International Journal of Biotechnology and Food Science
Vol. 3(4), pp. 41-48, July 2015
ISSN: 2384-7344
Research Paper

Evaluation and acceptability of yoghurt drink processed from goat milk and a combination of goat and cow milks

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Accepted 19th June 2015

Abstract. The present study was undertaken to determine the suitability and acceptability of yoghurt drink prepared from goat milk, either singly or admixed with 75% cow milk. Chemical and microbial analyses were carried out on both the fresh milk and the prepared product. The chemical analysis included quantification of the fat, protein, moisture, ash, total solids (TS), pH and titratable acidity (TA) of the fresh milk and the yoghurt drink; while the microbial analysis included the determination of the total bacterial count (TBC), coliform count, yeast and mould counts of the fresh milk prior to processing and on processed yoghurt drink 24 h after the processing. Sensory evaluation was also conducted on the processed yoghurt drink to determine the level of acceptability of the product. Results of the chemical and microbial analyses, as well as the sensory evaluation of yoghurt drinks prepared separately from goat and cow milks and the admixture, showed that the composition of goat milk is comparable to that of cow's milk (goat's milk was even better in some aspects than the cow's milk). The mean composition of protein, fat and lactose recorded in goat and cow milks were 3.62 ± 0.11 and 3.45 ± 0.12; 4.15 ± 0.32 and 4.63 ± 0.35; 4.63 ± 0.35, 4.68 ± 0.23 and 4.92 ± 0.28, respectively; whereas the mean TS contents of the two milks were 13.17 ± 0.22 and 13.80 ± 0.17, respectively. Similarly, the average total bacterial counts (TBC) in fresh milk samples taken directly from the pooled milk were 2.7×10^3 and 3.7×10^3 cfu/ml for goat and cow's milk, respectively. The organoleptic property (appearance, taste, texture and flavour) of goat milk yoghurt drink was adjudged acceptable compared with that of cow. It was concluded that goat milk has a very good potential for future utilization on commercial level, including yoghurt production in Nigeria.

Keywords: Goat milk, cow milk, yoghurt, organoleptic property, pH, titratable acidity.

INTRODUCTION

Milk is a complex biological fluid secreted in the mammary glands of mammals. Its function is to meet the nutritional needs of neonates of the species from which the milk is derived. However, milk and dairy products form a significant part of the human diet. They are rich sources of nutrients such as proteins, fats, vitamins and minerals; ironically, it is because of this that these products are susceptible to rapid microbial growth. In some instances, this microbial growth may be beneficial, while in others it is undesirable. Dairy products are vulnerable to spoilage or contamination with pathogens or microbial toxins; therefore, the microbiology of milk products is of key interest to milk handlers and those in the dairy industry.

Nigeria, with a population of more than 170 million is grossly underprovided with essential food components - particularly the milk protein. Reports indicate that cow provides essentially all the fluid milk consumed (Igwegbe et al., 2014); and that milk production has been nose diving or at best has remained constant since 1994 in the country. To ameliorate this problem of low-level protein intake, especially from cheap dairy sources, there is the need for concerted effort to bring about the massive production and utilization of protein based food items from milk of other animal species such as goat, and at competitive costs so that they would be affordable to the general masses. Goats are produced in appreciable numbers particularly in the Northern parts of Nigeria, estimates from the Federal Livestock Department in 1990 showed that there were 23 million goats in the country and that this number increased to 28 million in 2006 (FAO, 2006). The highly populated countries of Asia and Africa account for more than 70% of the world's goats, yet the per capita milk intake is low in those countries. Goats are prominent in Switzerland, Italy, Germany, France, Spain, the Island of Malta, Egypt, Russia, Norway, England, Australia, New Zealand, the United States and in many Asian countries (Campbell and Marshall, 1975; Linda et al., 2004). Goat meat is widely accepted and consumed round the globe, but the milk is only gaining in popularity and is being sold in supermarkets across the United States, Europe and Asia and represents a little portion of the bulk of the liquid milk market in those regions. In Nigeria, goat milk is still not yet widely consumed mainly because the populace is not aware of its high nutritional benefits.

