



Nutritional and biochemical composition of colostrum and milk in sheep of the arid Region

S VYAS¹, M KUMAR^{1✉}, A K PATEL¹, M PATIDAR¹, K ARORA¹ and S KACHHAWAHA²

Division of Livestock Production and Range Management,
ICAR-Central Arid Zone Research Institute, Jodhpur 342 003, Rajasthan, India

Received: 09 June 2025; Accepted: 26 September 2025

ABSTRACT

The present study was designed to study the effect of parity (PA), stage of lactation (SL), and their interaction (PA × SL) on daily milk yield and milk composition in Marwari sheep. The investigation was conducted at the Small Ruminant Research Unit of ICAR-CAZRI, Jodhpur during the year 2024. Twenty-two ewes in their first parity, along with seven, four, three, two, and three in second, third, fourth, fifth & sixth parity, respectively were included in the study. All ewes were reared, till the end of our study, in a semi-intensive management system with access to *ad libitum* permanent pasture and a daily concentrate supplement of 0.5 kg/ewe. Milk yield and composition were recorded during two sampling sessions between May and June, corresponding to different stages of lactation. The analysed milk composition parameters included fat, solids-not-fat (SNF), protein, lactose, salts, as well as milk density and freezing point. The mean ± SE values for fat, SNF, protein, lactose, and salts were 5.29 ± 0.19%, 10.29 ± 0.09%, 4.12 ± 0.03%, 6.21 ± 0.05%, and 0.91 ± 0.01%, respectively. The milk density and freezing point were recorded as 36.14 ± 0.43 g/cm³ and -0.75 ± 0.01°C, respectively. This research highlights the influence of parity and lactation stage on milk production and its composition in Marwari sheep, a breed well-adapted to the arid regions of India.

Keywords: Indian sheep breeds, Marwari breed, Milk characteristics, Parity, Stage of lactation, Sheep

The milk of non-bovine species such as goats, sheep, camels, and donkeys has gained increasing attention because of its nutritional and therapeutic properties. These milks are considered functional foods and potential raw materials for nutraceuticals and pharmaceuticals, with considerable potential to strengthen the immune system and improve human health (Park and Haenlein 2006; Haenlein 2007). Sheep milk is a valuable dairy commodity across the world, including India, due to its rich nutritional profile and unique properties that make it suitable for high-value dairy products.

India possesses a wide diversity of sheep breeds that are well adapted to the harsh agro-climatic conditions of plains, hills, and arid regions. These breeds are largely reared by marginalized communities in low-input systems, traditionally for meat and wool, while their potential as milk producers has remained underexplored (Acharya 1982; Arora and Bhatnagar 2010). Sheep milk, however, can serve as a raw material for the production of probiotic supplements and bioactive peptides with immuno-boosting

properties. Since the chemical and microbial composition of milk plays a decisive role in influencing nutrition, safety, and techno-functional properties, systematic investigation of Indian sheep milk is essential to establish quality standards and explore avenues for commercialization and international trade (NAAS 2021).

The Marwari breed, native to the arid and semi-arid regions of north-western Rajasthan, is one of the most important sheep populations in India. Well adapted to extreme desert conditions, Marwari sheep represent a promising resource for nutritionally superior milk production. Sheep milk is naturally rich in essential micronutrients such as calcium, phosphorus, magnesium, and zinc, in addition to vitamins A, D, and E, all of which play vital roles in bone health, immunity, and overall well-being (Pandya and Ghodke 2007). Studies have shown that compared to cow and goat milk, sheep milk contains significantly higher levels of total solids, protein, casein, fat, and ash, which enhance its nutritional density and digestibility (Bencini and Pulina 1997). The high proportion of short- and medium-chain fatty acids, along with smaller fat globules, further contributes to its better digestibility, making it suitable for individuals with lactose intolerance or gastrointestinal disorders such as irritable bowel syndrome (Park and Haenlein 2006).

Globally, sheep milk is recognized for its suitability in

Present address: ¹Division of Livestock Production and Range Management, ICAR-Central Arid Zone Research Institute, Jodhpur- 342003, Rajasthan, India. ²Division of Animal Health, ICAR-CSWRI, Avikanagar- 304501, Rajasthan, India.
✉Corresponding author email: nirjal.mahesh@gmail.com

producing premium dairy products. Its high protein and fat content make it particularly valuable for cheese production, with several international varieties such as Roquefort, Pecorino, and Manchego being derived exclusively from sheep milk (Haenlein 2007). In India, opportunities exist for developing both traditional products such as dahi, paneer, and ghee, and specialized products like probiotic yogurt, cheese, and milk powder, which could cater to niche health-conscious and export markets (Raynal-Ljutovac *et al.* 2008; Sawaya *et al.* 1984).

