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The processing properties, chemical characteristics and acceptability of yoghurt made from non bovine milks

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Abstract

The present study was conducted to process yoghurt from non bovine milk. Milk from sheep, camel and goat were examined for compositional content before the processing. Milk powder was additionally used for processing yoghurt as a control. The processing was done by adding 2.5% of the starter culture to worm milk (41º C) and the inoculated milk was distributed into plastic cups and incubated at 37º C. The incubation time was found as 3-4, 16- 18, 3- 4 and 3 hours, for sheep, camel, goat and powder milk, respectively. The consistency of yoghurt was observed to be firm, watery, slightly firm and firm, respectively. Yoghurt samples were then stored in refrigerator for 10 days. The composition and pH were examined during the storage period. The pH showed non significant differences between yoghurt from different milk types. The composition of yoghurt showed significantly ($P \leq 0.01$) high fat content in yoghurt made from sheep and camel yoghurt showed significantly ($P \leq 0.05$) lower fat, protein and ash content compared to others. However yoghurt made from sheep milk was significantly ($P \leq 0.01$) higher in total solids and ash contents.

The sensory evaluation of yoghurt produced from the milk of these three species; as was judged by the untrained panelists, revealed higher acceptability compared to powder milk yoghurt. Further investigations on goat yoghurt, powder milk and their mixture during the storage, showed that the taste of yoghurt made from goat and powder milk was accepted and found to be better than that of their mixture. The flavor of yoghurt in day 5 was found better for goat milk yoghurt, while in day 7 it was best for powder milk yoghurt, the mixture was rejected in day 7. The texture of the yoghurt made with goat and milk powder mixture was recorded as watery after 5 days of storage. Although goat yoghurt showed watery texture till day 3 it revealed an accepted texture until day 10. Powder milk yoghurt showed firm texture since day 7. Hence it is concluded that the future of sheep, camel and goat yoghurt production is bright if production constraints are addressed as there is an urgent need to focus on improving the production from these species and improving marketing channels. The present study would also suggest the creation of collection points with cooling facilities to initiate and sustain the use of milk from these animals in processing dairy products. The high total solids content of sheep milk could be incorporated to standardized solids not fat of yoghurt mixed to minimize and stop the huge importation of powder milk. This in terms will improve food security and hence the sustainable development.

Key words: camel, compositional properties, fermented milk, goat, powder milk, sheep, manufacturing, sensory evaluation, sustainability

Introduction

Fermentation is one of the oldest methods practiced by human beings for the transformation of milk into products with an extended shelf life (Tamime and Robinson 1999). Fermented milk has been claimed by some research findings for being more notorious and health promoting than fresh milk (Perdigon et al 1995 and El Zubeir et al 2005). The conversion of lactose to lactic acid has preservative effect on milk, moreover, the low pH of cultured milk inhabit the growth of putrefactive bacteria and other determined organisms, thereby, prolonging the shelf life of the products (Elagamy et al 1992).

Yoghurt is the best known of all cultured milk product and the most popular almost all over the world (Thapa 2000). Yoghurt has many forms including drinkable (liquid) or solid, low fat or fat free, fruity or cereal flavored, and is a healthy and nutritious food (McKinley 2005). Furthermore, the World Health Organization has supported the use of yoghurt in nutritional recovery (WHO 2000). It is generally accepted that three main factors determine the physical properties of yoghurt; these factors are the preparation of the base milk, comprising several possible treatments, the fermentation process and the post-fermentation treatment (Smit 2003). However the changes in the physical, chemical, and microbiological structure of yoghurt determine the storage and shelf life of the product and that the alteration of these properties causes color, aroma and texture deterioration of yoghurt, which are considered important quality criteria by consumers (Sofu and Ekinci 2007).

The use of goat and sheep milk for manufacture of different milk and milk products is increasing, although the proportion is much less compared to cow and buffalo milk worldwide (Pandya and Ghodke 2007). Moreover production of typical dairy products from goats and ewes using local and traditional resources plays a direct role in biodiversity enhancement as the breeding of dairy goats and sheep is characteristic of marginal and less favorite areas, where local breeds must adapt to local resources (Scintu and Piredda 2007).