Goats are enjoyable animals, easy to handle and haul, and relatively inexpensive to purchase, feed, and house. Goats, especially pasture-based production, offer the opportunity for profitable and sustainable diversity on a small farm (Knoess, 1979). For example, a vegetable farm can use goats to clean up weeds and fertilize the land, while producing milk for the family or for raising kids, calves, pigs, or other livestock. Goats will browse and help keep pastures from being overrun with woody plant species (Linda et al., 2004). In Nigeria, goats play a significant socio-economic role in the life of the people: they are slaughtered during ceremonies and festivals, and serve as a source of ready cash to small farmers.

Reports from various studies indicate that goat's milk has many medicinal properties. Since the time of Hippocrates, physicians have recommended goat milk for infants and invalids because it is so easily digested (Walker, 1964; Campbell and Marshall, 1975; Ohiokpehai, 2003). In a comparative study on the properties of goat milk with that of cow, Castro (2007) observed that goat milk could help in preventing diseases such as anemia and bone demineralization. He also found goat milk to be helpful in the digestion and metabolic utilization of minerals such as iron, calcium, phosphorus and magnesium. Moreover, goat milk can often be enjoyed by people who are allergic or intolerant to cow milk (Chibuzo, 1995), and infants of all species generally thrive on goat milk. Goat milk as a substitute for cow milk was investigated in 38 children during a 5 months period (Haenlein, 2004). The children on goat milk were observed to surpass those on cow milk in weight gain, height, skeletal mineralization, and blood serum contents of vitamin A, calcium, thiamin, riboflavin, niacin and hemoglobin. Similar findings were obtained in studies with rats (Park et al., 1986). Also, in French clinical studies over a 20 year period with cow milk allergy patients, the conclusion was that substitution with goat milk was followed by "undeniable" improvements (Haenlein, 1992). Additionally, persons allergic to certain foods can usually drink goat milk without ill effects. Value-added products such as cheese and yogurt made from goat milk are finding a growing acceptance in the dairy market, with sales of goat cheese reported to have increased by more than 16% in USA in the year 2000 (Linda et al., 2004).

Whereas few countries like the USA, France and the UK have pioneered a very well-organized industry for goat milk production, processing, marketing, promotion and research which has created a strong consumer clientele-like in those countries, this deserves very much to be copied in countries, such as Nigeria and other developing countries, for the general benefit to human nutrition on one hand, and goat and goat milk producers on the other hand. The present study was designed to evaluate the chemical composition and microbiological quality of a pool of fresh goats' milk and the organoleptic properties of yoghurt manufactured from the milk. The success in this study will help to prepare an enabling environment for the commercial production of fermented milk products from goat milk in Nigeria.

MATERIALS AND METHODS

Collection of the goat and cow milk samples

Samples of fresh goat and cow milk were purchased directly, from pools of the milk, from herds owned by farmers around Maiduguri Metropolis (Alua, Gidan Madara, Kasuwa Shani, Auna as well as from the University of Maiduguri Animal Farm). The milk was produced through hand milking of the animals, as it is the usual practice among the farmers in the areas, and samples were collected under strictly sterile conditions into clean plastic containers (20 L). Equal volumes of fresh goat and cow milk were purchased and transported to the Food Science and Technology Laboratory, University of Maiduguri and that of the National Agency for Food, Drug Administration and Control (NAFDAC), in iced coolers, for the organoleptic qualities (visual appearance, smell and flavour), proximate and microbial analyses of the fresh milk samples. Samples were stored at less than 7°C; the analyses on fresh pooled milk samples were carried out within 12 to 24 h after collection of the samples while those of the yoghurt, including sensory evaluation, were conducted twenty-four (24) hours after processing.

