

Study of effect of seasons on the goat milk composition reared under conditions of Jaipur tehsil of Jaipur district

Gitam Singh¹, Preenon Bagchi², Raghunandan Singh Nathawat³, Shubham Tanwar⁴, Kapil Pal⁵, Vatsala Pawar⁶, Sunny Pathak⁷

¹Dean, College of Agriculture, Madhav University, Sirohi-307026, Rajasthan, India

²Associate Professor, Department Bioinformatics, Jaipur National University, Jaipur, Rajasthan, India

³Assistant Professor, Department Botany, Jaipur National University, Jaipur, Rajasthan, India

⁴Assistant Professor, Department Bioinformatics, Jaipur National University, Jaipur, Rajasthan, India

⁵Associate Professor, Department of Mathematics, Jaipur National University, Jaipur, Rajasthan, India

⁶Associate Professor, Department of Chemistry, Jaipur National University, Jaipur, Rajasthan, India

⁷Assistant Professor, Department of Allied Health Sciences, Jaipur National University, Jaipur, Rajasthan, India

E-mail: gitam.singh@madhavuniversity.edu.in

Abstract

The goat is thought to have been the earliest domesticated ruminant and, of all the species of domesticated animals except the dog, has the widest ecological range. The research has conducted at the Shri Vinayak College of Agriculture, Nayla, Kanota, Jaipur district of Rajasthan during 2022-24. The overall average specific gravity, fat, protein, lactose, ash, total solids and solids not fat of goat breeds reared under conditions of Jaipur tehsil in different seasons of all 1200 samples was 1.0295 ± 0.00038 , 4.79 ± 0.048 per cent, 3.25 ± 0.032 , 4.44 ± 0.015 , 0.744 ± 0.008 per cent, 13.16 ± 0.036 and 8.39 ± 0.054 per cent, respectively. The specific gravity, fat, calcium, phosphorus, potassium, magnesium and chloride percentage in the milk of Jakhrana as well as Sirohi goat breeds under seasonal conditions was significantly differ. Season has conspicuous effects on milk quality of goats.

Keywords: Jakhrana, Sirohi, Seasons, Goat milk composition, Jaipur

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Introduction

The Jakhrana breed is found in the north-west arid and semi-arid regions mainly in eastern Rajasthan. The breed derives its name from the Jakhrana village in Alwar district where it is found in its purest form. They are large animals. The coat is predominantly black with white spots on the ears and the muzzle is short and lustrous. The face line is straight, with a narrow and slightly bulging forehead. The breed looks similar to the Beetal, the major difference being that the Jakhrana is taller. The ear length is medium and the udder is large, with conical teats. Does are reared for milk. A majority of the bucks are sold for meat, with a small number retained for breeding (Verma et al., 2004).

India today stands first in the area of milk production at the world level, with an annual growth rate of about 4%. The country's milk production in 2010 was estimated to be 110 million tons. A large quantity of milk produced in the country, amounting to over 46%, is being consumed as liquid milk. The production and use of animal products in the use of human diet is receiving tremendous attention. (Singh et al., 2012). The productive improvements among dairy animals can be made through proper management, feeding, handling, etc., which may influence the expression of productive characters as per their heritability nature. Before identifying the animals for breeding and production purposes, screening of animals shall be performed on the basis of physical traits (Singh et al., 2013). The goat population of our country increased from 47.14 million in the year 1951 to 124.5 million during 2005 (Singh and Sharma, 2013a) and (Singh et al., 2013b).

