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Preparation and Quality Assessment of Yoghurt Prepared from Dairy Milk and Coconut *(Cocos nucifera, L*) Milk

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Abstract

Yoghurt was produced using dairy and coconut milk. Five variants of yoghurt namely plain dairy and coconut yoghurt (variant I), dairy and coconut yoghurt with natural grape pulp (variant II), dairy and coconut yoghurt with synthetic grape flavour (variant III), dairy and coconut yoghurt with natural pineapple pulp (variant IV) and dairy and coconut yoghurt with synthetic pineapple flavour (variant V) were prepared. Among these five variants dairy and coconut yoghurt with pineapple pulp (variant IV) had received the highest mean scores for all the sensory criteria, and was selected for the further study. Physicochemical properties and selected nutrient components were analysed for the pineapple flavoured yoghurt prepared with dairy milk and coconut milk. Yoghurt made with coconut milk had scored higher values for all the analysed nutrients (energy - 142.49 ± 2.63, carbohydrate - 9.55 ± 0.12, protein – 8.02 ± 0.005 and fat – 13.03 ± 0.05) than yoghurt made with dairy milk (energy - 93.76±0.25, carbohydrate - 4.46 ± 0.05 , protein – 7.26 ± 0.11 and fat – 9.82 ± 0.02). The results of current study demonstrated that the addition of fruits to the yogurt significantly improved the product acceptability and also yoghurt produced from coconut milk can be a match able substitute for normal yoghurt.

Keywords: Coconut Yoghurt; Dairy Yoghurt; Lactose intolerance; Nutrient analysis; Sensory evaluation

Introduction

Yoghurt is a fermented product obtained through an anaerobic fermentation of lactose in milk by relevant microorganisms most of which are classified as pro-biotic (Tull, 1996). The substrate that is usually employed in this type of yoghurt is evaporated whole milk/skimmed solids or fresh milk from cow. Although this substrate produces good quality yoghurt, there are certain limitations for vegans and lactose intolerance people to consume. Even though the lactose gets converted into lactic acid by the bacteria during fermentation some people show allergic reactions by consumption. It is realized that strict vegetarians are also limited in their quest for probiotic yoghurts when there is the confinement to only animal base yoghurt. Selection of possible substrates which have the potential to produce yoghurt with comparable effect as seen with cow milk is necessary. It is therefore of great importance to find out the feasibility of using the coconut milk as substrate for yoghurt production as used in other experimental substrates such as, soy bean milk and tiger nuts milk (Belewu and Belewu, 2007), Soy - coconut milk (Kolapo and Olubamiwa, 2012) and Sesame milk (Afaneh et al., 2011).

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Belewu et al. (2005) have also documented the combination of soymilk (50%) and coconut milk (50%) in the preparation of soy-coconut yoghurt. Yoghurt obtained by using coconut milk has been found to be delicious and a nutritional product (Imele and Atemnkeng, 2001).

Coconut (Cocos nucifera) milk is being used by confectionaries, bakeries, biscuits and ice cream industries worldwide to enhance flavor and taste of various products (Persley, 1992). Current trends and changing consumer needs indicate a great opportunity for innovations and developments in fermented milks. Non-dairy products have shown a great sensory appeal (Soler, 2005; Potter et al., 2007; Granato et al., 2010 and Branco et al., 2010) and market potential worldwide due to a high percentage of population that present lactose-intolerance. Coconut milk was found to be rich in calcium. The milk was reported to be high in minerals and vitamin content (Nieuwentus and Nieuwelink, 2002) while total saturated fat was 10% of the total energy (Thai Food Composition, 2004). In the light of the above, this research was taken to promote the use of coconut in the production of yoghurt, and also to evaluate the range of acceptability of the flavoured yoghurt through sensory evaluation.