Proximate analysis of fresh milk samples

Fresh milk samples were analyzed in the laboratory for proximate composition — moisture, fat, protein, lactose, ash and total solids (TS), in addition to the measurement of the pH and titratable acidity (TA), in accordance with the procedures outlined in Atherton and Newlander (1981), AOAC (2000) and Suzanne Nielson (2010). Protein was determined through the quantification of the nitrogen content by the standard Micro-Kjeldahl method (AOAC, 2000; Nielson, 2010) and multiplying the total nitrogen obtained by a conversion factor of 6.38 to arrive at protein content. Fat content was determined by Gerber method (Atherton and Newlander, 1981; AOAC, 2000). The ash content was determined following the procedures described by Igwegbe et al. (2013); the lactose content was determined by subtracting the sum of protein, fat, ash and moisture from 100; the pH was measured with a pH meter (Model WTW410D8120, Welheim, German), while the titratable acidity was determined by titration of 9 ml of the fresh milk with 0.1NNaOH in the presence of phenolphthalein indicator (Atherton and Newlander, 1981). Proximate analysis was also conducted on the processed yoghurt using the above techniques.

Microbial analysis

All glassware — including Petri-dishes, test tubes, pipettes, flasks and bottles, were sterilized in a hot oven at 170 ± 5°C for at least two hours, while the media and distilled water were sterilized by autoclaving at 121°C for 15 min and at 15 lbs pressure (Marshall, 1992; Mohammad and El-Zubeir, 2011). Fresh milk samples were analyzed to determine their microbial qualities. Samples for the microbial assessment were collected directly from the pool using sterile test tubes. Microbial analysis was carried out using five (5) different media: nutrient agar for total aerobic plate-count; potato dextrose agar for mould count; violet red bile agar for coliform count; mannitol salt agar: for staphylococcus count; and desoxycholate citrate agar: for salmonella / shigella.

Each medium was prepared according to the manufacturer's instructions. Serial tenfold dilutions using sterile 0.85% saline solution up to $10^{-1} \times 10^{-8}$ dilutions were prepared for each of the milk samples. Pour plate method was used to make the viable count. In this method (Quinn et al., 2002), one ml of the inoculum was mixed thoroughly with molten plate count agar held in a water bath at 47 ± 2°C. Three plates were inoculated with each dilution. The agar was allowed to set; the plates were inverted and then incubated at 32 ± 2°C for 48 to 72 h. For each dilution, the viable colonies, which appeared colourless, in the three plates were counted and the mean was calculated. Similar microbial analysis was also carried out on the processed product.

Propagation of the yoghurt culture

Multiple strain, mixed type, lyophilized, mesophilic lactic cultures: *Lactobacillus bulgaricus* O-CH:143 (mainly homo-fermentative) and *Streptococcus thermophilus* B-CH:40 (mainly hetero-fermentative) Hansen's Laboratorium, Demark), were used at the ratio of 1:1 in the culture preparations. Pasteurized reconstituted cow milk powder was used as a propagation medium for the mother culture at room temperatures of 27 to 29°C for 24 h. Many transfers of 2% (v/v) were made and incubated at the same temperatures and time, to obtain more active daughter cultures, before the culture was finally deployed in the yoghurt preparation.

Preparation of the yoghurt

The most important requirements of milk to be used in yoghurt processing is that it should be free from anti-microbial residues such as those used in the treatment of mastitis; it must be free from contaminants or sanitizers and their products; the milk must be free from rancidity and colostrums; and most importantly, the milk should have low bacterial count and free from contamination with bacteriophages.

Ten (10) liters of fresh whole goat or cow's milk were batch pasteurized separately, by placing them in a container filled with water and heating (indirect heating to avoid any burnt flavour), with continuous stirring, until all the particles of the milk attained the temperature of 80 to 85°C, and then holding the milk at this temperature for 30 min. This treatment has lethal effect on the microflora of the milk and causes the denaturation and coagulation of the whey proteins that enhance the viscosity and texture of the milk. It also enhances the milk properties as a growth medium for the starter culture organisms. At the end of the pasteurization period, the pasteurized milk was cooled to 40 to 45°C before inoculating each batch with 2% (v/v) of freshly produced daughter culture (El-Zubeir et al., 2012). The inoculated milk samples were stirred thoroughly before incubation at 40 ± 5°C for 6 h (short incubation period). This temperature is a compromise between the optimums for the two micro-organisms contained in the starter culture. The pH and titratable acidy of the yoghurt was determined immediately at the end of the fermentation process (Atherton and Newlander, 1981), in triplicates.

