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Instrumental texture and syneresis analysis of yoghurt prepared from goat and cow milk

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Abstract
The objectives of this study were to compare the instrumental texture, syneresis and microstructure analysis of yoghurt processed from goat milk (Beetle breed) to that processed from cow milk (Sahiwal breed). Set-yoghurts from goat and cow milk from middle lactation period were produced. In fresh yoghurts the following properties were analyzed: firmness, consistency, cohesiveness, and index viscosity using instrumental texture analyzer and syneresis using centrifugal methods. Yoghurt from goat milk was characterized by lower firmness, consistency, and higher susceptibility to syneresis than yoghurts from cow milk. However, it is recommended that production of dairy products from goat milk is to be encouraged due to its known therapeutic value.

Keywords: Goat milk, Cow milk, Yoghurt, Textural property, Syneresis

Introduction
Yoghurt made from cow's milk is widely consumed in the world. On the other hand, there is a desire for alternatives to cow's milk due to problems relating to gastrointestinal intolerance and market demand for the formulation of novel dairy products. Although goats are important source of milk, meat and skin, yet they are neglected animals in India. They are generally reared in traditional systems with low inputs resulting in low yields. The term, universal foster mother, was often used to describe the goat [1].The particular interest in goat's milk is prompted by its indisputable dietetic properties. The average composition of goat's milk does not differ remarkably from that of cow's milk. The former has higher contents of dry matter, total protein and casein, milk fat and mineral substances, which determines its higher nutritive value [2]. The fatty acid profile of goat's milk is also different, being richer in volatile fatty acids (caproic, caprylic, and capric) that are responsible for the specific taste and odour of the respective dairy products. Goat milk is having higher content of medium-chain fatty acids that also accounts for the more prolonged bacteriostatic activity. The nutrient composition of goat milk is also different than that of cow's milk. The former contains 13% more calcium, 25% more vitamin B-6, 47% more vitamin A, 134% more potassium and 350% more niacin than cow's milk. Goat milk is also higher in chloride, copper and manganese and contains 27% more of the essential nutrient selenium. Goat milk contains none of the controversial Bovine Growth Hormone [2]. All these differences could lead to the milk behaving differently during the gelation process and gel formation; thus, affecting the final quality of dairy products obtained from the goat's milk. Yoghurt obtained from goat's milk differs in some physicochemical properties such as the firmness of the coagulum, which tends to be soft and less viscous, from yoghurt obtained from cow's milk [3].

People with lactose intolerance can drink goat milk as goat milk is having superior digestibility than cow's milk. Goat's milk is more easily absorbed than cow's milk, leaving less undigested residue behind in the colon to quite literally ferment and cause the uncomfortable symptoms of lactose intolerance [4]. There are some technological advantages of goat milk in comparison to cow milk, for instances; smaller fat globule size, which provides a smoother texture in derived products, lower amount of αs1-casein, resulting in softer gel production, a higher water holding capacity and a lower viscosity [5]. Powerful justification for goat milk can come from medical needs (not just desires) of people, especially infants afflicted with various ailments, including cow milk protein sensitivities. Swedish studies showed that cow milk was a major cause of colic, sometimes fatal, in 12 to 30 percent formula-fed, less than 3- month-old infants [6].

Curd texture or firmness is an important property of yogurt, which determines the quality and acceptability of the product. Adequate firmness without syneresis is essential for the superior quality of yogurt [7]. From the point of view of rheology, yoghurt is a non-Newtonian, rheological unstable, viscoelastic and pseudoplastic fluid. It is also shear thinning, which means that its viscosity decreases as the shear rate increases and depends on the "shear history". Jumah *et al.* [8] determined the flow curves of yoghurt curd during the gelation process and at the maximum viscosity value for sheep, goat, cow and camel milks. They found that the measured viscosity decreased with increasing angular velocity of the inner cylinder, suggesting that the yoghurt behaved as a shear-thinning fluid.

The objectives of the present study were to assess and compare the chemical, microbiological and sensory quality of yoghurt made from goat's milk with cow milk as well as investigating the effect of refrigerated storage on the shelf life of the manufactured yoghurt. Moreover, to the best of our knowledge, there is a lack of available data regarding the rheological aspects of yoghurts made from milk from Beetle breed of goat and Sahiwal breed of cow.