Goats are an integral part of livestock production and play a vital role in the socio-economic structure of the rural poor. The aim of this study was to project the importance and significance of goat milk with special reference to Indian field and farm rearing conditions. There are adverse ecological and physiological constraints in the Indian system of goat farming (Singh et al., 2014a). The global goat population currently stands at 921 million, of which over 90% are found in developing countries. Asia is home to about 60% of the total world goat population and has the largest goat breed share of 26%. Non-cattle milk accounts for approximately 15% of the total milk consumption by humans worldwide (Singh et al., 2014c). The goat was domesticated as early as 6-7 BC, as evidenced by archaeological remains collected in western Asia (Singh et al., 2014f). The major population of India is primarily dependent on an agricultural-based system for their daily life, including goat keeping that constitutes an important rural business of small marginal

farmers and landless laborers (Singh et al., 2014g). Reproductive management of an animal is governed through a number of parameters, viz. age at first conception, age at first calving, first gestation length, etc. However, this study is limited to studying the reproductive management in terms of the age of the animal at first calving (Singh et al., 2014h).

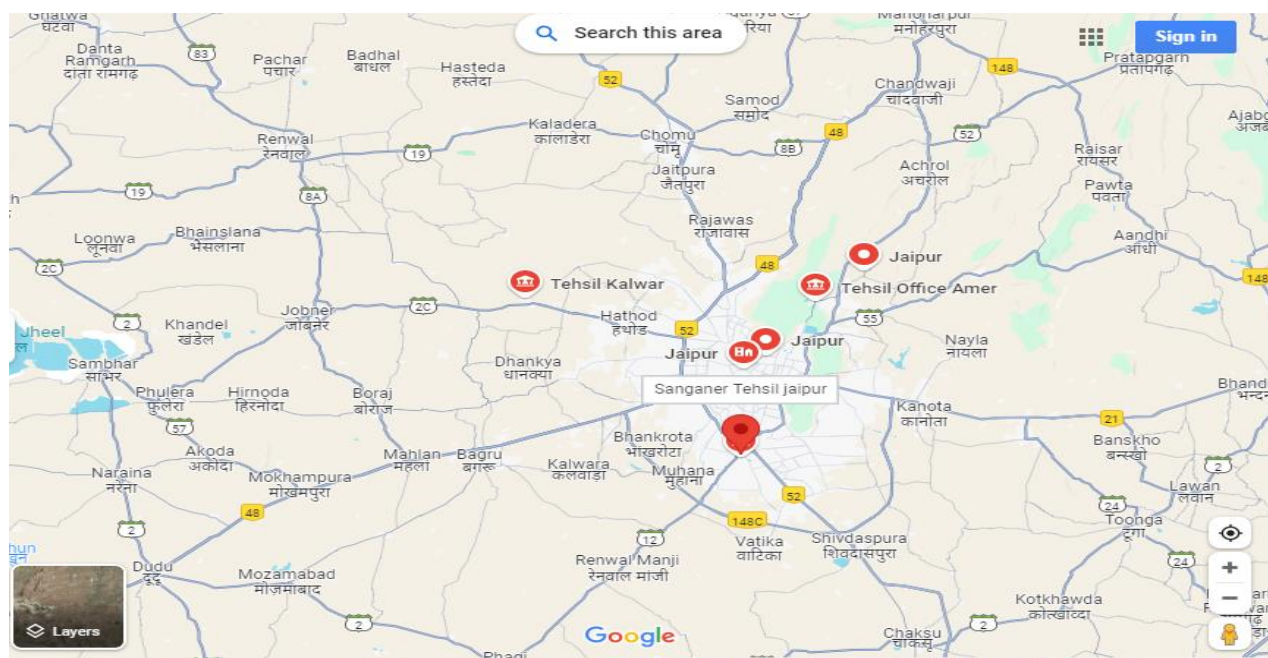


Fig. 1. Map showing location of Jaipur tehsil of Jaipur District

Goats, which were known as “wet nurses of infants” in the United Kingdom and “poor man's cow” in India, were the first animals to be domesticated. Goat milk contains less lactose than cow's milk, so it is less likely to trigger lactose intolerance (Singh and Sharma, 2015). The goat was domesticated as early as 6-7 BC, as evidenced by archaeological remains collected in western Asia. It has since played a significant socioeconomic role in the evolution of human civilization around the world (Singh and Sharma, 2015a). Pearl millet was recognized as a main source of energy for livestock and is fed at critical times, such as during lactation, illness, and for weight gain. Farmers felt that grass is more useful to fill the animals' stomachs and would therefore come before crop stover as a feed. Farmers preferred Deda over Kona because it has more biomass (Singh and Sharma, 2015b). This explains why goat farmers seldom consider the possibilities of increasing production through either crossbreeding or artificial insemination. A very important aspect in this regard is the awareness of risk by resource-poor farmers and their emphasis on minimizing it (Singh and Sharma, 2016). Goats play a vital socio-economic role in Asian agriculture, particularly for resource-poor people living in harsh environments. Goats, being a multipurpose animal, produce meat, milk, skin, fiber, and manure. The country is endowed with a large and biologically diverse population of goats. (Singh and Sharma, 2016a). The nutritional