Sensory evaluation of the yoghurt drink

Sensory evaluation was undertaken to determine the taste, colour, texture, flavour, appearance and overall

Table 1. Mean proximate composition of the fresh goat and cow milk used in the yoghurt preparation[1]

Component (%)	Goat milk[2]	Cow milk[2]
Moisture	86.54 ± 1.22[a]	86.70 ± 1.20[a]
Protein	3.62 ± 0.11[c]	3.45 ± 0.12[c]
Fat	4.15 ± 0.32[a]	4.63 ± 0.35[b]
Lactose	4.68 ± 0.23[b]	4.92 ± 0.28[b]
Ash	0.72 ± 0.05[d]	0.80 ± 0.07[d]
Titratable acidity (TA)	0.17 ± 0.12[g]	0.19 ± 0.13[g]
Total Solid (TS)	13.17 ± 0.22[e]	13.80 ± 0.17[f]

[1]In and row, means bearing similar superscript are not significantly different ($P < 0.05$)

[2]Means obtained from triplicate determinations.

acceptability of the yoghurt manufactured from 100% each of the goat and cow milk and a blend of 25 and 75% of goat and cow milk, respectively. Taste panelist consisted of students and staff of the University of Maiduguri who were already familiar with the qualities of normal standard yoghurt and could recognize both desirable and undesirable characteristics of yoghurt. Each panelist was asked to taste the three coded samples (A, B and C, randomly presented) and score each product for preference on a three-point scale ranging from ‘most preferred’ (preference score = 1), ‘moderately preferred’ (preference score = 2), to ‘least preferred’ (preference score = 3). The panelists were further asked to indicate any observed difference in visual appearance (texture, flavour and colour) and extent of variation among the products (Eissa et al., 2010).

Statistical analysis

Data were analyzed using Statistical Analysis Systems (SAS). Test for significant differences between means were determined using Duncan’s Multiple Range Test (Montgomery, 1976) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Chemical and microbial composition of the fresh milks and yoghurt

The results of proximate analysis of the fresh milk samples used in the preparation of yoghurt during this study are presented in Table 1. The quality of the raw milk is the single most important criterion that determines the quality of the end product. The quality of the raw fresh milk in turn is dependent on the sanitary procedures followed during the milk production and handling. The proximate composition of the fresh goat and cow milks was not significantly different ($P < 0.05$) except in fat and the total solid contents ($P > 0.05$). The mean composition of protein, fat and lactose recorded in goat and cow milks were 3.62 ± 0.11 and 3.45 ± 0.12; 4.15 ± 0.32 and 4.63 ± 0.35; 4.63 ± 0.35, 4.68 ± 0.23 and 4.92 ± 0.28, respectively; whereas the mean TS contents of the two milks were 13.98 ± 0.22 and 12.77 ± 0.17, respectively. Similarly, the average total bacterial counts (TBC) in fresh milk samples taken directly from the pooled milk were 2.7×10^3 and 3.7×10^3 cfu/ml for goat and cow milk, respectively (Table 2). The coliform count was < 10^1 cfu/ml whereas *Staphylococcus aureus* and *Salmonella/ Shigella* were <2.5×10^2 cfu/ml, while mould and yeast were not detected in both milk (Table 2). This range of TBC is evidence of good milk handling practices among the individual producer milk; this observation is also in collaboration with those made in similar studies in Sudan (Mohamed and El-Zubeir, 2007; El-Zubeir et al., 2012). Total bacterial count (also referred to as the standard plate count or SPC) is also an indication of on-farm general hygienic conditions, herd health status, milking equipment sanitation and milk storage temperatures (Hayes et al., 2001; Berry et al., 2006). Furthermore, many rapid tests are available in the literature for estimation of microbial quality of fresh milk (O’Mahony, 1988; El-Ziney and Al-Turki, 2007; Hassan et al., 2009; Ruegg et al., 2008). Successful milk quality assurance programmes focus on production of milk that is free of antibiotic residues and low in somatic cell and bacterial counts, due to their significance in the production of good quality products with longer shelf-life. In most countries, bacterial content is one of the factors considered in the level of payment for raw milk (Costello et al., 2003); a reasonable goal for SPC is ≤ 5000 cfu/ml and a count of > 10^4 cfu/ml is usually an indicative of a problem (Tamine and Robinson, 2007). In addition, the absence of yeast and mould in the fresh milk samples could be as result of the natural pH of the milks which was >6.55 resulting, in the predominance of bacterial growth.