In addition to nutritional and industrial importance, sheep milk also holds medicinal relevance. Ayurveda, the ancient Indian medical system, describes sheep milk as having therapeutic properties, particularly in the management of respiratory ailments, arthritis, skin health, and neurological disorders (Rao 2010; Singh 2009). Modern studies further confirm that its bioactive peptides, fatty acids, and lactic acid contribute to anti-inflammatory, antimicrobial, and skin-rejuvenating effects (Chessa *et al.* 2005; Park and Haenlein 2006).

Although the multifaceted potential of sheep milk is well recognized, the sector in India remains underdeveloped owing to limited scientific data, poor awareness among producers, absence of organized collection systems, and minimal research on milk quality across indigenous breeds. Promoting sheep milk as a supplementary livelihood avenue can enhance income security among smallholder and pastoral communities, particularly in arid and semi-arid zones where bovine dairying is constrained by water scarcity. Moreover, the inherently sustainable nature of sheep production characterized by low feed and water requirements, resilience to degraded rangelands, and relatively low greenhouse gas emissions-aligns with the principles of climate-resilient livestock farming. Strengthening the scientific understanding of the compositional and functional attributes of Indian sheep milk will, therefore, not only facilitate product diversification but also contribute to rural livelihood improvement and environmental sustainability.

Despite these advantages, the composition of sheep milk from Indian breeds remains poorly documented. While extensive data exist on specialized European dairy breeds, very few studies have evaluated Indian sheep breeds for milk yield, chemical composition, and variation across physiological factors such as parity and lactation stage (Bhatia and Arora 2010; NAAS 2021). Such information is crucial for characterizing the nutritional potential of Indian sheep milk and exploring its application in functional foods and nutraceuticals.

In this context, the present study was undertaken to analyze the composition of colostrum and milk in Marwari ewes, with a particular focus on the effect of parity and stage of lactation. Establishing baseline information on these parameters will provide valuable insights for the utilization of Indian sheep milk as a functional dairy resource and support its wider adoption in the food and health sectors.

Table 1. Total number of samples obtained for the study.

	Replicated
No. of sheep from which samples taken	34
No. of sheep parity-wise from which samples taken	
Parity 1	17
Parity 2	6
Parity 3	4
Parity 4	3
Parity 5	1
Parity 6	3
Total	34
No. of sheep in each group of lactation	
1-30 days	13
31-40 days	12
Days	25
>51	18
Total	68 (34 X 2)

MATERIALS AND METHODS

The experiment was carried at ICAR- Central Arid Zone Research Institute, Jodhpur situated at 230 m above sea level, 26.23 °N and 73.02 °E, with temperature varying from 15 °C in January to 45 °C in May having annual precipitation of 320 mm.

Animal selection and sample collection: Thirty-four sheep (ewes) of the Marwari breed were taken for the present study (Table 1). The animals were maintained at experimental animal sheds under well-ventilated and proper hygienic conditions. The ewes were maintained under a semi-intensive management system. During the experiment, the daily feed ration of ewes consisted of permanent pasture (*ad libitum*), concentrate pellets @0.5 kg/ewe/ day. The same diet was followed throughout the study, consisting of *Cenchrus ciliaris* as permanent pasture grass, along with concentrate feed containing 20% protein, 4% fat, 10% crude fibre. The ewes were sent out for grazing from 9.00 AM to 3.00 PM. The animals were milked in the afternoon after grazing, when the separation from lambs was more than 4 hrs, otherwise the lambs were continuously with their dams. During the experiment, all ewes were managed as a single flock under standardized conditions, ensuring uniform nutrition and husbandry practices without any detectable variation. During the period of sample collection, the maximum temperature was between 45-48 °C.