value of milk is closely related to its composition, which is affected by factors such as breed, diet, stage of lactation, season, etc. Goat milk has more calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), and chloride (Cl) and less sodium (Na) and sulfur (S) content than cow milk (Singh and Sharma, 2016b). Livestock production is the backbone of Indian agriculture, contributing 7% to national GDP and being a source of employment and livelihood for 70% of the population in rural areas. India ranks first in terms of milk production (129.7 million tonnes); however, the productivity is quite low, mainly because of the scarcity of feeds and fodders (Singh et al., 2017). Animals reared in intensive production systems consume a considerable amount of protein and other nitrogen-containing substances in their diets (Singh et al., 2017a). Small ruminants have a large impact on the economy and food supply of people in subtropical and tropical countries. This benefit is often not shown in national statistics because of informal trading and slaughtering (Singh and Sharma, 2017b). The consequence of domestication was a change in the phenotypic characteristics of wild goats, which resulted in the development of a multiplicity of goat breeds or types. These breeds or types were distributed across the world as a result of the migration and translocation of humans, usually due to changing climatic conditions and natural resources (Singh and Sharma, 2017d).



Fig. 2 Jakhrana



Sirohi Goat



Electronic Milk Analyzer

Goats play a vital socio-economic role in Asian agriculture, particularly for resource-poor people living in harsh environments. Non-cattle milk accounts for approximately 15% of the total milk consumption by humans worldwide. Asia contributes approximately 59% to world goat milk production (Singh, G. 2019). India is endowed with a significant share of the world's livestock population, growing steadily and continuously. Buffalo are predominantly animals of poor countries with a very high density of livestock and human population and with poor feed resources. In tropical and subtropical regions, dairy cattle usually depend exclusively on native or introduced pastures as their only source of nutrients, and in particular, during critical periods of the year, such as the winter or dry season, the animals cannot fulfill their nutrient requirements because forage is either scarce or of low quality (Singh, G., 2019a). Milk-secreting tissues and various ducts throughout the udder can be damaged by bacterial toxins, and sometimes permanent damage to the udder occurs. Severe acute cases can be fatal, but even in cows that recover, there may be consequences for the rest of the lactation and subsequent lactations (Singh and Singh, 2020). Livestock has become an integral part of all interventions aimed at reducing rural poverty and enhancing food and nutrition security. The dairy livestock owners who raise cattle and buffaloes are yet ignorant of scientific management practices (Singh and Somvanshi, 2020a).