Also, the mean pH values recorded were 6.6 ± 0.02 and 6.8 ± 0.10 for fresh goat and cow milks, respectively; while their titratable acidity (TA) expressed as percent lactic acid (LA) were 0.17 ± 0.11 and 0.19 ± 0.13,

Table 2. Microbial quality of fresh goat and cow milk used in the yoghurt preparation[1].

Parameter	Fresh goat milk (cfu/ml)	Fresh cow milk (cfu/ml)
Total Plate Count	2.7×10^3	3.7×10^3
Coliform	$<1.0 \times 10^1$	$<1.2 \times 10^1$
Salmonella / Shigella	ND*	ND*
Staphylococcus aureus	2.2×10^2	1.9×10^2
Mould and yeast	ND*	ND*

[1]Means obtained from triplicate determinations
*ND = Not detected.

Table 3. Mean scores of sensory evaluation of yoghurt prepared from goat, cow milk and blend of the two type of milk.

Sample code[2]	Organoleptic parameter[1]			
	Colour	Taste	Flavour	Overall acceptability
A	1.28 ± 0.37^a	2.02 ± 0.72^b	1.60 ± 0.37^c	1.35 ± 0.22^d
B	1.03 ± 0.80^b	1.98 ± 0.56^b	1.62 ± 0.41^c	1.05 ± 0.19^a
C	1.22 ± 0.45^a	1.56 ± 0.41^c	1.65 ± 0.23^c	1.11 ± 0.13^a

[1]In any column, means bearing similar superscript are not significantly different ($P < 0.05$)
[2]A = Goat's Milk Yoghurt; B = Cow's Milk Yoghurt; C = Blends of Goat and Cow Milks

respectively. These values of TA are also within the range, 0.18 to 0.22 that may be obtained from good quality fresh milk suitable for the processing of dairy products. The production of acid in milk is normally termed "souring" and the sour taste of such milk is due to lactic acid. The percentage of acid present in dairy products at any time is a rough indication of the age of the milk and the manner in which it has been handled. Milk produced under clean environment, using clean and hygienic utensils, freedom from colostrum; prompt cooling of milk soon after milking and transport under refrigerated state are the factors that determine the number of microorganisms, the degree of acidity and the suitability of the milk for heat treatment and subsequent preparation of such dairy products like yoghurt.

With respect to the physical appearance, the fresh goat milk slightly differs from that of cow in colour, which is thought to be as a result of difference in the size of the fat globules in the two types of milk. The fat globules in goat milk were observed to be smaller in size than those of the cow milk, and consequently, fat remained suspended (little cream rose to the top) in goat milk as compared with the cow milk when the samples of the two milks were stored at low temperature. Furthermore, the fresh goat milk was adjudged to be sweet, tasty and free of off-flavour — an indication of the suitability of the milk in yoghurt preparation. In general, the results of the chemical analysis, microbial quality and visual appearance of the fresh goat and cow milk obtained in this study were completely in agreement with those recorded in other studies (Boor et al., 1998; Berry et al., 2006; Mohamed and El-Zubeir, 2007; Ruegg et al., 2008).

Acceptability of the yoghurt prepared from goat and cow milks

Sensory assessment as judged by 20 taste panelists is presented in Table 3 as means of the scores. Objectives of a sensory evaluation may be one or more of the following: (i) to determine the presence of typically desirable characteristics; (ii) to determine the presence and magnitude of undesirable characteristics; (iii) to describe the flavour and/or aroma profile; (iv) to determine whether one sample differs from another; and (v) to determine whether one sample is preferred over another. In this study, the prepared yoghurt drink had a final titratable acidity of 0.89 ± 1.01%, 0.91 ± 1.00% and 0.93 ± 1.05%, the mean pH of 4.55 ± 0.63, 4.60 ± 0.29 and 4.72 ± 0.23 for yoghurt drinks prepared from goat and cow milks and a blend of the two milks, respectively. Although, goat milk resembles that of cow in composition (Table 1), the yoghurt prepared from the goat milk had small, light flakes, friable and easily dissolved curds than the curd formed in the cow milk yoghurt. Yoghurt made from goat milk was found to be significantly different ($P > 0.05$) in colour (appearance) but similar in flavour ($P < 0.05$) to that made from cow milk (Table 3), with average scores of 1.28 ± 0.37 and 1.03 ± 0.80 for colour; 2.02 ± 0.72 and 1.98 ± 0.52 for taste; and 1.60 ± 0.37 and 1.62 ± 0.41 for flavour, respectively. The sensory attribute of yoghurt is a combination of the flavour, colour (appearance), taste and texture (the mouth feel). The flavour results from chemical compounds in milk and those produced during processing and fermentation of milk. The similarity in flavour between the yoghurt from goat milk and that of the cow is a confirmation that the