Materials and methods

Material collection

The ingredients required for the preparation of the yoghurt were dairy milk, coconut milk, tapioca starch, sugar, china grass and thermophilic bacterial culture. Farm fresh dairy milk was used for the study. Coconut milk was prepared from the matured coconut (9-10 months old) freshly picked from the coconut tree in the farm. The ingredients like tapioca starch, sugar and china grass were purchased from the local market. The thermophilic culture was purchased from *Chr Hansen* Food Product Company, Denmark.

Extraction and preparation of coconut milk

The coconut milk was extracted by the method followed by Akoma et al. (2000). The coconut was crushed open and coconut flesh was then grated from the shell and homogenized in a blender together with double the quantity of water. It was then passed through a fine sieve. The extracted coconut milk was transferred into a vessel and pasteurized at 90°C with the addition of 1% sugar, 2% tapioca starch and 0.3 % of china grass and allowed to cool gradually to a temperature of 42 - 45°C and the mixture is blended in the mixer for the fine consistency of the yoghurt and was inoculated with thermophilic bacteria.

Preparation of dairy milk

The dairy milk was pasteurized at 90° C and allowed to cool gradually to a temperature of 42 - 45°C for the addition of thermophilic bacterial culture. Pasteurization is believed to modify milk protein so as to enhance proper viscosity and gelatinization of the product (Reed, 1982).

Preparation of culture

The thermophilic bacterial culture containing of *Lactobacillus bulgaricus, Lactobacillus lactis and Streptococcus thermophiles* was purchased from *Chr Hansen* company. It was available in 25g packets. One packet is used to culture 250 liters of milk for the preparation of the yoghurt in the aavin milk company, runs under the state government of Tamilnadu. The same procedure was adopted for the research work, the content is mixed in 250 ml of the water at 12° C inside the laminar flow. After setting, the culture was stored at freezing temperature for the further use. From this bulk culture 1ml is used to prepare one liter of the yoghurt.

Fruit preparation

Pineapple and grapes were used for the yoghurt variants. The pineapple was washed and its pulp obtained from the crushed fruit. Grape fruit was washed and chopped. 10% ratio sugar was mixed with grape and pineapple and pasteurized separately at 80°C for 20 minutes, and filled into separate jars. These pulps were stored at ambient temperature until added to yogurt.

Table 1. Quantification of Ingredients for 100g of the Yoghurt Variants

Ingredients	Variant I (Plain)		Variant II (Natural Grape)		Variant III (Synthetic grape)		Variant IV (Natural pineapple)		Variant V (Synthetic pineapple)	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Dairy milk	100ml	-	100ml	-	100ml	-	100ml	-	100ml	-
Coconut milk	-	100ml	-	100ml	-	100ml	-	100ml	-	100ml
Tapioca starch	-	2g	-	2g	-	2g	-	2g	-	2g
Agar agar	-	0.3g	-	0.3g	-	0.3g	-	0.3g	-	0.3g
Sugar	-	1g	-	1g	-	1g	-	1g	-	1g
Thermophilic Culture	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml	0.1 ml
Natural grape	-	-	15g	15g	-	-	-	-	-	-
Synthetic grape	-	-	-	-	0.5 ml	0.5ml	-	-	-	-
Natural pineapple	-	-	-	-	-	-	15g	15g	-	-
Synthetic pineapple	-	-	-	-	-	-	-	-	0.5 ml	0.5 ml

A- DAIRY YOGHURT **B- COCONUT YOGHURT**

Preparation of yoghurt

Five different variants in both dairy and coconut yoghurt were prepared. Several practical attempts were carried out with different levels of ingredients so as to select the range of percent incorporation which could be used in formulating the different variants of yoghurts. In order to make yoghurt processing attractive quite a number of process manipulations have been adopted including evaporation or concentration, addition of solids in the form of different starch, addition of different fruit pulp and synthetic fruit flavours and the lavels of starter cultures to make the yoghurt thick and free from whey separation. Through trial and error and by informal sensory evaluation the levels of ingredients were fixed (Table 1).