Originating in Asia, goats have spread over all the continents and inhabit almost all climatic zones from the Arctic Circle to the equator (Singh, G., 2024). Man, animal, and nature are in a symbiotic relationship for their survival and sustenance. The balance maintained among the three for several millennia has been disturbed by the overexploitation of natural resources to meet the demands of the increasing population of men and animals (Singh et al., 2024a). The nutritional value of milk is closely related to its composition, which is affected by factors such as breed, diet, stage of lactation, and season. Goat milk has more calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), and chloride (Cl), and less sodium (Na) and sulfur (S) compared to cow milk (Singh et al., 2024b) and (Singh et al., 2025a). Minerals are required by dairy animals for their metabolic functions, growth, milk production, reproduction, and health. Animals cannot synthesize minerals inside their bodies, and usually, feeds and fodders fed to the dairy animals do not provide all the minerals in the required quantity (Singh et al., 2024c). The goat is thought to have been the earliest domesticated ruminant and, of all the species of domesticated animals except the dog, has the widest ecological range (Singh et al., 2024d).

The productive improvements among dairy animals can be made through proper management, feeding, handling, etc., which may influence the expression of productive characters as per their heritability nature. (Singh et al., 2024e). The production and use of animal products in the use of human diet is receiving tremendous attention. (Singh et al., 2025).

Materials and Methods

The research has conducted at the Shri Vinayak College of Agriculture, Nayla, Kanota, Jaipur district of Rajasthan during 2022-24. 05 milk samples of Sirohi goat and 05 milk samples were collected from the Jakhrana goat breed during the lactation at different villages of Jaipur tehsil of the Jaipur district throughout two years. A total of 1200 milk samples were collected from both goat breeds in Jaipur tehsil, with 600 milk samples from Sirohi goats and 600 milk samples from Sirohi goats. All samples were analyzed by an electronic milk analyzer. Data were analyzed using the ANOVA procedure of RBD (at 5% and 1% significance levels) for the statistical analysis of all milk samples.

Results and Discussion

Effect of seasons on Specific gravity:-

The results on specific gravity of milk of Jakhrana and Sirohi goat breed reared under conditions of Jaipur tehsil in different seasons are presented in Table 1. It indicated that the specific gravity of milk of Jakhrana breed's reared under conditions of Jaipur tehsil in different seasons i.e. summer, rainy and winter was 1.0305 ± 0.0003 and 1.0311 ± 0.0003 , 1.0287 ± 0.0003 and 1.0301 ± 0.0003 , and 1.0290 ± 0.0003 and 1.0308 ± 0.00038 , respectively. Similarly in case of Sirohi breed's milk reared under conditions of Jaipur tehsil in summer, rainy and winter seasons it was 1.0292 ± 0.0004 and 1.0302 ± 0.00038 , 1.0282 ± 0.00038 and 1.0280 ± 0.00038 and 1.0284 ± 0.00039 , and 1.0301 ± 0.0003 , respectively. The overall average specific gravity of goat breeds reared under conditions of Jaipur tehsil in different seasons of all 1200 samples was 1.0295 ± 0.00038 .

Table 1: - Effect of seasons on Specific gravity of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t) 5% 1%
Jakhrana (i) Summer	1.0305±0.0003	0311±0.0003	.0308±0.00041	1.441 ^{NS}	1.960 2.576
(ii) Rainy	1.0287±0.0003	0301±0.0003	.0293±0.00038	2.063 ⁺	
(iii) Winter	1.0290±0.0003	0308±0.00038	.0294±0.00038	1.984 ⁺	
Sirohi(i) Summer	1.0292±0.0004	0302±0.00038	.0297±0.00039	2.033 ⁺	
(ii) Rainy	1.0282±0.0003	0280±0.00038	.0281±0.00038	1.765 ^{NS}	
(iii) Winter	1.0284±0.0003	0301±0.0003	.0292±0.00039	2.107 ⁺	
Overall mean	1.028±0.00039	031±0.000397	.0295±0.00038		

Note: NS=Non Significant

+=Significant at $p < 0.05$

These data suggested that the specific gravity was higher in summer seasons and lower in rainy seasons in both breeds of goat reared under conditions of Jaipur tehsil. Our results on specific gravity in different seasons in the milk of Jakhrana and Sirohi goat breed are in fair agreement with the findings of (Singh et al., 2014b) for the result of seasons.