Samples of colostrum were taken immediately post-lambing, before suckling had begun, and on the following 48 hrs of lactation. Milk samples were collected from 34 ewes twice, at 7 days and 15 days of lactation. Milk samples were collected on 7th and 15th day of lactation to represent the early lactation phase, as the 7th day reflects transition from colostrum to milk and the 15th day indicates

Table 2. Sheep milk analysis based on the days of lactation. Group 1 (less than 30 days lactation); Group 2 (30-40 days lactation); Group 3 (40-50 days lactation); Group 4 (more than 50 days lactation)

Milk parameters	Days of lactation	Fat	Solid not fat	Density	Protein	Lactose	Salts	
Group 1	Mean N=17	23.412	5.612	9.976	33.506	3.900	5.871	0.859
	SD	6.632	1.597	0.950	4.391	0.326	0.499	0.088
	SE	1.620	0.375	0.220	1.014	0.075	0.115	0.020
Group 2	Mean N=16	35.625	5.000	10.756	36.644	4.138	6.238	0.919
	SD	2.803	1.180	0.737	3.404	0.269	0.406	0.073
	SE	0.701	0.295	0.184	0.851	0.067	0.102	0.018
Group 3	Mean N=26	44.380	5.200	10.720	36.320	4.150	6.220	0.915
	SD	2.870	1.720	0.710	3.070	0.250	0.390	0.070
	SE	0.560	0.340	0.140	0.600	0.050	0.080	0.010
Group 4	Mean N=19	58.740	5.395	11.142	37.840	4.289	6.460	0.947
	SD	8.170	2.150	0.660	3.450	0.250	0.360	0.070
	SE	1.880	0.490	0.150	0.790	0.060	0.080	0.020
Overall	Mean N=78	41.513	5.296	10.668	36.144	4.126	6.208	0.912
	SD	13.561	1.722	0.853	3.809	0.300	0.453	0.078
	SE	1.535	0.195	0.097	0.431	0.034	0.051	0.009

stabilization of milk composition. Mid-stream milk was collected after discarding the first few streams to obtain a representative and uncontaminated sample. All samples were kept at 4°C and immediately transported to the laboratory. Milk composition (fat, total protein, lactose, and total solids) was determined using ultrasonic milk analyser (Model Aczet ultrasonic milk analyser).

Total antioxidant capacity (FRAP): The FRAP (Ferric reducing antioxidant power assay) procedure described by Benzie and Strain (1996) was followed to assess for the total antioxidant activity assay of colostrum and milk samples. A 100 µL aliquot of the milk extract and 10 µL colostrum extract was allowed to react with 3 mL FRAP reagent at 37°C for 30 minutes. The absorbance was measured at 593 nm. The values were expressed as the concentration of antioxidants having a ferric reducing ability equivalent (FRE) to that of 1 mmol L⁻¹ FeSO₄.

Isolation, quantification, and analysis of Protein variants by SDS-PAGE: The total soluble protein content in colostrum and milk was determined using Bradford assay (Bradford, 1976). For protein extraction, 1 mL of sample was mixed with 10 mL of phosphate buffer (pH 7.4) and centrifuged at 10,000 rpm for 10 min at 4 degrees Celsius (Remi bench top refrigerated centrifuge NEYA 16 R). For protein quantification, 10 µL of the resulting protein extract was combined with 990 µL of double-distilled water and 2

mL of Bradford reagent. The protein profile of sheep milk was further analyzed using SDS-PAGE, performed in a Mini-PROTEAN II electrophoresis cell (Bio-Rad Laboratories, USA). Skimmed milk was obtained by centrifugation at 5,000 × g for 15 min at 4 °C to remove the fat layer. Protein samples (10–30 µg) were mixed with Laemmli buffer containing 5% β-mercaptoethanol, denatured at 95 °C for 5 min, and loaded onto 12% polyacrylamide resolving gels with 4% stacking gels. Electrophoresis was performed using a Mini-PROTEAN II system (Bio-Rad, USA) at 80 V till the proteins entered the resolving gel, and thereafter at 120 V until the dye front reached the bottom. Gels were stained with Coomassie Brilliant Blue R-250, destained in 40% methanol and 10% acetic acid, and protein bands were visualized with a gel documentation system using a pre-stained molecular weight marker.

Statistical analysis: Recorded data were statistically analysed using the analysis of variance (ANOVA). The systematic effects were PA (two classes), the SL (three classes), and the interaction of PA x SL. Statistical analysis was done using the mathematical-statistical package STATISTICA version 9.0.

RESULTS AND DISCUSSION

The present study was conducted to evaluate the composition and quality of Marwari sheep milk, with

Table 3. Sheep milk analysis based on parity.