Materials and Methods

Materials

1. Fresh goat milk (Beetal breed) was obtained in clean plastic containers from the small farm house, GADVASU (Ludhiana) along with fresh cow milk (Sahiwal breed) obtained from Dairy farm, Animal Nutrition Department, College of Veterinary Science, GADVASU (Ludhiana) and taken to Dairy Microbiology Department, College of Dairy Science and Technology for determination of physiochemical and microbiological components.
2. Skim milk powder (Amul brand, Gujarat, India) was obtained from local market.
3. Yoghurt starter cultures NCDC 144 (*L. bulgaricus* and *S. thermophilus*) were procured from National Collection of Dairy Cultures (NCDC), ICAR-NDRI, Karnal, India.
4. De Man Rogosa and Sharpe (MRS) broth and M-17 broth (HiMedia, India) were used for propagation of the *L. bulgaricus* and *S. thermophiles*, respectively. All chemicals and media used in this study were of analytical grade.

   Cells were removed by centrifugation and maintained in 10 ml of sterile 12% reconstituted skim milk supplemented with 2% glucose and 1% yeast extract. These cell suspensions were stored at 4 °C until they were added to milk. All cultures including working cultures were propagated successively three times prior to use. The purity of all the bacterial cultures was always ascertained by Gram staining prior to use for any experiment.

Manufacture of Yoghurts

Yoghurt was prepared according to Lee and Lucey [9] procedure. Raw goat and cow milk were filtered and the milk was pasteurized at 85° C for 30 min and rapidly cooled to 43° C. Then the yoghurt starter culture (NCDC 144) having *Streptococcus salivarius* subspecies *thermophilus* and *Lactobacillus delbrueckii* subspecies *bulgaricus* in 1:1 ratio was added at the rate of 3% and blended thoroughly. After that all of the fermented milk groups were packed in plastic cups and left for a final fermentation at 42 ± 1 °C. Fermentation was ended when a pH of 4.7 was reached. Following incubation, yogurt samples were cooled to +4 °C and held at this temperature overnight.

Texture evaluation

Instrumental textural attributes of yoghurt samples were measured in terms of firmness, consistency, cohesiveness and index of viscosity using Texture analyzer TA-XT Plus (M/s Stable Micro Systems, Surrey, UK) equipped with 5 kg load cell. A back extrusion test using 40mm cylinder probe was used for texture profile analysis of the samples. The product was subjected to compressive force by probe up to the distance of 30 mm. The conditions set in the Texture analyzer for measuring textural properties were as follows: Pre-Test Speed, 1 mm/s; Post-Test Speed, 1 mm/s; Test speed, 1 mm/s; Trigger force, 10.0 g; Time, 5.0 s. For each evaluation, (3×3×2.5) cm3 size sample was used during texture analysis. The following texture parameters were recorded: firmness; maximum compression force in extrusion thrust into sample (g), consistency; area within curve during extrusion thrust (g.s), cohesiveness; maximum compression force during withdrawal of probe from sample (g) and index of viscosity; area within negative region of curve during probe withdrawal (g.s). Numerical values of firmness, consistency, cohesiveness and index of viscosity were measured using the exponent software (version 6.1.1.0).

Synersis by centrifugal method

Whey separation of yoghurt samples were done by using the method as described by Hassan *et al.* [10]. 25ml of set yoghurt at 5 ºC was slowly transferred to 50 ml capacity centrifuge tubes causing minimum disturbance to the coagulum. The centrifuge tubes were balanced by adjusting their weights and centrifuged at 3394 RPM in a Remi centrifuge (Make-Remi, India) for 20 min. The quantity of whey separated at the top of the coagulum inside centrifuge tubes was recorded as milliliters. The weight fraction of the supernatant liquid was used as index of whey syneresis (ml/100 g yoghurt).The higher the volume of whey separated, the higher was the whey separation and vice versa.

Statistical Analysis

The data obtained from the various experiments during standardization process and storage study of developed product were subjected to Two-way analysis of variance (ANOVA) and t-test using SAS 9.3 version under the guidance of statistician. Wherever required, the overall mean, standard error of compositional data and critical difference (with CD LSD) was also calculated using Microsoft excel (Microsoft office 2010).