Pasteurized and cooled substrates were inoculated with the prepared culture (1ml was used to inoculate 1 litre). The mixture was then filled in yoghurt maker bottles and kept in the yoghurt maker for 6-7 hours to allow for fermentation. The yoghurt maker maintains the temperature between 42 - 45 °C. When the pH lies between 4.5 – 4.8, yoghurts were removed from the yoghurt maker and added with synthetic flavours and natural fruit pulp and stored at refrigerated temperature.

Sensory evaluation of the different variants of yoghurt

Sensory Evaluation is defined as "A scientific discipline used to evoke, measure, analyze, and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste, and hearing (Stone and

Sidel, 1993)." The product acceptability was assessed using a 9 point hedonic scale for the quality factors such as colour, flavor, taste, consistency and overall acceptability by a panel consisting of ten judges. The judges included the professors, research scholars and junior research fellows of the department of Food and Nutrition. The scoring scale was: 1 (Dislike extremely), 2 (Dislike very much), 3 (Dislike moderately), 4 (Dislike slightly), 5 (Neither dislike nor acceptable), 6 (Slightly acceptable), 7 (Moderately acceptable), 8 (Highly acceptable) and 9 (Extremely acceptable) (Amerine et al., 1965).

Analysis of physico chemical properties and selected nutrient components for the milk samples and yoghurts

Milk samples and the selected yoghurt variant from the sensory evaluation were analysed in triplicates for physico chemical properties. Ph was determined in a digital type pH meter. Total acidity, total solids and moisture were determined using AOAC (1990). The method of Isanga and Zhang (2009) was used to determine susceptibility to synergies (STS). The yoghurt sample (20 ml) was placed on a filter paper on top of a funnel and allowed to drain for 3 h. The index of synergisis was calculated from the formula:

STS (%) = V1/V2 x 100.

[V1 = Volume of whey collected after drainage; V2 = Volume of yoghurt sample].

The method of Harte et al. (2003), with slight modification, was used to determine the water holding capacity (WHC) of stirred yoghurt samples after subjecting them to 15 min centrifugation at 6000 rpm at 5°C in a centrifuge.

WHC was calculated using the formula: WHC (%) = {1 – [W1/W2]} x 100

[W1 = weight of whey after centrifugation and W2 = weight of the yoghurt used].

Milk samples and the selected yoghurt variant form the sensory evaluation were analyzed in triplicates for the nutrient components namely energy, carbohydrate, protein, and fat by AOAC method (1990).

Results and discussion

Sensory evaluation

Using the rating test, differences were observed for degree of liking of colour, flavor, taste, consistency and overall acceptability. Dairy yoghurt with natural grape had got least score for colour (6.9 ±1.52) (Table 2), pineapple flavoured coconut yoghurt had scored high for all the sensory criteria (colour (8.7 ±0.95), taste (8.6 ±0.52), consistency (8.3 ±0.48) and overall acceptability (8.4 ±0.52) except flavour. In food products, especially fruit-based ones, the consumer often assesses the initial quality by their color and appearance; hence these attributes are the primary indicators of perceived quality (Lawless and Heymann, 1999). Moreover, color is a parameter for consideration for novel foods due to their initial acceptability by potential consumers, and color also determines purchase and regular consumption of products (Tarrega and Costell, 2007). The combination of pineapple and coconut yoghurt was excellent. Plain dairy yoghurt scored highest value for the flavor (8.6±0.70) on comparison with other variants, this might be because all the panelists were used to dairy yoghurt for a long period which might have influence the degree of liking for flavor than others.

Coconut yoghurt had scored high mean score for consistency in all the variants on comparison with dairy yoghurt, this is particularly due to the inclusion of stabilizer (0.3 percent) in coconut yoghurt. Chawla and Balachandran (1994) stated that incorporation of SNF in milk contribute to refinement in taste of yoghurt with improved consistency, viscosity and reduced whey separation. Stabilizer levels had significant effect on body and texture of indicating that the frozen yoghurt at 0.5 percent stabilizer was the best quality product with firm body and smooth texture.