Milk parameters		Days	Fat	Solid not fat	Density	Protein	Lactose	Salts
Parity								
1	Mean N=39	42.436	5.518	10.659	35.826	4.118	6.182	0.913
	SD	12.872	2.088	0.799	3.646	0.293	0.440	0.076
	SE	2.061	0.334	0.128	0.584	0.047	0.070	0.012
2	Mean N=14	35.000	4.929	10.736	37.114	4.179	6.307	0.921
	SD	14.592	1.372	1.180	4.998	0.385	0.573	0.104
	SE	4.037	0.380	0.326	1.383	0.107	0.159	0.029
3	Mean N=10	41.700	5.050	10.760	36.620	4.150	6.250	0.910
	SD	16.162	1.062	0.659	2.861	0.238	0.367	0.070
	SE	5.111	0.336	0.208	0.905	0.075	0.116	0.022
4	Mean N=6	41.333	5.050	10.650	36.217	4.117	6.200	0.917
	SD	6.749	1.385	0.772	3.567	0.291	0.424	0.069
	SE	2.755	0.566	0.315	1.456	0.119	0.173	0.028
5	Mean N=3	50.667	5.033	10.667	36.200	4.100	6.200	0.900
	SD	10.656	0.471	0.249	1.268	0.082	0.163	0.000
	SE	2.446	0.091	0.101	0.395	0.027	0.054	0.000
6	Mean N=6	46.000	5.500	10.433	35.050	4.033	6.083	0.883
	SD	8.775	0.849	0.621	2.856	0.205	0.358	0.037
	SE	3.582	0.346	0.253	1.166	0.084	0.146	0.015
Overall	Mean N=78	41.513	5.296	10.668	36.144	4.126	6.208	0.912
	SD	13.561	1.722	0.853	3.809	0.300	0.453	0.078
	SE	1.535	0.195	0.097	0.431	0.034	0.051	0.009

particular emphasis on the effect of parity and stage of lactation. Detailed characterization of key milk constituents, including fat, total solids, protein, lactose, and minerals, was carried out to assess the nutritional and functional attributes of the milk. In addition, physicochemical properties such as milk density and freezing point were measured to provide a comprehensive understanding of milk quality. The influence of parity (PA), stage of lactation (SL), and their interaction (PA × SL) on daily milk yield and fundamental milk constituents (total solids, fat, total protein, and lactose) is summarized in Tables 2 and 3. The mean ± SE values for fat, SNF, protein, lactose, and salts were $5.29 \pm 0.19\%$, $10.29 \pm 0.09\%$, $4.12 \pm 0.03\%$, $6.21 \pm 0.05\%$, and $0.91 \pm 0.01\%$, respectively. The milk density and freezing point were recorded as $36.14 \pm 0.43 \text{ g/cm}^3$ and

$-0.75 \pm 0.01^\circ\text{C}$, respectively.

The protein content of sheep milk is well recognized for its nutritional superiority, generally ranging between 5.5% and 6.5% (Haenlein, 2007). Similar observations have been reported for Indian breeds such as Malpura and Garole, whose protein levels are within this range and higher than those of cow and goat milk (Gadekar *et al.* 2019). The elevated protein content, coupled with high total solids, enhances the suitability of Malpura milk for paneer and cheese production. Proteins of sheep milk are of high biological value, containing all essential amino acids required for human health, thereby making it particularly beneficial for children, elderly individuals, and those with increased protein requirements (Park *et al.* 2007). In the present study, the average protein concentration of Marwari

Table 4. Colostrum sample nutritional analysis.

Parameters	Days	Fat	Solid not fat	Density	Protein	Lactose	Salts
Colostrum (N=6)	2	4	16.1	57.9	6.1	9.2	1.4

sheep milk was 4.12%. Although slightly lower than values reported in other Indian breeds, the protein level was still higher than in many bovine milks. The high protein content of colostrum, as reported earlier (Hadjipanayiotou, 1995), was evident in this study, underscoring its critical role in neonatal nutrition and passive immunity transfer. This suggests that while the Marwari breed may not match specialized dairy breeds in absolute protein levels, its milk still provides a nutritionally dense source of high-quality protein suitable for both direct consumption and processing into value-added products.

Sheep milk is also characterized by a relatively high fat content, usually between 6% and 8% (Raynal-Ljutovac *et al.* 2008). This property makes it highly desirable for cheese making and other value-added dairy products. In the present study, Marwari sheep milk contained 5.29% fat, which is slightly lower than the average reported for specialized dairy breeds but still nutritionally significant. The predominance of short- and medium-chain fatty acids in sheep milk lipids, compared with the long-chain fatty acids of cow milk, facilitates better digestibility and makes it particularly suitable for individuals with digestive ailments (Raynal-Ljutovac *et al.* 2008). Furthermore, these fatty acids have been associated with health-promoting properties, including improved lipid metabolism and enhanced energy availability, making sheep milk an attractive dietary component for populations with higher energy requirements or gastrointestinal sensitivities.