Results and discussion

Textural properties of cow and goat milk yoghurt

The textural characteristics of yoghurts produced from goat and cow milk, are presented in Table 1 and Figure 1 and Figure 2. A highly significant dependence was found for all analyzed parameters of yoghurts prepared from different types of milk. Pure cow milk yoghurt has shown higher firmness (308.37±2.14; 149.51±16.20), consistency (7887.73±318.93; 3038.63±31.30), while pure goat milk yoghurt showed high cohesiveness (-62.40±0.76; -155.01±16.72) and index of viscosity (-137.73±4.36; -288.17±14.47) (Table 1). Lipid content and globule size are important factors affecting the gel firmness [11], and goat milk contains more fat globules which are smaller in size, than cow

milk [12] which further supports result of low firmness in goat milk yoghurt in this study. Bozanic *et al.* [13] prepared yoghurt from goat milk and cow milk. They reported that yoghurt samples prepared from goat milk had a softer consistency and lower viscosity than those prepared from cow milk which is in total agreement with this study. Similarly, in another report yoghurt obtained from goat's milk shows a weaker gel in comparison to yoghurt obtained from cow's milk [3]. Yoghurt from goat milk was characterized by lower hardness, adhesiveness, extrusion forces, and higher susceptibility to syneresis than yoghurts from cow and sheep milk by Domagala, [14]. It was also seen that goat milk yoghurt was less viscous than cow milk yoghurt (Table 1and Figure 1 and 2). Farnsworth *et al.* [15] reported that increasing total solids of the milk was shown to improve yogurt viscosity. The result is in agreement with the result of Duitschaever [16] reported that goat milk yoghurt was less viscous than that made from cow milk.

Table 1: Textural properties of cow and goat milk yoghurt

Parameters	Treatment (Mean ± SE)	
	Cow Milk Yoghurt	Goat Milk Yoghurt
Firmness (g)	308.37^{b}±2.14	149.51^{a}±16.20
Consistency (g.sec)	7887.73^{b}±318.93	3038.63^{a}±31.30
Cohesiveness (g)	-155.01^{b}±16.72	-62.40^{a}±0.76
Index Viscosity (g.sec)	-288.17^{a}±14.47	-137.73^{a}±4.36

Different superscript letters (a & b) within the same row showed significant differences among the groups (P<0.05) and (n=3).

