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Comparative evaluation of yoghurt samples from goats and cows milk and commercial retail outlet

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Abstract

This paper compared the chemical (proximate and mineral), acidity, microbial count and organoleptic properties of yoghurt samples produced from Nigeria locally bred goat and cow milk with commercially retail yoghurt during 14 days of refrigerated storage. Yoghurt production was conducted by inoculation of the milk samples at 43°C ± 2°C for 6hrs with 2% of streptococcus-thermophillus and lactobacillus bulgarus active culture. The total ash content of yoghurt ranges from 0.23g/100g in the commercial yoghurt sample to 0.84 g/100g in yoghurt from goat milk which is considered significantly higher than that observed for yoghurt from cow milk. The commercially retail yoghurt had a significantly higher ($P < 0.05$) total solid matter than yoghurt from goat and cow milk. Calcium and phosphorus contents were significantly ($P < 0.05$) lowest in the commercial yoghurt (0.28%) to a significant higher value of 0.85% in goat milk. A statistically significant drop in pH value was observed in the commercial yoghurt sample after one and two week storage compared to yoghurts from goat and cow milk. High lactic acid bacteria were observed in yoghurt from cow milk with lactococci group being higher than the lactobacilli group throughout the storage period. The yeast count range from a significant low ($P <. 05$) value of 2.22 cfu/mL^{-1} in commercial yoghurt sample to 3.22 and 3.24 in goat and cow milk respectively on day zero of storage. By the 7 days of storage, the commercially retail yoghurt was significant ($P < 0.05$) least desirable with respect to colour, taste and overall acceptability while there was no significant difference in the consistency of all the yoghurt samples.

Keywords: *Goat milk, cowmilk,commercial retail yoahurts, chemical and organoleptic properties.*
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Introduction

Livestock are the main stay of pastoral people and contribute to food security during harsh environmental situation in developing countries. Ohiokpehai (2003) noted that immediately after a disaster like drought, goats ensured a family's livelihood and food security. Goat husbandry has been part of agriculture since almost the first use of domestic animals and presently its popularity is increasing throughout the world, this increase is reflected to a greater degree by the rise in the number of small herds maintained by individuals either as a source of income or as an avocation. Most of the goats in the tropical countries are kept for meat production, and are rarely milked despite it availability all year round and greatest potential as producers of good quality milk. Ohiokpehai (2003) reported the promotion of the full use of goat milk at household level to achieve cheap balanced diet and food/nutrition security is yet to be exploited. When exploited appropriately, it could contribute to expand food supplies in developing countries, thus providing an environment for food security.

Akinnokun (1975) reported that the average Nigerian consumes less than three quarters of his animal protein needs for repair of body tissue. Low intake of animal protein greatly diminishes the efficiency of most economic activities as manifested in reduced human productivity, malnutrition, high infant mortability, short life span and various types of wasting diseases.

Among all foods, milk is regarded as the most complete and most balanced in nutritional contents. Haenlein, (2002) reported that milk changes from sweet to sour, from liquid to increasingly solid while retaining its food qualities in the form of sour milk, yoghurt and cheeses. Sensitivity to cow milk usually becomes apparent in early infancy, often within a few days of the baby being given a formula of cow milk for the first time (Van der Horst 1976). The use of goat milk as a substitute in cases of allergy or intolerance to cow milk formula has been a major concern over the past decades (Maree, 1978). Goat milk has been found to be well tolerated by infants, especially those with gastrointestinal or respiratory symptoms and even those who suffered shock from ingestion of cow milk (Sampson and Burks, 1996).

Yoghurt is the Turkish word for milk that has been curdled with a lactic starter (Fias Co Farm 2006). Coagulation of the milk proteins is induced by thermophilic bacteria, such as *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* (Tamime *et al* 1989). These bacteria propagate well at an elevated temperature of 40°C to 45°C and aid digestion as well as the synthesis of vitamins (Modler and Kaláb 1983). The processing of yoghurt requires that the milk is coagulated by a slowly increasing concentration of lactic acid as the bacteria metabolize lactose. Lactic acid is much easier for the body to digest than milk sugars, so even people who can not drink milk due to lactose intolerant can still tolerate yoghurt intake. Compared to other milk products such as cheese, ice cream, or butter, yoghurt contains most milk constituents except lactose which the bacteria convert into lactic acid. This acid gives the yoghurt a pleasant acidic flavour and, at the same time, the sweetness caused by lactose is reduced. Tamime *et al*(1991) remarked that lactic acid bacteria protect the yoghurt from harmful pathogenic microorganisms and thus give it a longer shelf life.