Colostrum analysis: The analysis of colostrum over two days reveals its rich nutritional composition, emphasizing its role as a vital source of nourishment (Table 4). The fat content was estimated as 4%, reflecting its energy-dense nature, essential for early growth and development. Solid-not-fat (SNF) levels stand at 16.1%, indicating the substantial presence of nutrients such as proteins, lactose, and minerals. The density of colostrum was measured at 57.9, further supporting its thick and nutrient-packed consistency compared to regular milk. Protein levels were notably high at 6.1%, highlighting the critical immunological and growth-promoting factors that colostrum provides. Lastly, salts were present at 1.4%, contributing to the mineral balance and overall functionality of colostrum in supporting neonatal hydration and electrolyte needs. The lactose content of sheep milk is comparable to that of cow milk, typically ranging from 4.8 to 5.2% (Park *et al.* 2007). In contrast, the present study recorded a relatively higher lactose concentration (9.21%) in Marwari sheep milk serving as a readily digestible energy source. Such variation may be attributed to breed-specific differences and physiological stages of lactation. Colostrum samples, in particular, exhibited distinct compositional features, with enrichment in bioactive molecules such as

immunoglobulins, lactoferrin, and antioxidant vitamins (A, E, and C). These compounds are essential in safeguarding neonatal lambs from oxidative stress while simultaneously providing passive immune protection. The higher protein and bioactive molecule concentration in colostrum was also reflected in its enhanced ferric-reducing antioxidant activity, corroborating earlier reports on the functional superiority of colostrum. These findings highlight the dual nutritional and immunological value of sheep colostrum, emphasizing its potential application not only in neonatal nutrition but also in the development of functional dairy products for human consumption.

Total antioxidant capacity: The total antioxidant capacity of the ethanolic extract of sheep milk and colostrum indicated a significantly higher antioxidant capacity in colostrum (117.63 FRU/dL) compared to milk (44.30 FRU/dL). This substantial difference in antioxidant capacity may be attributed to the composition of colostrum, which is rich in bioactive compounds such as immunoglobulins, lactoferrin, vitamins (A, E, and C), and other antioxidants that play a crucial role in providing passive immunity and combating oxidative stress in newborn lambs. Milk yield from Indian breeds remains relatively low compared to specialized dairy breeds of sheep in Europe, thereby restricting its availability for large-scale commercial exploitation (Pandya and Ghodke, 2007). Additionally, inadequate infrastructure for systematic milking, collection, and processing of sheep milk poses a major bottleneck in value addition (Haenlein, 2007). Limited consumer awareness about the nutritional and therapeutic benefits of sheep milk further hampers its market potential. Economic factors, such as higher production costs associated with low-yielding flocks and smallholder-based production systems, also constrain the competitiveness of sheep milk in both domestic and international markets. Implementing cooperative-based milk collection and processing networks could enhance efficiency, reduce post-harvest losses, and improve income for rural producers.

SDS-PAGE analysis: SDS-PAGE analysis compared the protein profiles of milk and colostrum, revealing distinct bands corresponding to proteins indicating compositional differences. These bands suggested the presence of specific proteins that differed between the two samples.

Colostrum exhibited additional low-molecular-weight bands around 10–20 kDa, likely representing bioactive peptides or immune-related proteins crucial for neonatal development (Figure 1). In contrast, milk displayed fewer and less intense bands, reflecting its nutritional adaptation for sustained growth rather than immune protection. These variations highlighted the functional transition from colostrum to mature milk.

