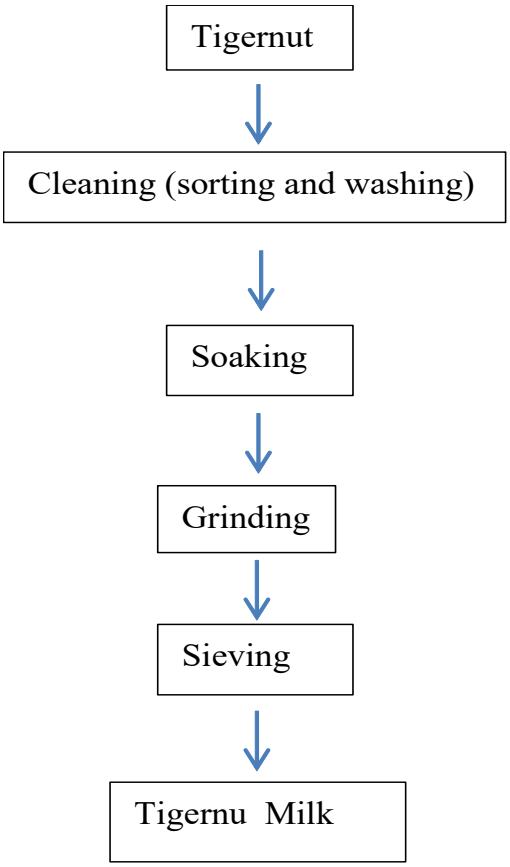
Materials and Methods

Sample and Sample Collection

Extraction of Tiger-nut milk:

Fresh tiger-nut was purchased from Samaru market in Zaria, Kaduna State Nigeria. Preparation of the tiger nut milk was done by picking out those foreign and bad nuts that could affect the taste and keeping quality of the milk. The tiger-nut was washed and rinsed in distilled water. It was then soaked in an opened plastic bucket with two litres water for three (3) hours under room temperature to soften the fibre. 900 g of Tiger- nuts were added to two litres of water and blended several times with a blender. The paste was then filtered through a muslin cloth to separate the milk from the mash. It was further strained to obtain fine milk.

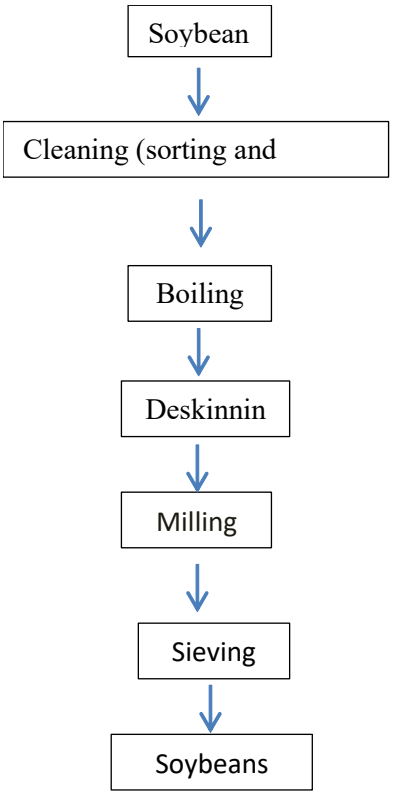
The filtered tiger-nut milk was transferred into a clean sterilized plastic container for further processes.



Flowchart for Wet-Extraction of Milk from Tiger Nut Adopted with modification from Bamishaiye and Bamishaiye (2011)

Extraction of soymilk:

Soybeans were purchased from Samaru market and the foreign and bad seeds were removed. It was then boiled, water removed and deskinned and milled to paste. The paste was then filtered through a muslin cloth to separate the milk from the mash. It was further strained to obtain fine milk. The filtered soymilk was transferred into a clean sterilized plastic container for further processes.



Flowchart for soymilk Extraction

Production of yoghurt from cow, tigernut and soymilk

Skimmed milk of 0.8 kg was dissolved in two litres of water was pasteurized at 90°C for 15 minutes and later cooled to a temperature of 43 °C. One litre of cow milk which is the control was labelled Sample A1, half litre of tiger-nuts milk and half litre of cow milk mixture was labelled Sample A2, half litre of the cow milk solution added to half litre of soymilk was labelled Sample A3, half litre of tiger-nuts milk and half litre of soymilk mixture was labelled as sample A4 and half litre of the cow milk solution was added to quarter litre of soymilk and quarter litre of tiger-nuts milk was labelled Sample A5. The Samples at a temperature of 43°C were inoculated with 4% v/v starter culture and mixed thoroughly. The jars were afterwards covered and incubated at 42°C for 6 hours to cause curdling and setting of the milk samples. After incubation, the Samples, A1, A2, A3, A4 and A5 were stirred with a whisker and 150 g of sugar was added to each sample to taste. The jars were placed in a refrigerator to cool and avoid further fermentation.