The objective of this study was to determine the suitability of goat milk for home-made yoghurt to enhance the nutrient intake of not only the poor resource goat farmers as well as accessing the chemical, mineral and microbial properties of yoghurt prepared from goat ad cow milk.

Materials and Methods

The experimental materials were milk from goat and cow obtained from local breeds in Igangan, Oyo State of Nigeria during the middle of lactation. The control samples (Commercial yoghurt) was purchased (with expiration date within experimental period) 24hrs prior to analysis and stored at a temperature of 6°C ± 1°C. The yoghurt was produced from the goat and cow milk according to the method described by Domagałal and Kupiec (2003) and Cais-Sokolinska *et al* (2004) with slight modification. Raw milk was heated at 85°C ± 4°C for 15 min in water bath, cooled down to 43°C ± 2°C and inoculated with 2% of *streptococcus-thermophillus* and *lactobacillus bulgarus* active culture. Incubation was terminated after 6hrs by an instantaneous reduction of the temperature to 7°C ± 1°C and allowed to mature for 20hrs. Then the product was cooled down to 6°C ± 1°C and stored at this temperature for 0, 7 and 14 days before some analysis. During the storage period, the products were analysed on the 0, 7 and 14 days for acidity level (pH and °SH), microbial and sensory properties. Proximate and mineral analysis was done 24hrs after the production of the yoghurt samples

Yoghurt Sample Analyses

The proximate, mineral, acidity (titratable and pH), microbial, and organoleptic measurements were determined in the yoghurt samples. The contents of protein, fat, total solids, and ash were determined by using the Kjeldahl method, Gerber method, drying at 105°C until constant mass, and ashing at 550°C, respectively, according to the standard methods of AOAC (1995). The mineral constituents except phosphorous, were done by atomic absorption spectrophotometer using a Perkin-Elmer 560 instrument; phosphorus was determined using calorimetric method (IDF/ISO, 1992). The pH value was determined using a pH meter (Knick, type 647-1), and the titratable acidity was measured using the Soxhlet–Henkel method and result expressed in Soxhlet-Henkel degrees (°SH). The microbial determination was done using the method described by Guizani *et al* (2001). Yoghurt samples were mixed and dilutions prepared in a sterile 0.1% peptone diluents. Aliquots of 0.1 mL of the dilutions were spread inoculated over the surface of standard microbial. Culture media and incubation conditions used for the different microbial groups were: total aerobic plate counts on plate count agar at 30 °C for 72 h; lactococci on M17 agar at 30 °C for 72 h; lactobacilli on MRS agar at 30 °C for 24-36 h and yeasts on potato dextrose agar acidified with tartaric acid to pH 3.5 at 30 °C for 3 days. Plating was performed aerobically in duplicates for each dilution. The results are expressed as colony-forming units (cfu) mL^{-1} of yoghurt. Purified strains of lactic acid bacteria were identified using resistance to 4 and 6.5% NaCl, growth in litmus milk, growth at 10, 15 and 45°C and at pH 9.6 (morphological and cultural characteristics). Isolates were further identified using the API 50 CHLtest kit for the genus Lactobacillus and API 20 STREP test kit for the genera Lactococcus. Organoleptic evaluation was done on a 5-point hedonic scale test as described by Munoz *et al.* (1992). Twenty panellists conducted the evaluation assessing the degree of liking for attributes of appearance, colour, flavour, consistency, taste, and over all acceptability.

Statistical Analyses

The yoghurt production was done in three repetition and three yoghurt samples were collected from each replicate (n=9). Statistical analyses were carried out using the Excel spread sheet and statistical software SPSS/PC+ package (Norusis 1992).

Results and Discussion

Table 1 shows a significant difference in the moisture content of all the yoghurt samples. The commercially purchased yoghurt was significantly ($P < 0.05$) lower in crude protein, fat, and ash but higher in non protein nitrogen. Goat's milk contained 1.5g/100g total solids lower than cow's milk, but had 1.1g/100g and 0.22g/100g more of protein and ash, respectively (Table 1). The total ash content of yoghurt samples ranges from 0.23g/100g in the commercial yoghurt sample to 0.84 g/100g in yoghurt from goat milk which is considered significantly higher than that observed for yoghurt from cow milk. While there has been variance in the value of

Table 1: Chemical properties of the yoghurt samples (g/100g)