Overall, the findings of this study underlined the

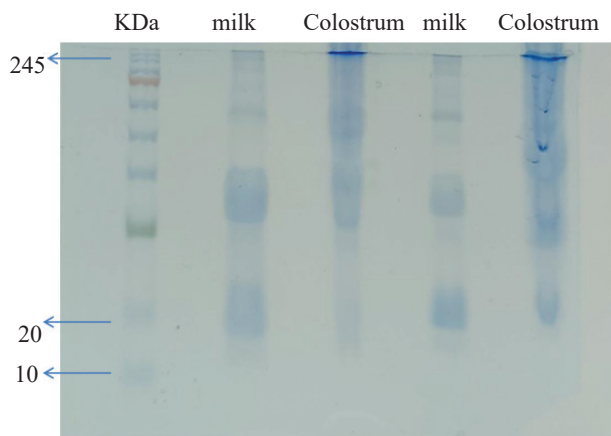


Fig.1 SDS-PAGE analysis of different protein fractions isolated from sheep milk and colostrum. In Lane 1 of the gel standard molecular weight marker was compared with the different band distribution in the other lanes.

nutritional and functional significance of Marwari sheep milk, highlighting its potential contribution to dietary protein and bioactive nutrient intake. Strategies aimed at promoting consumer education, developing processing technologies suited for smallholder systems, and establishing niche markets could substantially enhance the commercial viability of sheep milk in India (Raynal-Ljutovac *et al.* 2008). While challenges remain in scaling up production and utilization, targeted interventions in breed improvement, processing infrastructure, and market development could unlock the full potential of sheep milk as a valuable resource for both human nutrition and economic empowerment of smallholder farmers.

It may be concluded that Marwari sheep milk is nutritionally rich, with high levels of protein, fat, and lactose, while colostrum showed superior protein and antioxidant capacity, underscoring its role in neonatal health. Though yield is relatively low compared to specialized dairy breeds, its composition highlights strong potential for functional foods and nutraceuticals. Addressing productivity and processing challenges could further enable wider utilization of this resource in the Indian dairy sector.

REFERENCES

Acharya RM, 1982. *Sheep and goat breeds of India*. FAO Animal

Production and Health Paper. United Nations, Rome, Italy pp 30.

- Arora R and Bhatnagar R. 2010. Textbook of Animal Husbandry and Livestock Extension. *International Book Distributing Co.*
- Bencini R and Pulina G. 1997. The quality of sheep milk: A review. *Wool Technology and Sheep Breeding* **45**(3): 182–220.
- Benzie IF and Strain JJ. 1996. The ferric reducing ability of plasma (FRAP) as a measure of “antioxidant power”: the FRAP assay. *Analytical Biochemistry* **239**(1): 70–76.
- Bhatia S and Arora R. 2010. Biodiversity and conservation of Indian sheep genetic resources-An overview. *Asian-Australasian Journal of Animal Sciences* **23** (3): 314–26.
- Bradford MM. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical biochemistry* **72**(1–2): 248–54.
- Chessa S, Rignanesse D and Giaccone P. 2005. Characterization and expression of the sheep β -lactoglobulin gene. *Small Ruminant Research* **56**(1–3): 243–51.
- Gadekar YP, Shinde AK, Gauri J and Bhatt S. 2019. The quality of sheep milk and its products. *Indian Journal of Dairy Science* **72**: 119–21.
- Hadjipanayiotou M. 1995. Composition of ewe, goat and cow milk and of colostrum of ewes and goats. *Small Ruminant Research* **18**: 255–62.
- Haenlein GFW. 2004. Goat milk in human nutrition. *Small Ruminant Research* **51**(2): 155–63.
- Haenlein GFW. 2007. About the evolution of goat and sheep milk production. *Small Ruminant Research* **68**(1–2): 3–6.
- National Academy of Agricultural Science NAAS 2021. Potential of Non-Bovine Milk. Policy paper 97, National Academy of Agricultural Science, New Delhi
- Pandya A J and Ghodke KM. 2007. Goat and sheep milk products other than cheeses and yoghurt. *Small Ruminant Research* **68**(1–2): 193–206.
- Park YW and Haenlein G FW. 2006. Handbook of milk of non-bovine mammals Blackwell Publishing, USA PP 1–194.
- Park YW, Juárez M, Ramos M and Haenlein GFW. 2007. Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research* **68**(1–2): 88–113.
- Rao PVS. 2010. *Principles and Practice of Ayurvedic Medicine*. Chaukhamba Publications.
- Raynal-Ljutovac K, Lagriffoul G, Paccard P, Guillet I and Chilliard Y. 2008. Composition of goat and sheep milk products: An update. *Small Ruminant Research* **79** (1): 57–72.
- Sawaya WN, Khan P and Al Shalhat AF. 1984. Physical and chemical characteristics of ghee and butter from goat’s and sheep’s milk. *Food Chemistry* **14**: 227–32.
- Singh RH. 2009. *The holistic principles of Ayurvedic medicine*. Chaukhamba Surbharati Prakashan.