Among all the five variants, variant IV (Natural pineapple) had received highest scores for the sensory attributes (pineapple flavoured dairy milk yoghurt colour – 8.4 ± 1.07, flavor – 8.5 ± 0.97 , taste – 8.3 ± 0.82 , consistency – 7.3 ± 1.70 , and overall acceptability – 8.3 ± 1.34 and coconut milk yoghurt colour – 8.7 ±0.95,

Table 2. Mean Organoleptic Scores of the Yoghurt Variants

Criteria	Variant I (Plain yoghurt)		Variant II (Natural grape)		Variant III (Synthetic grape)		Variant IV (Natural pineapple)		Variant V (Synthetic pineapple)	
	A	B	A	B	A	B	A	B	A	B
Colour	8.3±1.57	8.4±0.70	6.9±1.52	7.4 ±0.97	8.1±1.20	8 ± 0.94	8.4 ±1.07	8.7±0.95	7.8±1.62	8±1.15
Flavour	8.6±0.70	7.6±0.84	7.7±0.82	7.8 ±0.79	7±1.41	7.5±1.35	8.5 ±0.97	8.5±0.53	6.4±2.01	6.6±1.26
Taste	7.4±1.35	7.8±1.03	6.6±1.43	8.2 ±0.63	6.2±1.40	7.4±0.97	8.3 ±0.82	8.6±0.52	5.8±1.81	6.5±1.43
Consistency	7.4±1.78	8.4±0.52	5.9±1.92	8.3 ±0.48	6±1.83	8.4±0.52	7.3 ±1.70	8.3±0.48	6.2±1.62	8.3±0.48
Overall acceptability	8.2±0.92	7.6±0.97	7.1±0.88	7.4 ±0.97	5.5±1.43	7.2±0.92	8.3 ±1.34	8.4±0.52	5.5±1.72	6.9±0.57

A- Dairy yoghurt B- Coconut yoghurt

Table 3. Physicochemical properties of the milk samples

S. no	Parameters	Dairy milk	Coconut milk
1	PH	6.26 ± 0.05	5.28 ± 0.02
2	Total solids	14.30 ± 0.01	19.70 ± 0.005
3	Total acidity	0.77 ± 0.005	0.91 ± 0
4	Moisture	85.67 ± 0.01	81.23 ± 0.05

flavor – 8.5 ± 0.53 , taste – 8.6 ± 0.52, consistency – 8.3 ± 0.48 , and overall acceptability – 8.4 ± 0.52). Hence, it was selected for the further study. The flavors are key factors for food stuff acceptability by consumers. Organoleptic evaluations have shown a marked preference for the fruity yoghurt (Barnes et al., 1991). Addition of different fruit in yogurt manufacture has been attempted increasingly. Fruit yogurt has more taste and pleasing flavor (Mahmood et al., 2008).

Physicochemical properties of the milk samples and pineapple flavoured yoghurt

The pH values of the dairy milk (6.26 ± 0.05) (Table 3) and coconut milk (5.28 ± 0.02) were similar (dairy milk – 6.3 and coconut milk – 6.0) to the results by Ladokun and Oni (2014). The total solid of dairy milk was 14.30 ± 0.0, which is lower than coconut milk (19.70 ± 0.005).

The total acidity of dairy and coconut milk were 0.77 ± 0.005 and 0.91 ± 0 respectively. The significance of moisture content in milk is that, high moisture content implies high water activity which supports microbial growth consequently reducing the shelf life of the milk sample (Ajai et al., 2012). The moisture level of the dairy milk (85.67 ± 0.01) is higher than the coconut milk (81.23 ± 0.05).