2:- Effect of seasons on Fat %:-

The data on fat content of milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil to study seasonal effect are presented in Table 2.

Table 2:- Effect of seasons on Fat % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t) 5% 1%
Jakhrana (i) Summer	4.42±0.044	4.51±0.047	4.46±0.046	1.986 ⁺	1.960 2.576
(ii) Rainy	4.65±0.045	4.88±0.043	4.76±0.044	2.791 ⁺⁺	
(iii) Winter	4.61±0.043	4.71±0.045	4.65±0.043	2.034 ⁺	
Sirohi(i) Summer	4.71 ± 0.050	4.87±0.049	4.79±0.050	2.602 ⁺⁺	
(ii) Rainy	4.95 ± 0.047	5.11±0.055	5.02±0.046	2.596 ⁺⁺	
(iii) Winter	4.79 ± 0.042	4.99±0.049	4.89±0.045	2.710 ⁺⁺	
Overall mean	4.68±0.046	4.85±0.046	4.79±0.048		

Note: + = Significant at $p < 0.05$ ++ = Significant at $p < 0.01$

The results laid down in Table 2 indicated that the fat percentage in the milk of Jakhrana breed reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was found to be 4.42±0.044 and 4.51±0.047, 4.65±0.045 and 4.88±0.043 and 4.61±0.043 and 4.71±0.045, respectively. In case of Sirohi breed, reared under conditions of Jaipur tehsil for the aforesaid seasons was found to be 4.70±0.049 and 4.87±0.049, 4.94±0.046 and 5.11±0.055 and 4.80±0.043 and 4.98±0.055, respectively. The overall average fat percentage of all 1200 samples was 4.79±0.048 per cent. The higher fat per cent was recorded in rainy season in both breed samples. Our data on seasonal variation in Jakhrana and Sirohi goat milk compared favorably with (Singh et al., 2014e).

3:- Effect of seasons on Protein %:-

The observations on protein percentage in the milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was investigated and compiled in Table 3.

Table 3:- Effect of seasons on Protein % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t) 5% 1%
Jakhrana (i) Summer	3.25±0.030	3.14±0.041	3.195±0.035	2.116 ⁺	1.960 2.576
(ii) Rainy	3.34±0.028	3.20±0.030	3.270±0.029	2.341 ⁺	
(iii) Winter	3.40±0.026	3.24±0.034	3.320±0.030	2.416 ⁺	
Sirohi (i) Summer	3.11±0.028	3.02±0.039	3.065±0.036	2.050 ⁺	
(ii) Rainy	3.23±0.026	3.10±0.036	3.165±0.036	2.146 ⁺	
(iii) Winter	3.32±0.026	3.15±0.032	3.235±0.25	2.428 ⁺	
Overall mean	3.275±0.0275	3.14±0.0355	3.25±0.032		

Note: ++ = Significant at p < 0.05

Protein percentage in the milk of Jakhrana breed reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was 3.25±0.030 and 3.14±0.041, 3.34±0.028 and 3.20±0.030 and 3.40±0.026 and 3.24±0.034, respectively. Similarly the protein content of Sirohi milk reared under conditions of Jaipur tehsil in aforesaid seasons was 3.11±0.028 and 3.02±0.039, 3.23±0.026 and 3.10±0.036 and 3.32±0.026 and 3.15±0.032 per cent, respectively. The overall average protein per cent of aforesaid samples and seasons reared under conditions of Jaipur tehsil was 3.25±0.032. The results obtain in this investigation on the level of protein content are equal with the findings of (Singh and Sharma, 2014).

4:- Effect of seasons on Lactose %:-

The season wise study of milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil was studied and recorded in Table 4.