Low daily volume, even of herd bulk milk may be one of the reasons for the difficulty in establishing an efficient processing industry of goat and sheep milk in many countries (Pandya and Ghodke 2007). However sheep and goat assure suitable income for the rural population, protecting the products with a denomination against a competition based on low prices (Scintu and Piredda 2007). Sheep milk is especially suitable for yoghurt production because of its high protein and total solids content (Janness 1980). Goat milk either singly or admixed with cow or buffalo milk, can be utilized for conversion into value-added products such as Ghee (clarified butter fat), Khoa (heat-desiccated milk product), Chhana (acid and heat coagulated milk product), Dahi (curd), yoghurt, cheese (Paneer, Cheddar, Mozzarella and Gouda) and dried milk products (Agnihotri and Prasad 1993). Few attempts have been made to systematically study the use of goat or sheep milk for manufacture of milk beverages, ice cream, butter, milk powder, condensed milk, traditional products, even yoghurt, etc. (Pandya and Ghodke 2007). Sheep has become important specie in many tropical countries because of their high comparative biological efficiency in milk production as well as to their suitability to small scale production. Furthermore they possess an adaptive capacity to maintain high production with low cost

(Musa 2002). On the other hand the milk composition from dromedary is excellent from the nutritional viewpoint, although it is often described as not easily fermented (Attia et al 2001 and Hassan et al 2006).

Knowledge of the behavior of yoghurt during long storage is important, because its shelf life is based on whether the products display any of the physical, chemical or sensory characteristics that are unacceptable for consumption (Salvador and Fiszman 2004). Flavor and texture are the most pronounced factors that influence the quality and acceptance of yoghurt and related fermented milks (Labropoulos et al 1984). Textural attributes, including the desired oral viscosity, are important criteria for quality and consumer acceptance of yoghurt (Walstra 1998).

Making yoghurt from cows' milk is a usual practice however sheep, camel and goat milks are not used on commercial level to produce yoghurt. These three species under disciplined management are a profitable way of marketing marginal natural resources without endangering the environment. In Sudan camel and sheep are usually kept by nomads who did not pay attention to processing and marketing of their milk and goats are mostly owned by the smallholders for subsistence. Hence this study is designed to evaluate the compositional quality and the acceptability of yoghurt produced from milk of sheep, camel and goat compared to powder milk. It also aim to focus on the future prospective of utilizing the milk from non traditional animals in order to benefits the herders and the community at both micro and macro economical levels.

Material and methods

Yoghurt preparation

Milk samples from sheep, camel, goat, whole milk powder (medium heat) and goat+ powder mixture was used in this study. The milk samples; 5 liter from sheep, goat and camel and the powder milk was reconstituted as a control; were first heat treated (90° C for 30 seconds), cooled to 45º C before been inoculated with 2.5% mother starter culture that was added to recombined milk powder. The milk powder was not analyzed in this study; however the reconstitution was done according the manufacturer's instructions. The original starter culture consisted of *Streptococcus thermophilus* and *Lactobacillus delbruckii subsp. bulgaricus* (YO-mix 532, DANISCO, Denmark). After inoculation the milk was gently mixed, distributed into cups (75 ml) and then incubated at 37º C. The acidity of the yoghurt samples was determined each hour to judge on the incubation time. The produced yoghurts were allowed to room temperature for 30 minutes and then stored in refrigerator.

Chemical analysis

The compositional contents of milk and yoghurt samples were estimated during the present study. The fat was determined using Gerber method, protein was done using Kjeldahl method, ash was done using the muffle furnace and the total solids contents were done using dry oven method as described by Bradley et al (1992).

Sensory evaluation

Color, flavor, taste and texture of the yoghurt samples were subjected to evaluation by non trained panelists (n=10) during the storage period using sensory evaluation sheets.