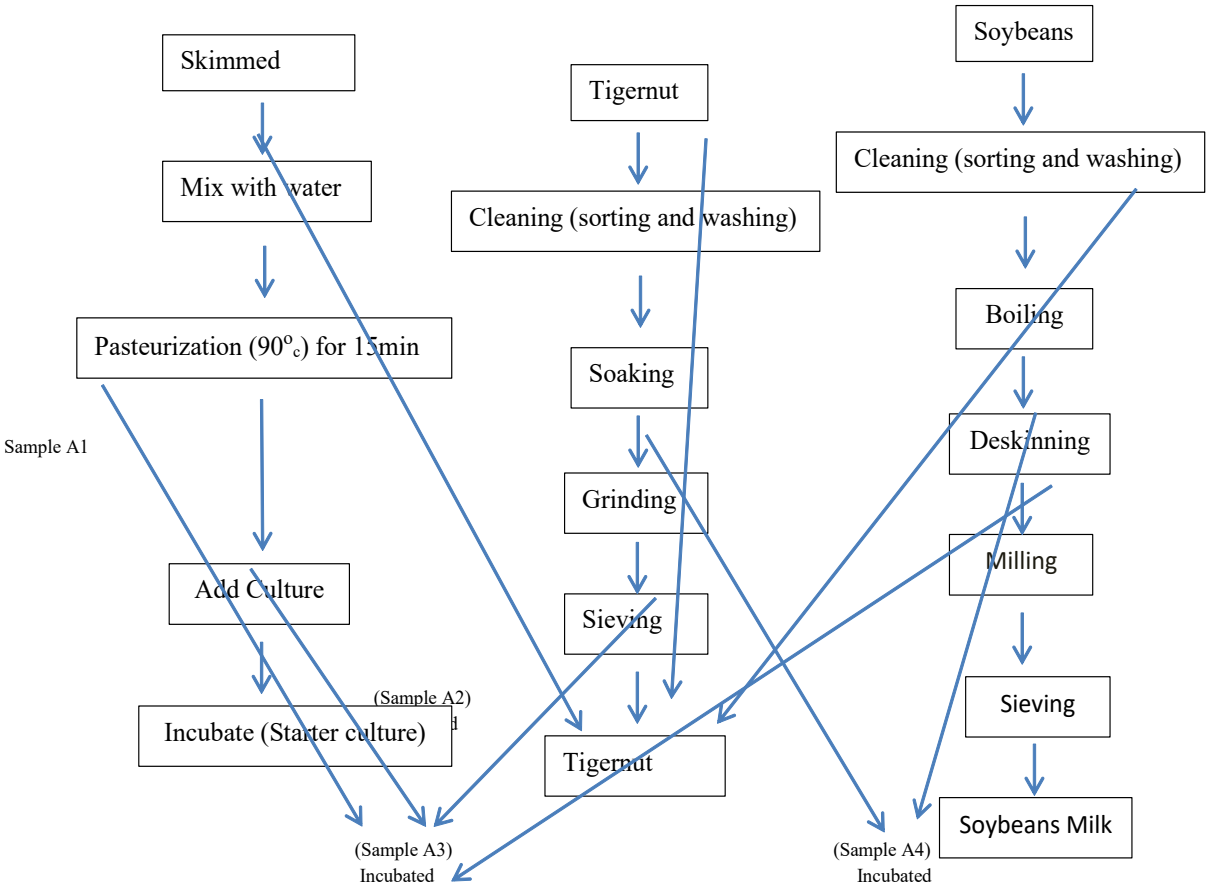


Figure 1:Flowchart of Production of Yoghurt from Cow Milk, Tigernut and Soybean adopted with modification from Bristone (2006)

Vitamin And Mineral Analysis

A total of five (5) yoghurt samples were collected in sterile bottles. Samples were transported to the laboratory in a cold box and stored in a refrigerator until they were used for the vitamin and mineral analysis. UV- visible spectroscopy was used for the analysis

Mineral Analysis

Mineral analysis was carried out using dry digestion method. The method described by AOAC (10) was adopted. Magnesium, Calcium, 1ron, potassium was analysed from the triple acid digestion (wet digestion method). Exactly 5g of the samples was weighed into porcelain crucible and the crucible with the sample was placed in a muffle furnace. Then, the temperature was increased gradually until it reached 550 °C. The sample was washed until a white or grey ash was observed in the crucible. The ash was dissolved by adding 2ml of conc. HNO3 to the crucible. The dissolved ash was transferred into 100 ml volumetric flask and diluted to 100 ml with water, agitated and filtered. The standard and unknown samples were run in an atomic absorption spectrophotometer (Shimadzu AA, 650 model) with specific lamps (for all mineral elements and heavy metals) and flame photometer (for Na and K) using air acetylene flame integrated mode and quantity of unknown concentration was determined from the calibration curve of standards.