The pH of the yoghurt prepared from dairy milk and coconut milk was 4.6 ± 0 and 4.76 ± 0.05 respectively (Fig. 1). The yoghurt is removed from the yoghurt maker to stop fermentation once the pH reaches between 4.5 - 4.8. To reach this particular range of pH, the yoghurts was kept in the yoghurt maker for about 6 – 7 hours.

The total solids of the yoghurt (dairy - 19.57 ± 0.50, coconut - 26.51 ± 0.01) were increased after fermentation on comparison with

the total solids of the initial levels of the milk (dairy - 14.30 ± 0.01 %, coconut - 19.70 ± 0.005 %). The total solids are an indication of the dry matter content of the yoghurt samples (Belewu et al., 2010 and Khalifa et al., 2011).

Yoghurt made with dairy milk and coconut milk has the total acidity of 0.94 ± 0 % and 0.87 ± 0.005 % respectively. Estevez et al. (2010) also reported that higher total solids led to more acid production than lower total solids in soy yoghurts. Yousef et al. (2013) had recorded the acidity of fruit yoghurts from 0.83- 1.21 percent.

The water holding capacity of the yoghurt made with dairy milk was 57 ± 0 and coconut milk was 77.67 ± 0.57. Lower WHC or whey separation is referring to a weakness of gel network (Singh and Muthukun, 2008). Kovalenko and Briggs (2002) showed 84.1-96 % of WHC in soy-based desserts. The STS in dairy yoghurt (41.33 ± 1.15 %) was high on comparision with (11.67 ± 0.57 %) coconut yoghurt. Granato et al. (2010) developed soy-based desserts with the addition of oligo fructose and different concentrations of guava juice (22, 27, and 32%) and soy protein (1, 2, and 3%) and found that only the sample containing 27% of guava juice and 1% of soy protein had whey formation after centrifugation (7.0%), while all other desserts presented 100% WHC after 72 hours of refrigeration.

Ranganadhan and Gupta (1987) state that good quality yoghurt was a gel like coagulation and porcelain like surface without wheying off, this statement was in agreement with the coconut yoghurt in the present investigation. The improvement in WHC and STS in the coconut yoghurt is may be due to the addition of stabilizer (0.3 percent china grass) and thickening agent (2 percent tapioca starch).

The moisture content of different types of yogurt varied from 71.7- 86.3 percent (Yousef et al., 2013), which was in close relation in the present research, the moisture content of the yoghurt made with dairy milk was 80.11 ± 0.01 and the coconut milk was 73.45 ± 0.01. Moisture content and the total solids affected the texture, low moisture content and high total solid increased the firmness and consistency of yogurt and therefore gives acceptable mouthfeel.

Analysis of selected nutrient components of milk samples and pineapple flavoured yoghurt

The energy, protein, and fat levels of coconut milk (199.29 ± 0.25, 10.37 ± 0.22, 17.07 ± 0.01), is higher than dairy milk (64.24 ± 0.04, 9.3 ± 0, 8.8 ± 0). The carbohydrate level of coconut milk is less (1.30 ± 0.01) than dairy milk (2.70 ± 0.01) (Table 4).

The fat content of the milk samples ranged from 8.8 ± 0 - 17.07 ± 0.01%. The major contrast in the food proximate content was the values obtained for the fat contents. From previous studies, fat contents are usually higher in animal origin than plant origin (Belewu et al. 2010). The findings in this study disagree with earlier studies because coconut milk has the fat content of 17.07 ± 0.01%, and dairy milk has 8.8 ± 0.

Yoghurt made from coconut milk had higher nutritional values than dairy milk. The energy value of yoghurt made from dairy milk was 93.76±0.25 and that of coconut milk was 142.49 ± 2.63, which is nearly one and half times higher than dairy yoghurt. Tapioca starch was added in the preparation of coconut yoghurt, which was not used for dairy yoghurt because coconut yoghurt oozes much water during the fermentation process. To enhance the product appeal tapioca starch (2 percent) was added to the coconut yoghurt, which had an impact in raising the carbohydrate level than dairy yoghurt. The carbohydrate content was 4.46 ± 0.05 and 9.55 ± 0.12 for yoghurt made from dairy and coconut milk respectively. In the proximate analysis, the carbohydrate level of coconut milk (1.30 ± 0.01) is less than dairy milk (2.70 ± 0.01).