Statistical analysis

The data of the present study were statistically analyzed using SPSS software (Statistical Package for Social Sciences) program (version 10). Student t- test was used for mean separation, while the graphs were plotted using excel computer program (Microsoft 1997).

Results and discussion

Processing properties of non bovine yoghurt

The incubation time of yoghurt samples were found to be 3- 4, 16- 18, 3- 4 and 3 hours, for ovine, dromedary, caprine and powder milk, respectively. The longer incubation period of yoghurt prepared from camel milk supported the previous work of Hassan et al (2006) and El Zubeir and Ibrahium (2009). This might be due to that camel milk contains antibacterial agent (Elagamy et al 1992). Moreover during the lactic fermentation process, dromedary milk showed behaviour different from that of bovine milk at the microbiological, biochemical and structural levels that are certainly due to intrinsic factors (Attia et al 2001). The consistency of yoghurt was reported as firm, watery, slightly firm and firm respectively, which supported Hassan et al (2006) and El Zubeir and Ibrahium (2009). The highest value for viscosity was exhibited by ovine milk, followed by caprine, bovine and camel milks. Furthermore for bovine, ovine and caprine milk, three different transient viscosity stages were identified and described by mathematical expressions. Goat milk is known to have better qualities such as digestibility and longer shelf life when processed than cow milk (Ohiokpehai 2003). Camel milk showed no significant variation in viscosity during gelation (Jumah et al 2001). In fact the coagulation caused by lactic fermentation did not produce a curd but simply flakes that lack firmness and that were unable to undergo further technological treatment (Abu- Tarbouch 1994). The firm and thick consistency of yoghurt made from ovine milk supported Jumah et al (2001) and Park (2007).

Chemical composition of non bovine milk and yoghurt

Milk from sheep, camel and goat showed pH value of 6.6, 6.9and 6.5, respectively (Table 1). The chemical analysis for raw milk showed fat content of 6.5, 3.5 and 3.5%, protein of 6.7, 3.7 and 4.9%, ash of 0.7, 0.7 and 0.5% and total solids of 17.4, 11.8 and 14.1% for sheep, camel and goat, respectively (Table 1). These results were on line with those reported by Janness (1980), Mehaia et al (1995) Musa (2002) and Shuiep et al (2008).

Table 1. Chemical contents of milk from non bovine sources used for yoghurt preparation

Species	pH	Fat (%)	Protein (%)	Ash (%)	Total solids (%)
Sheep	6.6	6.5	6.7	0.7	17.4
Camel	6.9	3.5	3.7	0.7	11.8
Goat	6.5	3.5	4.9	0.5	14.1

Non significant differences (P≥0.05) were obtained when comparing protein content and the pH of yoghurt made from milk of sheep, camel, goat and powder (Table 2). Moreover sheep milk yoghurt revealed significantly higher (P≤0.01) fat, ash and total solids content in comparison to that made from goat and camel milk (Table 2). This supported Raynal-Ljutovac (2007) who reported that sheep milk contains higher levels of total solids and major nutrient than goat and cow milk. Also Eissa et al (2010) reported that ccompared to cow fresh milk; goat milk was rich in fat, protein, ash and total solids but had low pH values.

Table 2. Chemical composition of yoghurt processed from non bovine milk

Source of milk for yoghurt		pH	Fat (%)	Protein (%)	Ash (%)	Total solids (%)
Sheep	Range	3.5- 6.2	3.5- 7.5	4.0- 6.4	0.95- 1.01	18.4- 20.1
	Mean± Sd.	5.13± 1.32	5.65± 1.77	4.85± 1.62	1.16± 0.36	19.5± 1.16
Camel	Range	4.5- 5.0	2.4- 2.7	3.3- 4.2	0.32- 0.50	9.8- 11.1
	Mean± Sd.	4.65± 0.23	2.62± 0.96	3.77± 0.33	0.37± 0.06	10.6± 0.56
Goat	Range	4.3- 6	3- 4.2	2.7- 5.5	0.6- 0.8	12.5- 13.4
	Mean± Sd.	5.28± 0.82	3.3± 0.6	4.48± 1.30	0.65± 0.1	13.2± 0.47
Goat+ powder	Range	3.9- 6.1	3.3- 4.5	4.3- 5.5	0.7- 0.8	14.8- 15.9
	Mean± Sd.	5.13± 1.05	3.75± 0.55	4.95± 0.59	0 .73± 0.05	15.4± 0.45
Powder	Range	3- 6	3.6- 4.8	4.6- 5.9	0.7- 0.9	16.1- 17.2
	Mean± Sd.	4.85± 1.41	4.3± 0.6	5.38± 0.55	0 .75± 0.1	16.9± 0.54
Significant level		ns	**	ns	**	**