Determination Of Vitamins

Prepared yoghurt sample (2ml) was measured into a 250ml volumetric flask and made up with mobile mixture and refluxed. The mixture was centrifuged and decanted. The filtrate was filtered using HPLC filter paper. Analysis was performed by injecting 20µl of the above carefully prepared sample into a Buck scientific (USA) BLC10/11-model HPLC equipped with UV 254nm detector for fat- and water-soluble vitamins respectively. A C18, 4.6x150mm, 5µm column and a mobile phase of 95.5 (methanol: water) was used at a flow rate of 1.00 ml/minute at ambient temperature. A 0.1mg mixed standard was analysed in a similar manner for identification. Peak identification was conducted by comparing the retention times of authentic standards and those obtained from the samples concentrations which were calculated using a four-point calibration curve.

Sensory Analysis

Forty panellists from NAERLS/ABU comprising both male and female staff were used in the sensory evaluation study. The panellists were selected based on their ability to discriminate and produce the results. All samples were served at temperatures of 10-15^{o}C using plastic cups. Each individual evaluated organoleptically for appearance, taste, colour, flavour, consistency, sweetness and thickness. Water was available for panel members to rinse their mouths between samples. The tests were conducted in a food laboratory comprising partitioned boots with good fluorescent lighting.

A 9-point hedonic scale was used to evaluate the organoleptic parameter of appearance, taste, colour, flavour, consistency, sweetness and thickness. Each sensory attribute was rated on the 9-point hedonic scale where 1= dislike extremely, 5= neither like nor dislike and 9= like extremely.

Statistical Analysis

All the statistical calculations were performed using analysis of variance (ANOVA) where appropriate and means were separated by Duncan's multiple range test (DMRT) at 0.05% significant level.

The results obtained from proximate, minerals, vitamins and sensory analyses were subjected to independent sample T-test using IBM SPSS (20 Version). Significance different between samples was tested at $p<0.05$.

Results And Discussion

The milk samples were analysed for minerals magnesium (mg), calcium (ca), iron (fe), potassium(k) and vitamins (A, B_{12}, C, E) in addition, sensory evaluation was conducted. The various milk extracts used in making yogurt were investigated in a completely randomized design model using Cow milk (A_1) as control, 50% Cow milk + 50% Tiger nut milk (A_2), 50% Cow milk + 50% Soybean milk (A_3), 50% Tiger nut + 50% Soymilk (A_4), and 50% Cow milk + 50% Soybean milk+ 50% Tiger nut milk (A_5). Sensory evaluation of the yogurt was conducted using a 9-point hedonic scale. It involved the participation of 40 panellists which comprised of staff of NAERLS, Ahmadu Bello University: Zaria. Each individual evaluated seven sensory characteristics (appearance, taste, colour, flavour, consistency, sweetness and thickness)

1.0 NUTRIENT ANALYSIS RESULT

Table 1: Vitamin Composition of the Yoghurt Samples

SAMPLE	VITAMINS			
	A (IU/mL)	B12(mg/mL)	C(mg/mL)	E(mg/mL)
A1	7.11±0.01c	15.8±0.07c	0.13±0.01a	7.68±0.07a
A2	5.88±0.23c	13.81±0.05a	0.14±0.05d	4.10±0.04c
A3	3.90±0.01a	10.61±0.03d	1.18±0.04a	9.47±0.07c
A4	7.87±0.06d	8.16±0.02c	0.15±0.02d	8.66±0.04a
A5	0.79±0.02b	7.72±0.07a	1.17±0.02a	7.88±0.03a

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

Key: A_1- Cow milk (control), A_2 - Cow milk and Tiger nut milk, A_3 - Cow milk and Soybean milk, A_4 - Tiger nut and Soymilk, A_5 - Cow milk and Soybean milk and Tiger nut milk

From the result of vitamin composition of yoghurt, the yoghurt samples presented in table 1 showed that there are significant differences (p>0.05) across all the samples, with sample (A_4) having the highest content of vitamin A (7.87 $IU_{/mL}$). this maybe because it is gotten from animal sources, Sample (A_5) had the lowest vitamin A content (0.79 $IU_{/mL}$). Sample (A_1) which is the control had the highest level of vitamin $_{B12.}$ The result of the vitamin content suggests that sample ($A_{3)}$ can compare favourably with sample (A_4) in terms of vitamin C and E.