Nutrients	Goat milk yoghurt	Cow milk yoghurt	Commercial yoghurt
Moisture	84.4 ± 0.5^a	85.3 ± 0.7^a	85.9 ± 0.5^a
Crude Protein	6.5 ± 0.4^a	5.4 ± 0.3^b	2.6 ± 0.3^c
Non protein nitrogen	7.6 ± 1.0^c	5.3 ± 1.0^c	11.2 ± 1.0^a
Fat	4.2 ± 0.4^a	4.8 ± 0.6^b	2.6 ± 0.3^c
Ash	0.84 ± 0.1^a	0.62 ± 0.1^b	0.23 ± 0.1^c
Total Solid	13.1 ± 0.4^b	14.6 ± 0.4^b	18.6 ± 0.3^a

Means with different letters within a row are significantly different at ($P<0.05$).

Table 2: Mineral Composition of the yoghurt processed from goat and cow milk and commercially retailed (%)

Minerals	Goat milk yoghurt	Cow milk yoghurt	Commercial yoghurt
Calcium	3.10 ± 0.04^a	2.90 ± 0.01^b	2.40 ± 0.01^c
Phosphorus	0.85 ± 0.01^a	0.47 ± 0.03^b	0.28 ± 0.03^c
Potassium	2.47 ± 0.05^a	2.57 ± 0.04^a	1.40 ± 0.02^c
Magnesium	1.80± 0.15a	1.20± 0.30b	1.07± 0.24c
Sodium	2.50 ± 0.62^a	1.48 ± 0.24^b	1.18 ± 0.36^c

Means with different letters within a row are significantly different at ($P<0.05$).

protein, the quantity of ash is always higher in goat milk and products in comparison with cow milk and products (Modler and Kalab 1983; Bozanic and Tratnik 2001; Tratnik *et al* 2006). The commercially retail yoghurt had a significantly higher ($P < 0.05$) total solid matter than yoghurt from goat and cow milk. This could be because the typical standardization industrial processing of yoghurt involves reducing the fat content and increasing the total solids (Tamime *et al* 1991). The solid matter could be increased by the addition of concentrated milk or milk powder. Increasing the solid content makes it easier to produce firmer yoghurt and thus the acceptability, which is the ultimate goal of any manufacturing industry.

Table 2 shows that the concentrations of the various elements of the ash fraction demonstrate a wide variation. Calcium and phosphorus content was significantly ($p< 0.05$) lowest in the commercial yoghurt (2.01 and 0.28% respectively) to a significant higher value of 3.1 and 0.85% respectively in goat milk yoghurt. Implication of this high Ca and P in goat milk yoghurt could be of importance in achieving a high level of peak bone mass (PBM) during childhood and adolescence while it could assist in maintaining and reducing PBM and bone loss during adulthood and old age respectively. It should be noted that nutritional value of milk is often evaluated in terms of the calcium and phosphorous that the milk makes available. In previous studies (Tamime *et al* 1991), the concentrations of these two minerals are similar in cow and goat milk yoghurt. Similar to previous studies (Guizani 2001; Tratnik *et al* 2006), significant difference in the value of magnesium and sodium was observed for all yoghurt samples in the present study. According to Tratnik *et al* (2006), goat's milk has higher mineral levels than cow's milk, especially potassium, chlorine and magnesium, which makes the taste of goat's milk rather salty. Haenlein (2004) associated the high sodium in goat yoghurt to physiological origin or from influence of infectious mastitis which causes the sodium chloride concentration to increase.

The lowest titratable acidity (TTA) directly after production was found in commercial yoghurt and highest in yoghurt from goat milk (Table 3). A similar higher TTA was observed in goat's kefir (fermented milk) while examining the quality of plain and supplemented kefir from goat's and cow's milk (Tratnik *et al* 2006). The low TTA observed in the commercially retailed yoghurt could be due to the duration of incubation. Cais-Sokolińska *et al* (2004) previously reported that the incubation time of the inoculated processed milk had a significant impact on the TTA of the examined yoghurts, irrespective of the type of the applied bacterial cultures. Except for yoghurt from cow milk that had a significant higher TTA on the last day of storage, no significant increment was observed for other yoghurt samples. Bonczar and Reguła (2003) observed the same result in an experiment on the influence of different amount of starter culture on the properties of yoghurts from ewe's milk. In the contrary, Bonczar *et al* (2002) observed lower titratable acidity in fresh yoghurts.