The energy, protein, and fat levels of coconut milk (199.29 ± 0.25, 10.37 ± 0.22, 17.07 ± 0.01), is higher than dairy milk (64.24 ± 0.04, 9.3 ± 0, 8.8 ± 0). The carbohydrate level of coconut milk is less (1.30 ± 0.01) than dairy milk (2.70 ± 0.01).

Figure 1. Physicochemical properties of the pineapple flavoured yoghurt

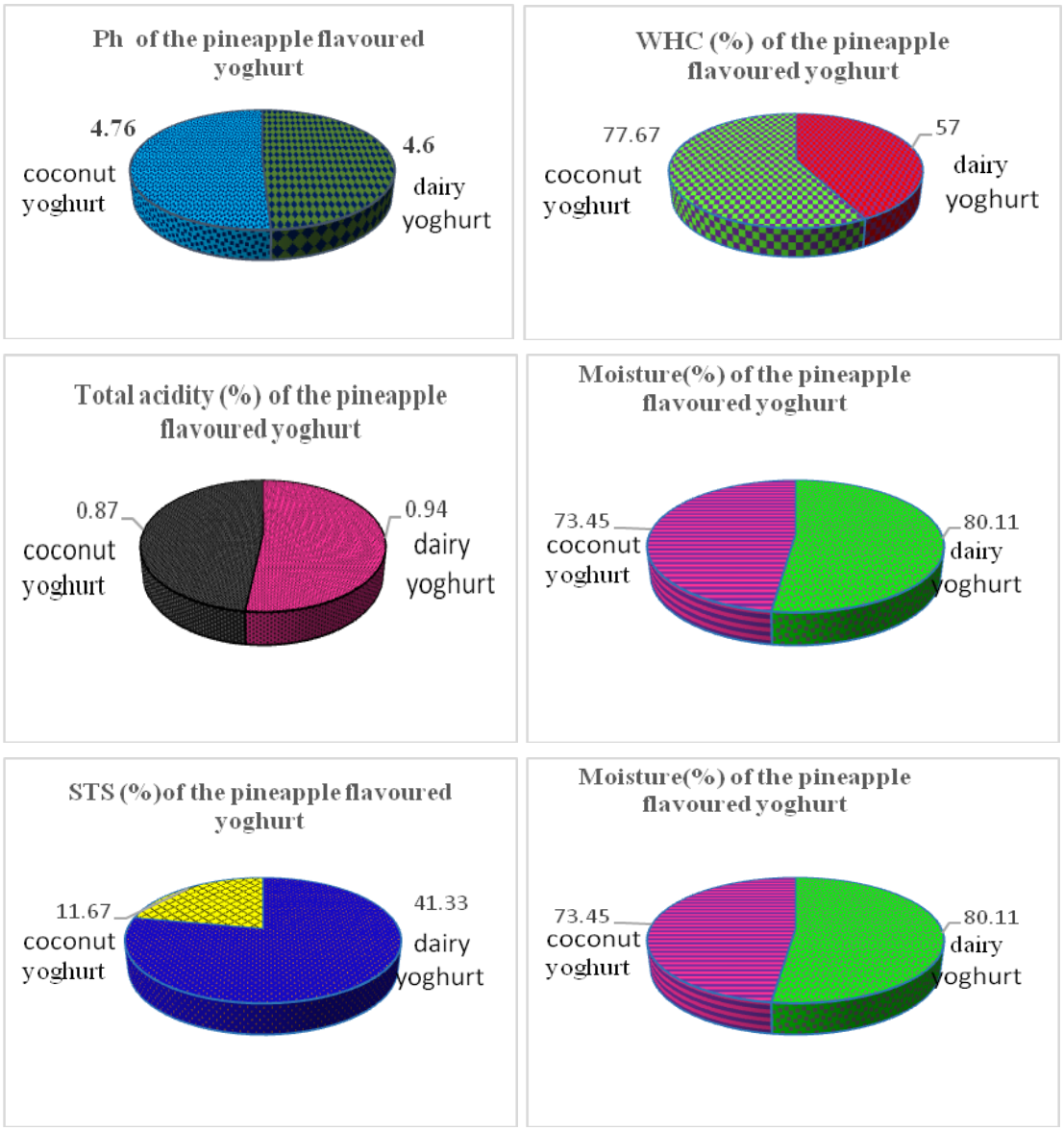

Table 4. The nutrient content of pineapple flavoured yoghurt and milk samples (100g)

S. No	Nutrients	Dairy yoghurt	Coconut yoghurt	Dairy milk	Coconut milk
1	Energy (Kcal)	93.76±0.25	142.49 ± 2.63	64.24 ± 0.04	199.29 ± 0.25
2	Carbohydrate (g)	4.46 ± 0.05	9.55 ± 0.12	2.70 ± 0.01	1.30 ± 0.01
3	Protein (g)	7.26 ± 011	8.02 ± 0.005	9.3 ± 0	10.37 ± 0.22
4	Fat (g)	9.82 ± 0.02	13.03 ± 0.05	8.8 ± 0	17.07 ± 0.01

The fat content of the milk samples ranged from 8.8 ± 0 - 17.07 ± 0.01%. The major contrast in the food proximate content was the values obtained for the fat contents. From previous studies, fat contents are usually higher in animal origin than plant origin (Belewu et al., 2010). The findings in this study disagree with earlier studies because coconut milk has the fat content of 17.07 ± 0.01%, and dairy milk has 8.8 ± 0.

All the nutrients were higher in the yoghurt made from coconut milk than dairy milk. The energy value of yoghurt made from dairy milk was 93.76±0.25 and that of coconut milk was 142.49 ± 2.63, which is nearly one and half times higher than dairy yoghurt. The carbohydrate content was 4.46 ± 0.05 and 9.55 ± 0.12 for yoghurt made from dairy and coconut milk respectively. In the proximate analysis, the carbohydrate level of coconut milk (1.30 ± 0.01) is less than dairy milk (2.70 ± 0.01).