Table 4. Mean chemical composition of the yoghurt prepared from the goat and cow milk and a blend of both milk[1].

Chemical component (%)	Goat milk	Cow milk	Blend of goat and cow milk (25% + 75%)
pH[2]	4.55 ± 0.63^{a}	4.60 ± 0.29^{ab}	4.72 ± 0.23^{b}
Titratable acidity	0.89 ± 1.01^{a}	0.91 ± 1.00^{a}	0.93 ± 1.05^{a}
Fat	3.67 ± 0.63^{c}	3.53 ± 1.05^{c}	3.44 ± 0.17^{c}
Protein	4.50 ± 1.22^{d}	4.47 ± 1.00^{d}	4.48 ± 0.22^{d}
Total Solid	13.86 ± 1.03^{b}	13.07 ± 1.15^{c}	13.96 ± 1.01^{b}
Ash	0.78 ± 0.12^{e}	0.82 ± 0.16^{e}	0.81 ± 0.17^{e}

[1]In any row, means bearing similar superscripts are not significantly different (P > 0.05)
[2]pH is not recorded in (%)

flavour of yoghurt is always the same irrespective of the milk source. Milk from any animal source is an extremely complicated entity which is comprised of lipids, proteins, carbohydrates, and minerals; and over 400 compounds have been identified in milk products (Lee and Lucey, 2010). The underlying flavour of yoghurt arises principally from the native volatile components in the milk, influenced by the pasteurization and fermentation processes (Al-Rowaily, 2008). The main flavour compounds found in yoghurt include acetaldehyde, acetoin, diacetyle, acetic acid, propionic and butyric acids (Baglio, 2014). Furthermore, milk of goats produced under sanitary conditions will be free from off-flavour. And, the same factors that adversely affect the flavour of cows' milk also affect goats' milk. However, researchers advise that producers of goat milk must be certain that the buck (male goat) is kept at least 50 m away from the lactating doe (female goat) to prevent the milk from absorbing the buck's odour (Eissa et al., 2010; Ekram and El-Zubeir, 2011). On the other hand, the appearance of the yoghurt is a combination of the colour and the visual separation of the whey. It has been reported that the goat is essentially 100 percent efficient in converting carotene into vitamin A, a process that makes goat milk whiter in colour than that of cow. It follows then, that the yoghurt made from the milk is very whitish in colour. The curd of goat milk appeared like small light and friable flakes that dissolved easily upon stirring. Goat milk yoghurt was observed to be more delicate and thinner than the cow milk yoghurt — in other words, the yoghurt from the goat's milk was slightly less firm in consistency than that of the cow's milk. These observations are in agreement with those made by other researchers including Janness (1980), Jumah et al. (2001), Maina (2008), Cheng (2010), Eissa et al. (2010), Ekram et al. (2011) and El-Zubeir et al. (2012).

For the overall acceptability, the yoghurt drink prepared with a combination of 25% goat milk and 75% cow milk (C) was adjudged as significantly different (P < 0.05) from the yoghurt drink manufactured from 100% goat milk (Table 3); also, the yoghurt prepared from 100% cow milk (B) was scored as significantly different (P < 0.05) from that prepared from 100% goat milk (A), although all the three types of the yoghurt were generally rated as "most preferred". This finding collaborates well with that of Maina (2008) who observed that the acceptability of the yoghurt from goat milk could be improved by substitution of a proportion of cow milk with that of goat milk; while El-Zubeir et al. (2012) observed that the goat milk had better qualities such as digestibility and longer shelf-life when processed than cow milk.