The acidity level in each yoghurt samples during the storage period remained statistically the same after one week storage (Table 3). A significant pH value of between 4.32 and 4.45 was observed for cow milk yoghurt in the present study. Contrarily, lower pH value has previously been reported for goat milk when compared with cow milk (Ohiokpehai 2003, Gall 1981). No significant drop in pH value for all yoghurt samples after 14 days storage. Salji and Ismail (1983) previously found a decline of the pH value from 1.3 to 9.6% of the yoghurt stored for 3 weeks at the temperature of 7°C.

The load counts of the micro-organisms are summarized in Table 4. As shown, the total bacteria counts and yeast were significantly ($p < 0.05$) high in yoghurts form goat and cow milk in comparison with the commercially retail yoghurt. The lactic acid bacteria are reported as lactococci and lactobacilli in the present study (Table 4). These two organisms are reported to play a major role in the manufacture of cultured dairy products (Guizani *et al* 2001). In yoghurts from goat and cow milk, lactococci group is higher than the lactobacilli group throughout the study. This was contrary for the commercially retail yoghurt after 7days storage. Baroudi and Collins (1975) earlier reported the predominant of lactobacilli in commercial yoghurts. Yoghurt from cow milk has

Table 3: Titratable and active acidity pH in yoghurts samples at before and during storage in cold conditions for 14 days

Yoghurt Samples	Storage Days 0	7	14
		Titratable acidity (°SH)	
Goat	43.43 ± 2.57	43.91 ±1.30	44.24 ± 1.16
Cow	38.51 ± 1.38	39.44 ± 1.45	40.53 ± 1.08
Commercial	32.81 ± 1.04	33.01 ± 1.33	32.67 ± 2.74
		Active Acidity pH	
Goat	4.80 ± 0.08^{ac}	4.86 ± 0.04^{ab}	4.59 ± 0.12^{ab}
Cow	4.41 ± 0.11^{c}	4.45 ± 0.11^{b}	4.32 ± 0.06^{b}
Commercial	5.67 ± 0.14^{a}	5.22 ± 0.14^{a}	5.01 ± 0.01^{a}

Means with different letters within a row are significantly different at (P<0.05).

Table 4: Microbial load analysis of yoghurt sample s (cfu/mL^{-1})

	Goat	Cow milk yoghurt	Commercial yoghurt
0 day			
Total Mesophilic Flora	8.40 ± 0.17^{b}	8.00 ± 0.42^{b}	3.00 ± 0.09^{a}
Lactic Acid Bacteria			
Lactococci	5.30± 0.20^{c}	8.12 ± 0.34^{a}	6.20 ± 0.18^{b}
lactobacilli	5.18± 0.19^{b}	6.58 ± 0.11^{b}	5.51 ± 0.51^{b}
Yeast	3.22 ± 0.16^{a}	3.34 ± 0.20^{a}	2.22 ± 0.23^{b}
7 day			
Total Viable Count	8.80 ± 0.23^{a}	8.80 ± 0.19^{a}	3.80 ± 0.31^{b}
Lactic Acid Bacteria			
Lactococci	5.40± 0.20^{c}	8.40± 0.00^{a}	6.01± 0.12^{c}
lactobacilli	5.58± 0.19^{b}	5.90± 0.09^{b}	7.17± 0.13^{b}
Yeast Count	3.28 ± 0.10^{a}	3.26 ± 0.06^{a}	2.33 ± 0.06^{b}
14 day			
Total Viable Count	10.80 ± 0.17^{a}	11.80 ± 0.17^{a}	6.80 ± 0.17^{a}
Lactic Acid Bacteria			
Lactococci	6.07± 0.20^{a}	6.24± 0.20^{a}	5.31± 0.20^{b}
lactobacilli	7.58± 0.19^{b}	7.58± 0.19^{b}	6.58± 0.19^{b}
Yeast Count	3.14 ± 0.16^{b}	3.22 ± 0.16^{a}	3.22 ± 0.16^{c}

Means with different letters within a row are significantly different at ($P<0.05$).

a significant higher ($p < 0.05$) lactic acid bacteria in the present study. This could be attributed to the higher lactose in cow's milk. Ohiokpehai (2003) reported a range of 40-45% and 45-50% respectively in goat and cow milk. High lactic acid in yoghurt could be attributed to increase potential in acidity and souring capacity (Gomes and Malcata 1999).