ns: *Not significant*
**: *significant (p≤0.05)*

The chemical composition of milk, namely total solids and protein content, has a major effect on the rheological properties of curd (Jumah et al 2001). Similarly yoghurt studies, including Labneh from the Middle East, found highest viscosity for sheep followed by goats, cows, and camels, and viscosity increased with solids contents (Park 2007). He also added that in normal fluid milk, the viscosity is affected by the state and concentrations of fat, protein, temperature, pH, and age of the milk. On the other hand the significantly higher fat content of sheep milk could be a good reason to start a new production line that can produce the cream of sheep milk's simultaneously with the processing of yoghurt. Similarly the significantly (P≤0.05) higher total solids content of yoghurt from sheep indicated the possibilities of adding milk from sheep to bovine or caprine yoghurt in order to standardized total solids instead of importation of skim milk powder used for the processing of yoghurt. The lower total solids content of yoghurt made from camel milk (Table 2) is related to high water content of camel milk (Shuiep et al 2008). This could explain the watery texture of camel milk yoghurt.

Sensory evaluation of non bovine yoghurt

The sensory evaluation of the yoghurt produced from camel milk revealed high acceptability for color, flavor and taste in comparison to powder milk yoghurt. However the panelists noticed that the yoghurt made from camel milk is watery in texture. These results are in line to that of Hassan et al (2006). Attia et al (2001) reported that fermented dromedary milk did not produce a curd structure but few dispersed small casein fragments at the surface and a film or firm gel at the bottom of the vessel. The present findings suggested the use of camel milk for processing of fluid or drinking yoghurt.

Investigations carried out to evaluate the sensory properties showed that yoghurt made with the milk from sheep, goat, powder milk and the mixture of goat and powder revealed more than 60% and 30% acceptability or moderately acceptability, respectively, for yoghurt color (Fig. 1).