Table 2: **Mineral Composition of the Yoghurt Samples (mg/100g)**

Sample	Minerals			
	Mg	Ca	Fe	K
A1	0.88±0.05a	1.02±0.01b	1.44±0.57a	3.99±0.34c
A2	0.73±0.03a	0.28±0.20c	0.47±0.32c	2.53±0.03b
A3	0.66±0.05a	1.14±0.35cd	1.40±0.74b	2.02±0.04c
A4	0.91±0.07a	0.03±0.23d	0.42±0.97a	0.03±0.02c
A5	0.58±0.07a	0.90±0.28b	0.44±0.23c	3.69±0.14e

Key: A_1- Cow milk (control), A_2 - Cow milk and Tiger nut milk, A_3 - Cow milk and Soybean milk, A_4 - Tiger nut and Soymilk, A_5 - Cow milk and Soybean milk and Tiger nut milk

The results for the mineral composition of the yoghurt sample are as presented on table 2. There was a significance difference (p>0.05) in Mg across all samples, the result shows that sample (A_4) has the highest amount of Mg (0.91±0.07mg/100g) compared to Sample (A_1) (0.88±0.05mg/100g), sample($A_{2)(}$ mg/ 0.73±0.03a 100$g_{)}$ sample ($A_{3)\,(0.66}$±0.05 mg/ 100$g_{)\,and}$ Sample (A_5) (0.58±0.07 mg/100g)

Sample (A_3) was richest in Ca (1.14±0.35 mg/100g), and Fe(1.40±0.74 mg/100g), Sample (A_4) (0.03±0.23/100g) was lowest in Ca and Fe content. From the result, there was significant difference (p>0.05) in the K content, with Sample (A_1) (3.99±0.34mg/100g) having the highest level of K and Sample (A_4) (0.03±0.02c mg/100g) having the lowest K level.

Table 3: Results of Sensory Evaluation of Composite Yorgurt

SAMPLE CODE	APPEARANCE	TASTE	COLOUR	FLAVOUR	CONSISTENCY	SWEETNESS	THICKNESS
A1	4.720±0.97^{a}	4.51±1.03^{a}	3.15±1.03^{ab}	3.56±2.27^{a}	4.10±0.97^{a}	4.22±0.89^{d}	4.35±1.89^{a}
A2	3.27±1.66^{b}	3.57±2.03^{bc}	3.10±1.48^{bcd}	3.27±1.03^{bc}	3.72±1.37^{b}	3.95±1.89^{d}	3.50±1.89^{d}
A3	3.410±1.37^{c}	4.59±2.03^{bc}	4.13±2.07^{bc}	3.75±1.03^{bc}	3.15±1.37^{c}	4.35±2.15^{cd}	4.30±0.89^{d}
A4	3.87±1.27^{d}	3.52±1.29^{c}	4.10±1.29^{c}	3.57±1.03^{c}	2.63±1.27^{d}	2.65±1.84^{c}	2.11±1.89^{d}
A5	3.86±1.20^{cd}	2.34±1.03^{c}	3.34±1.29^{c}	3.41±1.03^{c}	3.99±1.10^{cd}	4.05±0.89^{d}	3.21±1.89^{c}

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

Key: A_1- Cow milk (control), A_2 - Cow milk and Tiger nut milk, A_3 - Cow milk and Soybean milk, A_4 - Tiger nut and Soymilk, A_5 - Cow milk and Soybean milk and Tiger nut milk

Table 3 shows the mean sensory evaluation scores of the composite yoghurt. There was a significant difference ($p<0.05$) in all the sensory attributes among the samples (sample A1, control) and sample A2, A3, A4 andA5 except taste and thickness. There was no significant difference ($p>0.05$) in the taste between all the samples. Eluchie et al. (2011) reported similar observation. This could be attributed to the production of yoghurt produced by using the starter yoghurt culture. In terms of taste, flavour, consistency and sweetness, there was no significant difference ($p< 0.05$) between sample A1 and sample A2, A3 and A5 except sample A4 that was significantly different($p> 0.05$) from the samples. Samples A2 and A3 was most accepted. Thus, in the production of yoghurt, soymilk can be substituted up to 40% in normal cow milk yoghurt preparation without affecting the vitamin and mineral composition and sensory properties of the yoghurt.