Tapioca starch was added in the preparation of coconut yoghurt, which was not used for dairy yoghurt because naturally dairy milk get curdled due to denaturation of protein during the fermentation process. In the coconut milk even though it has high protein content than dairy milk, the quality of the protein is not much related to dairy milk, thus oozes much water during the fermentation process. To enhance the product appeal tapioca starch (2 percent) was added to the coconut yoghurt, which had an impact in raising the carbohydrate level than dairy yoghurt.

The protein level of the yoghurt made from dairy milk (7.26 ± 011) and coconut milk (8.02 ± 0.005) were in the equal range. Ndife, et al. (2014) had reported the protein content of yoghurt enriched with coconut ranges between 2.17 to 3.05%. The fat level of dairy yoghurt (9.82 ± 0.02) was less on comparison with coconut yoghurt (13.03 ± 0.05).

Conclusion

The data emanating from the present study depicts that, yoghurt can be prepared from coconut milk exclusively with stabilizer and thickening agent and can be comparable with normal dairy yoghurt. The sensory scores evoked that yoghurt is highly acceptable with natural pineapple pulp than synthetic. Coconut yoghurt also had good nutritional value on comparison with dairy yoghurt. The addition of fruit in the yoghurt could improve the taste preference of the yoghurt that one can expect. Coconut yoghurt could be helpful in meeting a significant portion of the daily needs of the nutrients for lactose intolerants, hence it can be recommended as a promising substitute for normal yoghurt.

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