Yeasts were detected in all the yoghurt samples (Table 4). The yeast count range from a significant low (P<05) value of 2.22 cfu/mL^{-1} in commercial yoghurt sample to 3.22 and 3.24 in goat and cow milk respectively on day zero of storage. However, their presence is relatively small in numbers compared with the counts of lactic acid bacteria. Yeasts have been reported in many dairy products such as yoghurt (Suriyarachchi and Fleet, 1981), cottage cheese (Fleet and Mian, 1987), cream (Fleet, 1990), and seem to have diverse roles in dairy products (Guizani *et al* 2001). Suriyarachchi and Fleet, (1981) observed that yeasts play major role as spoilage microorganisms in some dairy products as well as playing a beneficial role in the production of some fermented dairy products as they could activate the growth of lactic acid bacteria (Terzaghi, and Sandine 1975). Baroudi and Collins (1975) showed that yeasts were responsible for the production of acetaldehyde and ethanol in traditional Lebanese laban (Lebanese yoghurt). The results of the organoleptic assessment (colour, flavour, taste, consistency, and overall acceptability) of the three yoghurt samples during days of storage are presented in Table 5. According to the evaluating persons there was no significant difference in the overall acceptability of all the yoghurts on the zero and 7 days of storage. Contrarily, goat milk products has been reported to have lower sensory scores than cow milk products but could be improved by addition of flavour (Tratnik *et al* 2006).The commercial yoghurt was however most desirable in term of taste and flavour. This could be due to the fact that many commercially retail yoghurt are sweetened and flavoured. The consistency of yoghurt from the goat milk was least desired by the panellists. According to previous

Table 5: Sensory analysis* yoghurt samples from goat, cow and commercial yoghurt

	Goat	Cow	Commercial
0 day			
Colour	3.3 ± 0.06[a]	3.3 ± 0.00[a]	3.5 ± 0.06[a]
Flavour	3.1 ± 0.14[b]	3.3 ± 0.08[b]	4.2 ± 0.10[a]
Taste	3.8 ± 0.06[b]	3.5 ± 0.12[b]	4.5 ± 0.07[a]
Consistency	3.5 ± 0.03[b]	4.8 ± 0.01[a]	4.7 ± 0.05[a]
Overall Acceptability	3.5 ± 0.13[a]	3.9 ± 0.11[a]	3.5 ± 0.13[a]
7 day			
Colour	3.6 ± 1.01[a]	3.4 ±1.02[a]	2.6 ± 1.01[b]
Flavour	3.5 ± 0.12[a]	4.0 ± 1.08[a]	4.0± 0.10[a]
Taste	3.3 ± 0.15[a]	3.4 ± 0.13[a]	2.4 ± 0.07[b]
Consistency	3.2 ± 0.08[a]	3.6 ± 0.04[a]	3.4 ± 0.11[a]
Overall Acceptability	3.4 ± 0.11[a]	3.3 ± 0.23[a]	2.5 ± 0.13[b]
14 day			
Colour	3.2 ± 0.06[a]	3.0 ± 0.00[a]	2.4 ± 0.06[b]
Flavour	3.2 ± 0.14[a]	2.9 ± 0.08[ab]	2.4 ± 0.11[b]
Taste	2.5 ± 0.06[a]	2.4 ± 0.12[a]	2.2 ± 0.07[a]
Consistency	2.9 ± 0.03[ab]	3.0 ± 0.03[a]	2.5 ± 0.05[b]
Overall Acceptability	2.7 ± 0.13[a]	2.9 ± 0.11[a]	2.0 ± 0.13[b]

*A hedonic scale presented in 5 categories (1= dislike very much, 2 = dislike, 3 = neither dislike nor like, 4 = like and 5 = like very much). 1

Means with different letters within a row are significantly different at ($P<0.05$).

published data, fermented goat's milk usually has lower gel firmness and softer consistency in comparison with cow's milk (Alichandis and Polychroniadou 1997; Martin-Diana *et al* 2003). By the 14 days of storage, the commercially retail yoghurt was significant ($p < 0.05$) least desirable with respect to colour, taste and overall acceptability while no significant difference in the consistency of all the yoghurt samples was observed. Effect of the storage time resulting in less desirability for all yoghurt samples was observed on the 14 days of storage.

Conclusion

Results obtained in this study showed that goat milk compared favourably well with cow milk in the production of yoghurt. A yoghurt sample from goat milk was superior in terms of Ca, P and Na to cow milk and commercial yoghurt samples. While total bacteria counts and yeast were higher in yoghurts from goat and cow milk in comparison with the commercially retail yoghurt, lowest TTA was observed for commercial yoghurt. The sensory desirability of all yoghurt samples diminishes after 14 days storage. The present study shows that type of raw milk and period of storage affect yoghurt quality. Based on the result of this study, a shelf-life of about 7 days is recommended for home-made yoghurt from either goat or cow milk.

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