Table 4:- Effect of seasons on Lactose % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t) 5% 1%
Jakhrana (i) Summer	4.37±0.015	4.35±0.014	4.36±0.014	2.734 ⁺⁺	1.960 2.576
(ii) Rainy	4.48±0.017	4.40±0.010	4.44±0.014	4.316 ⁺⁺	
(iii) Winter	4.62±0.013	4.51±0.011	4.57±0.012	5.103 ⁺⁺	
Sirohi (i) Summer	4.39±0.018	4.33±0.008	4.36±0.014	2.063 ⁺	
(ii) Rainy	4.43±0.014	4.37±0.012	4.40±0.014	3.628 ⁺⁺	
(iii) Winter	4.50±0.015	4.44±0.009	4.47±0.013	3.021 ⁺⁺	
Overall mean	4.465±0.0165	4.40±0.0115	4.44±0.015		

Note: + = Significant at p < 0.05

++ = Significant at p < 0.01

It is evident from the table 4 that the lactose content of milk of Jakhrana breed reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was found to be 4.37±0.015 and 4.35±0.014, 4.48±0.017 and 4.40±0.010 and 4.62±0.013 and 4.51±0.011 per cent, respectively. In case of Sirohi breed under rearing conditions in summer, rainy and winter seasons had an average of 4.39±0.018 and 4.33±0.008, 4.43±0.014 and 4.37±0.012 and 4.50±0.015 and 4.44±0.009 per cent, respectively. The overall average lactose per cent in all 1200 samples was found to be 4.44±0.015. Our results on lactose content of goat milk in different seasons are corroborated by the observations of (Singh et al., 2018) reported lower level of lactose in winter season in the milk of aforesaid goats where (Singh and Sharma, 2014) reported higher level of lactose content in different seasons in Sirohi and other goat breed's milk.

5:- Effect of seasons on Ash %:-

The results on ash per cent in milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil in different seasons under studied are presented in Table 5.

Table 5:- Effect of seasons on Ash % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t)	
					5%	1%
Jakhrana (i) Summer	0.74±0.005	0.72±0.013	0.73±0.009	1.994 ⁺	1.960	2.576
(ii) Rainy	0.78±0.008	0.75±0.010	0.765±0.009	2.314 ⁺		
(iii) Winter	0.82±0.008	0.81±0.010	0.810±0.009	2.097 ⁺		
Sirohi (i) Summer	0.70±0.007	0.68±0.011	0.690±0.009	2.063 ⁺		
(ii) Rainy	0.73±0.009	0.70±0.010	0.715±0.09	2.734 ⁺⁺		
(iii) Winter	0.79±0.006	0.72±0.012	0.755±0.009	3.643 ⁺⁺		
Overall mean	0.75±0.0071	0.73±0.0115	0.744±0.008			

Note: Figure in parenthesis indicated number of samples.

+ = Significant at $p < 0.05$

++ = Significant at $p < 0.01$

Perusal of Table 5 indicated that the ash content of Jakhrana goat breed milk reared under conditions of Jaipur tehsil in different seasons i.e. summer, rainy and winter was found to be 0.74±0.005 and 0.72±0.013, 0.78±0.008 and 0.75±0.010 and 0.82±0.008 and 0.81±0.010 per cent, respectively. Similarly in case of Sirohi goat breed's milk reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was found to be 0.70±0.007 and 0.68±0.011, 0.73±0.009 and 0.70±0.010 and 0.79±0.006 and 0.72±0.012 per cent, respectively. The overall average ash content of Jakhrana and Sirohi goat breeds in all seasons was 0.744±0.008 per cent. Our results on ash content in different seasons are greater than observations of (Singh et al., 2025a).

6:- Effect of seasons on Total Solids %:-

The data on total solids percentage of milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil to studied seasonal effect are presented in Table 6.