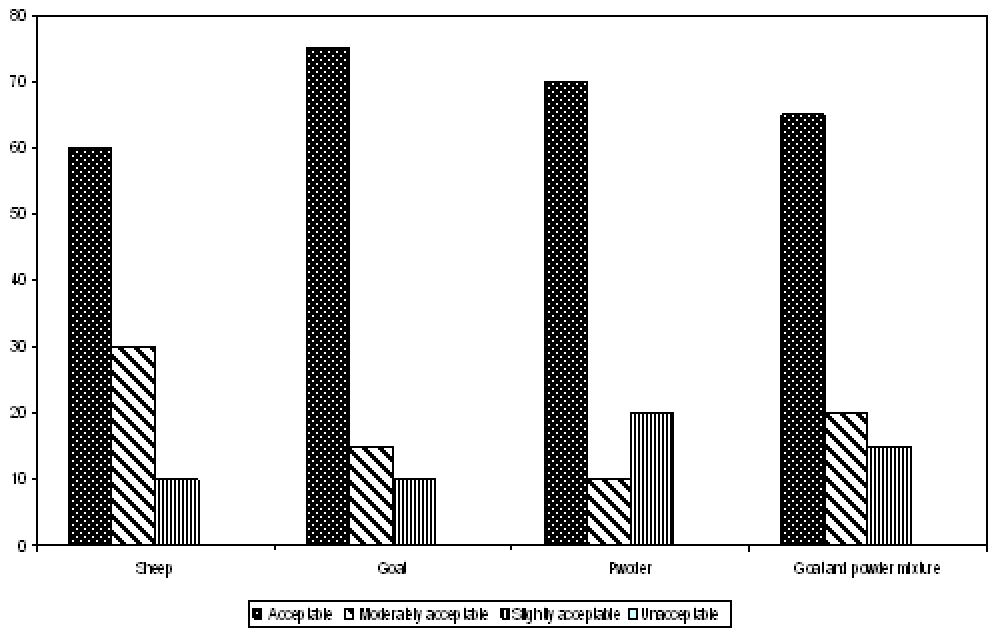

Figure 1: Color acceptability of yoghurt from sheep, goat and powder milk

However the best flavor score was reported for yoghurt made from sheep followed by powder and goat compared to the mixture of goat and powder yoghurt (Fig. 2). Moreover during day 5 was found better for goat milk yoghurt, while in day 7 it was best for powder milk yoghurt. However, the mixture was rejected in day 7.

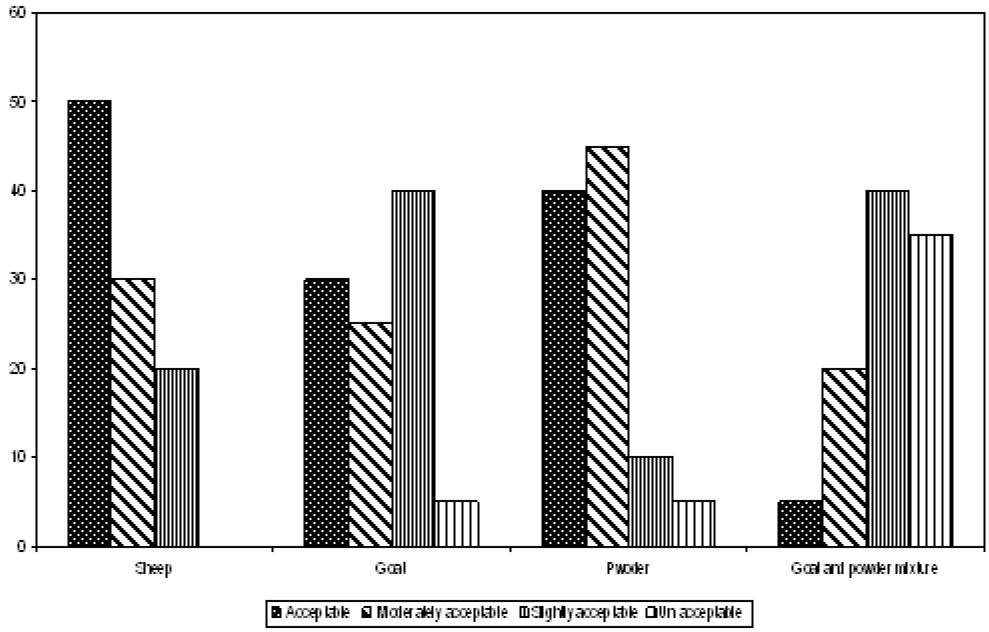

Figure 2: Flavor acceptability of yoghurt from sheep, goat and powder milk

Similarly the yoghurt made from sheep milk revealed the highest score and that the taste of yoghurt made from goat and powder milk was accepted and found to be better than that of their mixture (Fig. 3).