The result of the chemical analysis of the yoghurt drink prepared from goat and cow milk and a combination of 25 and 75% goat and cow milk, respectively, showed significant differences (P < 0.05) in pH and the total solid contents of the yoghurt prepared from 100% goat's milk and that of a combination of the two types of milk (Table 4). No significant difference (P > 0.05) was observed between the protein, fat, titratable acidity and ash contents of the processed yoghurt (Table 4). The chemical composition of the fresh milks and the yoghurt drink prepared from them are also in collaboration with the standard recommended for good quality yoghurt. It has been observed that insufficient heat treatment of milk, low total solids, over acidification, insufficient denaturation of Whey proteins, too high incubation temperature and too low acidification (pH > 4.60) are the most important factors that may affect the quality of yoghurt such as whey separation and viscosity.

Microbial quality of the yoghurt prepared from goat and cow milk

The means of the microbial counts — total plate count, *coliform, salmonella/shigella*, mould and yeast counts, are presented in Table 5. The TPC consists dominantly of the lactic acid bacteria (LAB). The LAB count of freshly produced yoghurt has been estimated at 10^8 to 10^9 cfu/g (Birollo et al., 2000), depending on the temperature and fermentation period. In this study, an incubation temperature of 40 ± 5°C was used and for a period of 6 h (short incubation period). This temperature is a compromise between the optimums for the two lactic acid producing bacteria contained in the starter culture. The smaller numbers of other microorganism recorded — coliform, *salmonella/shigella*, yeast and mould, is thought to be as result of the antimicrobial effects of the lactic

Table 5. Microbial quality of the yoghurt prepared from the goat and cow milk and a blend of both milk ($cfuml^{-1}$)[1].

Type of microorganism	Goat milk	Cow milk	Blend of goat and cow milk (25% + 75%)
Total Plate Count	7.32×10^6	7.30×10^6	7.30×10^6
Coliform	0.02×10^3	0.03×10^3	0.03×10^3
Salmonella / Shigella	$<0.01 \times 10^3$	$<0.01 \times 10^3$	$<0.01 \times 10^3$
Mould and Yeast	$<2.11 \times 10^3$	$<2.11 \times 10^3$	$<2.11 \times 10^3$

[1]Means obtained from triplicate determinations.

acid produced by the LAB, causing the pH of the growth environment to decrease to levels quite unfavourable for the growth of those organisms (Pazakova et al., 1997; Lee and Chen, 2004). The presence of yeast and mould may also be as result of contamination during processing since yeast and mould were not detected in any of the fresh milk used in the processing (Table 2). It is extremely important that microbial tests are carried out to ensure that bacterial activity in raw milk is of acceptable level, and that no harmful bacteria remain in the processed products. Furthermore, milk processing of any kind must be done under carefully controlled hygienic conditions. After the incubation period of 6 h, the yoghurt was cooled and stored at below 10°C. This was necessary to slow the multiplication of any contaminating organism.

Conclusion

This study has proven the suitability of fresh goat milk produced under good hygienic condition in the manufacture of acceptable yoghurt of excellent nutritional, microbial and sensory qualities. Goat milk and cow milk are some of the healthiest beverages that are available today, but goat milk is easy to digest than cow milk because of small fat globules and is naturally homogenized. Goat milk is non allergic as compared to cow milk and it can be used in the treatment of certain diseases. Efforts should therefore be intensified toward commercial production of yoghurt and other dairy products using goat milk as the basic raw material.

ACKNOWLEDGEMENTS

The authors would like to thank the Management of the University of Maiduguri, particularly the Department of Food Science and Technology, Faculty of Engineering, for providing the enabling environment to carry out this research. We are also grateful to Abu M. Ahmed, Beef Value Chain Officer, Federal Ministry of Agriculture and Rural development, Benue State, for providing the Statistics on goat production in Nigeria; and to the entire Laboratory staff of the National Agency for Food, Drug Administration and Control (NAFDAC) Maiduguri Branch, for assisting in the analysis of the milk and yoghurt samples. This study was supported by a grant from Friesland Campina WAMCO Nigeria Plc.

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