Table 6:- Effect of seasons on Total Solids % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t)	
					5%	1%
Jakhrana (i) Summer	13.11±0.028	13.03±0.041	13.07±0.039	3.083 ⁺⁺	1.960	2.576
(ii) Rainy	13.14±0.030	13.10±0.040	13.12±0.036	2.038 ⁺		
(iii) Winter	13.20±0.041	13.05±0.043	13.13±0.043	5.634 ⁺⁺		
Sirohi (i) Summer	13.17±0.040	13.10±0.034	13.14±0.035	2.469 ⁺		
(ii) Rainy	13.21±0.033	13.16±0.033	13.19±0.033	1.966 ⁺		
(iii) Winter	13.29±0.033	13.20±0.038	13.24±0.039	2.101 ⁺		
Overall mean	13.185±0.032	13.15±0.036	13.16±0.036			

Note: ++ = Significant at $p < 0.05$

++ = Significant at $p < 0.01$

The results laid down in Table 4.6B indicated that the total solids percentage in the milk of Jakhrana goats reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was found to be 13.11±0.028 and 13.03±0.041, 13.14±0.030 and 13.10±0.040 and 13.20±0.041 and 13.05±0.043, respectively. In case of Sirohi goats breeds reared under conditions of Jaipur tehsil for aforesaid seasons, the total solids per cent were found to be 13.17±0.040 and 13.10±0.034, 13.21±0.033 and 13.16±0.033 and 13.29±0.033 and 13.20±0.038, respectively. The overall average total solids percentage of all 1200 samples of milk was found to be 13.16±0.036. The value reported by (Singh and Sharma, 2014) for seasonal effect on total solids content in the goat breed's milk support results of present study.

7 Effect of seasons on Solids-Not-Fat %:-

The observations on solids-not-fat percentage of milk of Jakhrana and Sirohi goat breeds reared under conditions of Jaipur tehsil to studied seasonal effect are presented in Table 7.

Table 7:- Effect of seasons on Solids-Not-Fat % of milk under field and farm rearing conditions.

Breeds	Field	Farm	Overall average	Test of significance	Table value (t)	
					5%	1%
Jakhrana (i) Summer (ii) Rainy (iii) Winter	8.54±0.056	8.34±0.052	8.44±0.054	9.312 ⁺⁺	1.960	2.576
	8.47±0.055	8.25±0.055	8.36±0.055	8.169 ⁺⁺		
	8.73±0.055	8.52±0.053	8.63±0.053	10.631 ⁺⁺		
Sirohi(i)Summer (ii) Rainy (iii) Winter	8.41±0.056	8.24±0.054	8.33±0.055	7.361 ⁺⁺		
	8.25±0.058	8.00±0.053	8.12±0.056	11.260 ⁺⁺		
	8.52±0.056	8.28±0.050	8.40±0.054	10.093 ⁺⁺		
Overall mean	8.50±0.055	8.27±0.052	8.39±0.054			

Note: ++=Significant at $p < 0.01$

Solids-not-fat percentage in the milk of Jakhrana goat breed reared under conditions of Jaipur tehsil in summer, rainy and winter seasons was found to be 8.54 ± 0.056 and 8.34 ± 0.052 , 8.47 ± 0.055 and 8.25 ± 0.055 and 8.73 ± 0.055 and 8.52 ± 0.053 , respectively. In case of Sirohi goat breeds reared under conditions of Jaipur tehsil for aforesaid seasons, the solids-not-fat per cent was found to be 8.41 ± 0.056 and 8.24 ± 0.054 , 8.25 ± 0.058 and 8.00 ± 0.053 and 8.52 ± 0.056 and 8.28 ± 0.050 , respectively. The overall average solids-not-fat content of all 1200 animals' milk in all seasons was 8.39 ± 0.054 per cent. The results of present investigation on the level of solids-not-fat per cent in different seasons are similar with the findings of (Singh and Sharma, 2014) whereas, (Singh et al., 2017c) reported lower values on it.

Conclusion

The specific gravity, fat, calcium, phosphorus, potassium, magnesium and chloride percentage in the milk of Jakhrana as well as Sirohi goat breeds under seasonal conditions was significantly differ. Season has conspicuous effects on milk quality of goats.

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