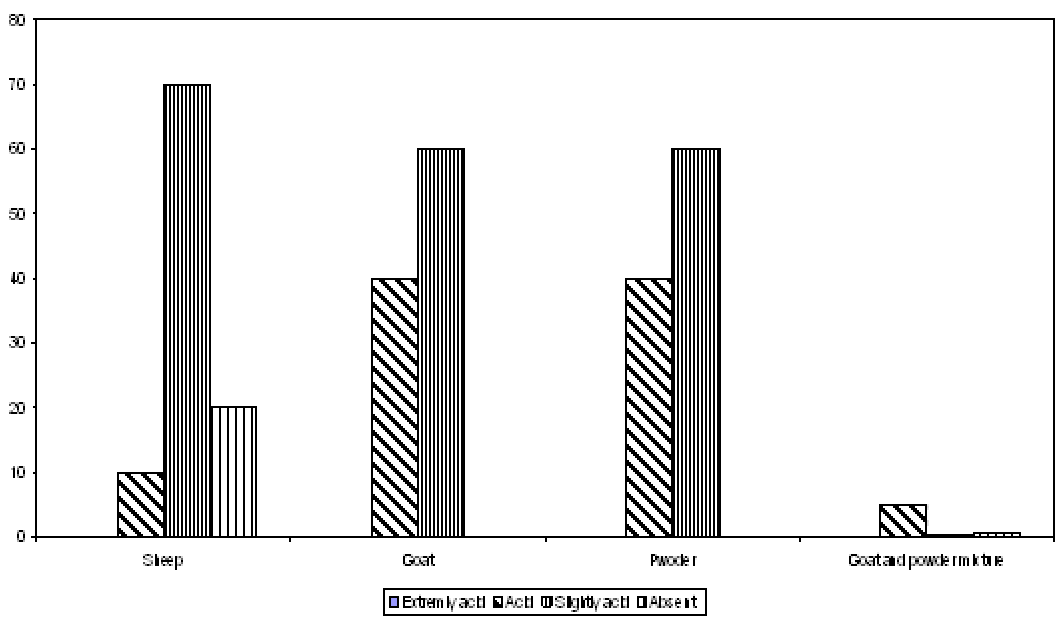

Figure 3: Taste acceptability of yoghurt from sheep, goat and powder milk

Firm acceptable texture was reported for yoghurt made from sheep followed by powder milk compared to goat (Fig. 4). The texture of the yoghurt made from the mixture of goat and milk powder was recorded as watery after 5 days of storage. The goat yoghurt although showed watery texture until day 3; it revealed an accepted texture until day 10. Powder milk yoghurt showed firm texture since day 7. This supported Domaga (2009) who reported that microstructure of goat milk yoghurt was more delicate in comparison with microstructure of cow and sheep milk yoghurt. He concluded that the composition and/or properties of goat milk for yoghurt production, or processing conditions need to be modified to obtain the proper texture and reduced syneresis in final product.