Discussion

Mineral and vitamins composition of yoghurt

From the result of the mineral composition of the yoghurt samples presented in Table 2 it showed that, there is a significant difference ($p<0.05$) across all the samples A4 having high content of Magnesium (mg) (0.91±0.07^{a}). This may be because it was gotten from animal source. Sample A5 has the lowest level of Magnesium (mg) (0.58±0.07^{a}). Sample A1 which is the control has the highest level of Iron (Fe) Phosphorus (K), and Calcium (Ca). The results of the mineral content suggest that sample A1can compare favorably with sample A3 in terms of Magnesium, Calcium, Iron and Phosphorus. The result for the vitamin composition of the yoghurt samples is as presented in Table 1. There was a significant difference ($p<0.05$) in vitamin A content across all the samples, the result shows that vitamin A content is higher in sample A4 (7.87±0.06 IU/mL) compared to the other samples A1 (7.11±0.01 IU/ mL), A2 (5.88±0.23 IU/ mL) and A3 (3.90±0.01 IU/mL). Sample A1 had the highest value of vitamin B_{12} (15.8±0.07mg/100mL), and the lowest value was observed in A5 (7.72±0.07 mg/ 100mL). From the result, there was no significant difference in the vitamin B12 content between sample A3 (10.61±0.03mg/100mL) and A4 (8.16±0.02mg/100mL) respectively. Vitamin C was found to be highest in sample A3 (1.18±0.04 mg/100mL), and

lowest in sample A1 (0.13±0.01mg/100mL). Vitamin E was found to be highest in sample A3 (9.47±0.07 mg/100mL), and lowest in sample A2 (4.10±0.04 mg/100mL).

The sensory evaluation of yoghurt samples

The results for the sensory evaluation are presented in Table 3. The evaluation conducted included all the 5 samples. Each sample was evaluated organoleptically for appearance, taste, colour, flavour, consistency, sweetness and thickness. The result showed that, there was no significant difference ($p<0.05$) in terms of the appearance of sample A2(3.27 ± 1.66^{b}), sample A3(3.410 ± 1.37^{c}) . Sample A1 had the highest value in terms of appearance (4.720 ± 0.97^{a}), rating this is because Cow milk is naturally white in color. However, there was a great significant difference ($p<0.05$) in the color of sample A3 (4.13 ± 2.07^{bc}) when compared with sample A4 (4.10 ± 1.29^{c}), this is because the natural color of tiger nut used for the production is yellowish. Even though the result showed that A1 and A2 are not significantly different, A3 can compete favorably with A4 and A5 in terms of color. Hence sample A2can be presented as substitute for A3 and A4 in terms of color. There was no significant different ($p<0.5$) between the taste of sample AI (4.51 ± 1.03^{a}), and A3 (4.59 ± 2.03^{bc}). Sample A5 (2.34 ± 1.03^{c}) had the lowest mean score. The sample A3 had the highest mean score (3.75 ± 1.03^{bc}) for flavor, followed by sample A4 (3.57 ± 1.03^{c}), and then A1(3.56 ± 2.27^{a}, this was significantly different ($p<0.05$) from other samples as shown in Table 3, but there was no significant difference ($p<0.05$) between samples A2 and A5. The mean score for consistency showed that, there was no significant difference in samples A1(4.10 ± 0.97^{a}), A2 (3.72 ± 1.37^{b}), A3(3.15 ± 1.37^{c}) and A5 (3.99 ± 1.10^{cd}). The lowest mean score was observed in A4 (2.63 ± 1.27^{d}). Sample A3 had the highest mean score (4.35 ± 2.15^{cd}) for sweetness followed by sample A1 (4.22 ± 0.89^{d}), sample A4 (2.65±1.84c) had the lowest mean score in terms of sweetness. The mean score for thickness showed that, sample A1 (4.35 ± 1.89^{a}) had the highest mean score. The lowest mean score was observed in sample 4 (2.11 ± 1.89^{d}). The mean score values of the sensory evaluation for the composite yoghurts were reasonable higher compared to the yoghurts in their natural forms this is because of plant milk added during the evaluation process.

CONCLUSION

This research clearly shows that sample A3 which was yoghurt made from composite of tigernut and soybean was the most preferred by consumers and can serve as substitute for the ones produced from cow milk. Since the product contain the desired nutrient in their correct proportions as indicated by the results obtained from the analysis. The product can nutritionally replace yoghurt produced from cow milk as tigernut and soybean are of plant source and is less expensive when compared to the ones produced solely from animal sources.

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