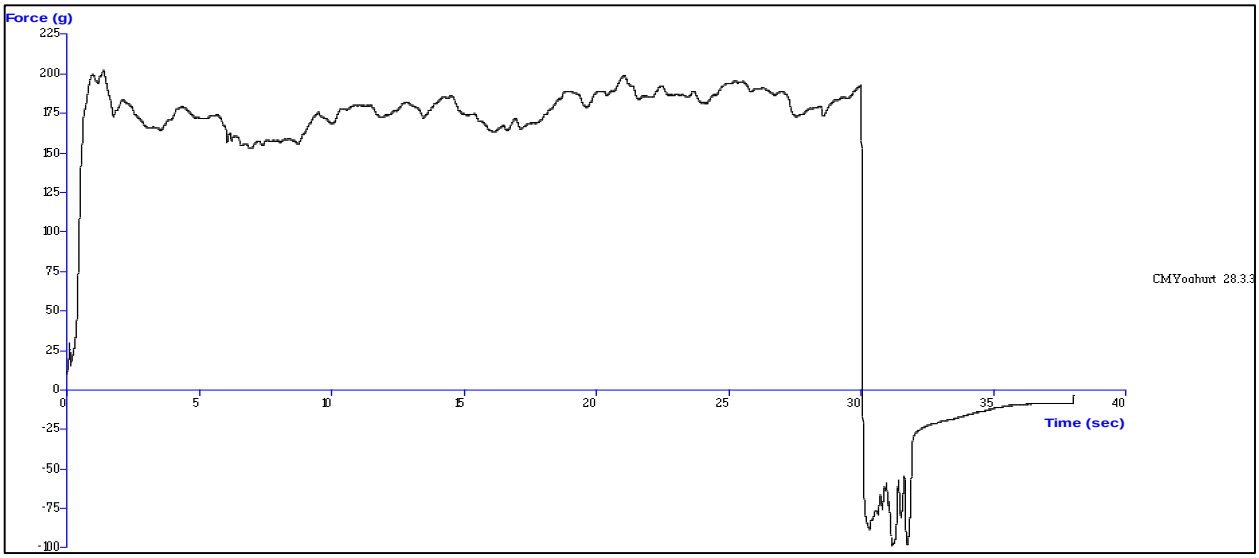

Fig 1: Texture profile analysis of cow milk yoghurt

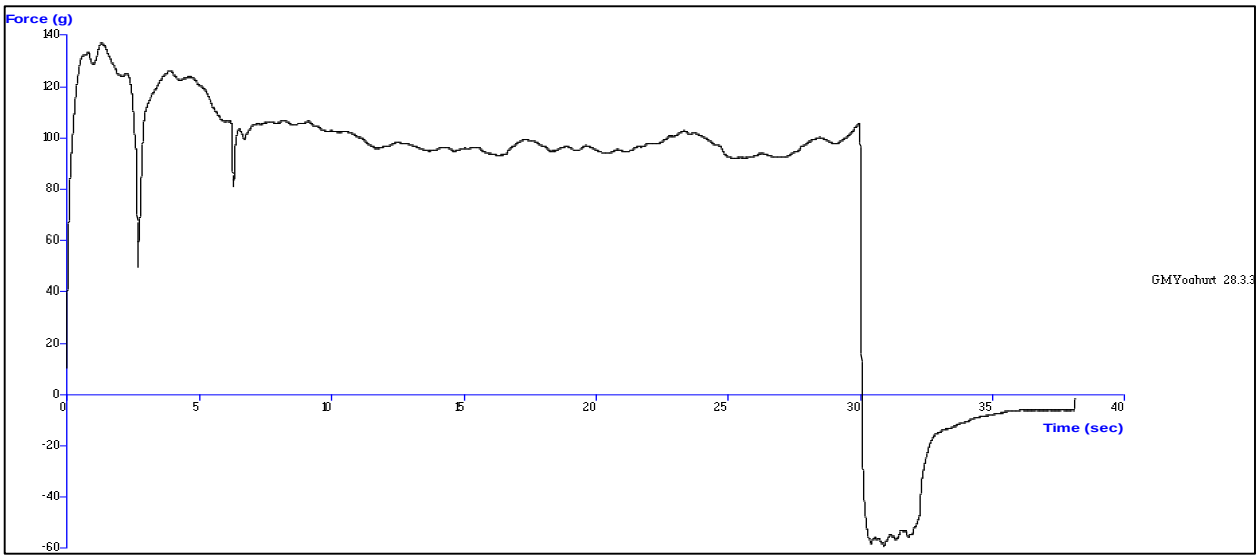

Fig 2: Texture profile analysis of goat milk yoghurt

Synersis analysis of cow and goat milk yoghurt

Syneresis is the major visible defect that occurs during yoghurt storage and can affect the final product acceptance [17]. Syneresis occurs due to the loss of yoghurt gel capacity to entrap serum phase through the weakening of the gel network, resulting on whey separation [18].Contents of total solids and protein, as well as milk type affect yoghurt syneresis [14]. It was found, that yoghurts from goat milk revealed the highest syneresis (9.92±0.02), whereas yoghurt from cow milk was found to be lowest (9.65±0.03) Table 2. The differences in syneresis were of statistical significance (p<0.05). Similar results were reported by Kucukcetin *et al.* [19], in which yoghurts water holding capacity were affected by the milk type.

Table 2: Syneresis analysis of cow and goat milk yoghurt

Parameters	Treatment (Mean ± SE)	
	Cow Milk Yoghurt	Goat Milk Yoghurt
Whey separation (ml/100g yoghurt)	9.65^{b}±0.03	9.92^{a}±0.02

Different superscript letters (a & b) within the same row showed significant differences among the groups (P<0.05) and (n=3).

Conclusions

Since goats are important for milk production in India especially in Punjab state because of the large population of goats, the research attempted to utilize goat's milk in the production of yoghurt from fresh goat's milk and compared it with fresh cow's milk. In the second stage we used pure strains of yoghurt starter cultures in the production of yoghurt from the two types of milk. Both yoghurts had shown good texture and appearance but texture analysis of cow milk yoghurt and goat milk yoghurt revealed that goat milk yoghurt was having lower firmness and consistency. However, it is recommended that production of dairy products from goat milk is to be encouraged. Research in goat dairy production, processing and introduction of new bio-technologies need to be strengthened.

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Compliance with Ethical Standards This article does not contain any studies with human or animal subjects.

Conflict of Interest The authors declare that they have no conflict of interest.

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