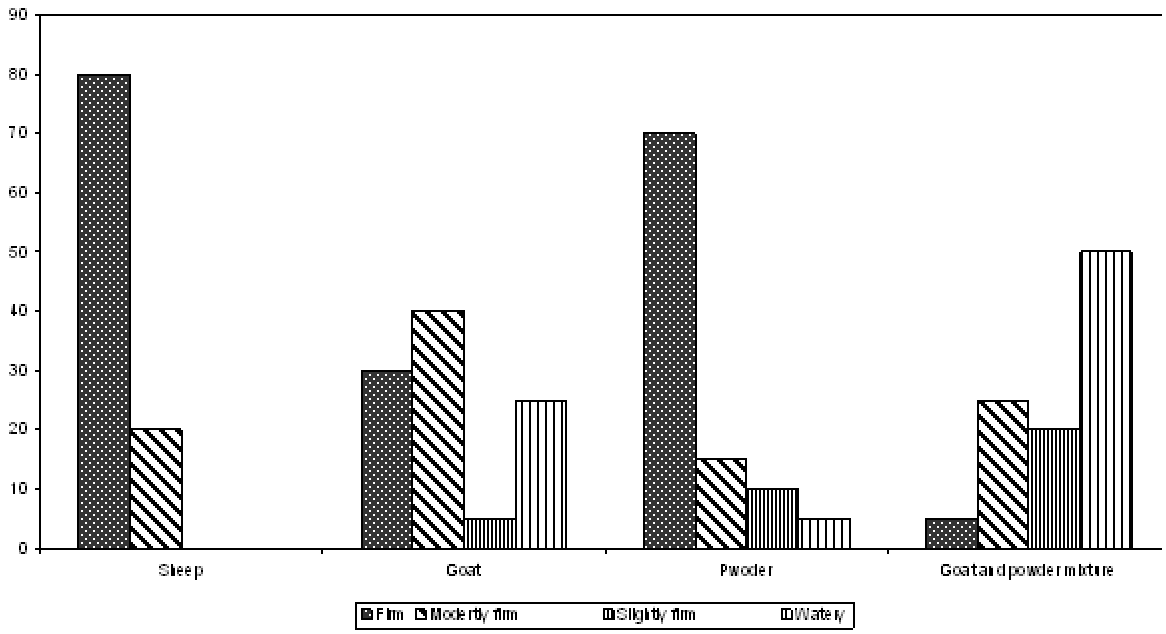

Figure 4: Texture acceptability of yoghurt from sheep, goat and powder milk

The present study would suggest the initiation of collection points with cooling facilities to facilitate and sustain the use of milk from sheep, camel and goat in dairy products processing. Moreover the high total solids content of sheep milk would encourage the use of this milk as a mixture in the processing of bovine and caprine milk yoghurt instead of the huge importation of milk powder to ensure food security and sustainable development.

References

Abu-Tarboush H M 1994 Growth behaviour of *Lactobacillus acidophilus* and biochemical characteristic and acceptability of acidophilus milk made from camel milk. Milchwissenschaf, Volume 49, pp 379- 382.

Agnihotri M K and Prasad V S 1993 Biochemistry and processing of goat milk and milk products. Small Ruminant Research, Volume 12, pp 151- 157.

Attia H, Kerouatou N and Dhouib A 2001 Dromedary milk lactic acid fermentation: Microbiological and rheological characteristic. Journal of Industrial Microbiology and Biotechnology, Volume 26, pp 263- 270.

Bradley R L, Arnold E, Jr Barbano D M, Semerad R G, Smith D E and Viries B K 1992 Chemical and physical methods. In: The Standard Methods for the Examination of Dairy Products. Marshall T R (Ed). American Public Health Association, Washington DC, USA.

Domaga J 2009 Instrumental texture, syneresis and microstructure of yoghurts prepared from goat, cow and sheep milk. International Journal of Food Properties, Volume 12, pp 605- 615.

El Zubeir I E M, Abdella W M and El Owni O A O 2005 Chemical composition of fermented milk (*roub* and *mish*) in Sudan. Journal of Food Control, Volume 16, pp 333- 337.

El Zubeir I E M and Ibrahium M I 2009 Effect of pasteurization of milk on the keeping quality of fermented camel milk (*Garriss*) in Sudan. Livestock Research for Rural Development, Volume 21. Retrived from http://www.lrrd.org/lrrd21/2/zube21019.htm.

Elagamy E I, Ruppanner R, Ismail A, Champagne C P and Assaf R 1992 Antibacterial and antiviral activity of camel milk protective protein. Journal of Dairy Research, Volume 59, pp 169- 175.

Eissa E A, Mohamed-Ahmed I A, Yagoub A E A and Babiker E E 2010 Physicochemical, microbiological and sensory characteristics of yoghurt produced from goat milk. Livestock Research for Rural Development, Volume 22 (*8*). Available at http://www.lrrd.org/lrrd22/8/eiss22137.htm.

Hassan R A, El Zubeir I E M and Babiker S A 2006 Microbiology of fermented camel milk (*Gariss*) in Sudan. Research Journal of Microbiology, Volume 1, pp 160- 165. Available at http://www.academicjournals.net/fulltext/jm/2006/160-165.pdf**.**

Janness R 1980 Composition and characteristics of goat milk. A review1968- 79. Journal of Dairy Science, Volume 63, pp 1605- 1630. Available at http://download.journals.elsevierhealth.com/pdfs/journals/0022-0302/PIIS0022030280831250.pdf.

Jumah R Y, Shaker R R and Abu-Jdayil B 2001 Effect of milk source on the rheological properties of yogurt during the gelation process. International Journal of Dairy Technology, Volume 54, pp 89- 93.

Labropoulos A E, Collins W F and Stone W K 1984 Effects of ultra- high temperature and vat processes on heat-induced rheological properties of yoghurt. Journal f Dairy Science, Volume 64, pp 405- 409.

McKinley M C 2005 The nutrition and health benefits of yoghurt. International Journal of Dairy Technology, Volume 58, pp 1- 12. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1471-0307.2005.00180.x/full.

Mehaia M A, Hablas M A, Abdel- Rahman K M and El Mougy S A 1995 Milk composition of Majaheim, Wadha and Hamra camels in Saudi Arabia. Food Chemistry, Volume 52, pp 115- 122.

Musa S 2002 The effect of pregnancy on milk composition and yield in sheep. M. Sc. thesis. University of Khartoum, Sudan.

Ohiokpehai O 2003 Processed food products and nutrient composition of goat milk. Pakistan Journal of Nutrition, Volume 2, pp 68- 71. Available at http://www.pjbs.org/pjnonline/fin93.pdf.

Pandya A J and Ghodke K M 2007 Goat and sheep milk products other than cheeses and yoghurt. Special issue entitled "Goat and Sheep Milk" Guest edited by George Haenlein, Young Park, Ketsia Raynal-Ljutovac and Antonio Pirisi. Small Ruminant Research, Volume 68, pp 193- 206.

Park Y W 2007 Rheological characteristics of goat and sheep milk. Small Ruminant Research. In: Goat and Sheep Milk, Volume 68, pp 73- 87..

Perdigon G, Alvarez S, Rachid M, Aguero G and Gobbato N 1995 Immune system stimulation by probiotics. Journal of Dairy Science, Volume 78, pp 1597- 1606. Available at http://download.journals.elsevierhealth.com/pdfs/journals/0022-0302/PIIS0022030295767844.pdf.

Raynal-Ljutovac K, Park Y W, Gaucheron F and Bouhallab S 2007 Heat stability and enzymatic modifications of goat and sheep milk. Small Ruminant Research, Volume 68, pp 207- 220.

Salvador A and Fiszman S M 2004 Textural and sensory characteristics of whole and skimmed flavored set-type yogurt during long storage. Journal of Dairy Science, Volume 87, pp 4033- 4041. Available http://download.journals.elsevierhealth.com/pdfs/journals/0022-0302/PIIS0022030204735444.pdf.

Scintu M F and Piredda G 2007 Typicity and biodiversity of goat and sheep milk products. Small Ruminant Research, Volume 68, pp 221- 231.

Shuiep E S, El Zubeir I E M, El Owni O A O and Musa H H 2008 Influence of season and management on composition of raw camel (*Camelus dromedarius*) milk in Khartoum State, Sudan. Tropical and Subtropical Agroecosystems, Volume 8, pp 101- 106. Available at http://www.uady.mx/~veterina/publicaciones/journal/2008-1/151-camel-SN.pdf.

Smit G 2003 Dairy Processing: Improving Quality. CRC Press, Boca Raton FL. USA.

Sofu A and Ekinci F Y 2007 Estimation of storage time of yoghurt with artificial neural network modeling. Journal of Dairy Science, Volume 90, pp 3118- 3125. Available at http://download.journals.elsevierhealth.com/pdfs/journals/0022-0302/PIIS0022030207717599.pdf.

Tamime A Y and Robinson R K 1999 Yoghurt Science and Technology, 2nd (ed) CRC Press, Boca Raton F. L. New York.

Thapa T B 2000 Small-scale milk processing technologies: Other milk products. Electronic Conference, Food and Agriculture Organization of the United Nation. Rome, Italy. http://www.fao.org/ag/againfo/themes/documents/LPS/DAIRY/ecs/Papers/di_pap22.htm.

Walstra P 1998 Relation between structure and texture of cultured milk products. In: Texture of Fermented Milk Products and Dairy Desserts. Special issue 9802. pp 9- 15. International Dairy Federation, Brussels, Belgium.

WHO 2000 Nutrition for health and development, pp 9- 10. Geneva: WHO. http://pediatrics.aappublications.org/cgi/content/full/109/4/678.

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