

Research Article

Effect of Stages of Lactation on Goat Milk Composition under Field and Farm Rearing Condition

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ABSTRACT

The aim of this study was to evaluate the conspicuous effects on milk quality of farm and field rearing goats. Milk samples were collected from two important goat breed Jamunapari and Jakhrana from different villages. The analysis were performed on 1215 milk samples collected from 377 Jamunapari and 736 Jakhrana goats, at varied environmental conditions of time period April – June, July – September and November – February. The sample selection criteria were also decide according to stages of lactation time period 10 – 40 days, 41 – 90 days and 91 to 150 days. Electronic Milk Analyzer provides specific gravity (1.0295±0.00038), Fat % (4.76±0.046), Protein % (3.205±0.031), Lactose % (4.433±0.014), Ash % (0.745±0.009), TS% (13.15±0.034), and SNF % (8.38±0.053) of all the samples. Lactation stages showed significant effect on milk quality. The percentages of fat, protein, lactose, ash, TS, and SNF, were significantly higher ($p<0.05$) with advancement of lactation in both breeds. The milk of farm rearing goats had significantly ($p<0.05$) higher content of fat, protein, lactose, ash, TS, and SNF, in comparison to field rearing goats. Variation in milk quality for different months of the year and rearing conditions are directly proportional to variation in eco-environmental condition.

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INTRODUCTION

Major population of India is primarily depends on agricultural based system for their daily life including goat keeping that constitute an important rural business of small marginal farmers and landless labours. At present, world's total numbers of goats and sheep are 861.9 and 1078.2 million heads, respectively. Despite the least attention from the planners, goat population increased by 146% of the total goat population present in the year 1990 (590.1 million) (FAOSTAT, 2008). Top four goat holding countries are present in Asia; among these highest numbers of goats are in China (17.3%), followed by India (14.6%), Pakistan (6.6%) and Bangladesh (6.5%). Constituting about 45% of the total goat population in the world. Dairy goat, is an integral part of socioeconomic system, is considered as a cow of poor. The goat eats little, occupies a small area and produces enough milk for the average unitary family. On the contrary, maintaining a cow at home is difficult leading to, popularity for goat rearing practices. Dairy goats produce about 15.2 million metric tons (MT) of milk, accounting for 2% of the world's milk produced by all the livestock species (FAOSTAT, 2008).

Goat milk is more widely produced than sheep milk, and globally goat production yield 60 % of its value of milk, 35 per cent as meat and 5 per cent as skin. There is evidence that on live weight basis the goat is a more efficient milk producer than the other species (Malau-Aduli 2001). Goat farming has multifold advantages like short generation

interval, high rate of prolificacy, easy in management and marketing over large ruminants in the world.

The strong Roman nose renders the upper jaw and lip in many Jamunapari shorter than the lower jaw, the condition being called an "undershot upper jaw" or brachygnathia, It causes a challenge for this goat to feed on grasses growing on ground. It is the tallest breed, commonly known as the "Pari" (Angel) due to its splendid appearance (Figure 1A). Its home tract and natural habitat is the Chakarnagar area of the Etawah district in the State of Uttar Pradesh, along the delta of the Jamuna and Chambal Rivers, and the Bhind district of the State of Madhya Pradesh along the Kaweri River, east of New Delhi. Female Jamunapari weigh around 2.7 kg at birth, 13.6kg at six months, and 29.4kg at 12 months of age (Figure 1). Male kids have significantly higher body weights. Growth rate averages about 0.9 kg per week up to three months of age, and 0.9kg per 10 days thereafter (Rout et al., 2004). Due to present deforestation and land reclamation, the original home tract with its brush vegetation is now becoming greatly changed to the disadvantage of the browsing Jamunapari, and thus contributing to the endangerment of the Jamunapari breed.

The second important breed of goat in this region is Jakhrana which has also been studied in present work. According to the 18th livestock Census 2007, the number of Jakhrana goat in the country is 1,953,046 that are fairly widespread in the states of Rajasthan and Haryana. These



Figure 1: A) Jamunapari goat; B) Jakhkana goat

goats are comparatively larger than other breeds of goat. Body 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 (Figure 1B). This breed is well known for its milk potential averaging a daily yield between 2 to 5 liters. The milk has a relatively higher fat content (5.06%), SNF (8.60%) and protein (3.70%) (Verma et al., 2004). These goats show good prolificacy and kidding (upto 90%) during June–July and October–November.

It is clear that goat milk is a valuable source of nutrients and is in many ways comparable to cow milk. It is a potential resource that should be utilized. Goat milk varies in quality by, composition changes with breed, stage of lactation (Jenness 1980; Parkash and Jenness 1968; Shingfield et al., 2008), and feeding (Morand-Fehr et al., 2007; Silanikove et al., 2010). In conclusion, people should know about the important component of goat milk that may change according to birth rate, lactation stages and season with rearing conditions.

METHODOLOGY

The experiment was conducted at the Central Institute for Research on Goats, Makhdoom, Mathura; under the Division of Nutrition Feed Resources and Products Technology. Milk samples were collected from breed Jamunapari and Jakhkana under the farm and field rearing conditions. Field samples were collected from different villages. The Jamunapari and Jakhkana breeds milk samples were from villages of Mathura and Agra, India (27° 10' N, 78° 00' E and 169 m above MSL). Geologically the Institute is situated under the Yamuna river with semi-arid soil. Temperature ranges between 6° C in winter to as high 45° C in summer. Annual average rainfall is a period of 50 – 60 days. Monsoon arrives in mid July and remains active till mid September Agnihotri and Rajkumar (2007). The methodology used was an adaption from Bourbouze (1995) and Alvarez Funes and Paz Motola (1997).

Experimental Goats and Management

A total of 1215 milk samples were collected from field and farm rearing condition: 377 Jamunapari {early 56 (field 26 and farm 30), middle 128 (field 58 and farm 70) and late 295 (field 18 and farm 277)} milk samples. Similarly, 736 Jakhkana samples were collected as {early 281 (field 30 and

farm 251), middle 128 (field 53 and farm 75) and late 327 (field 22 and farm 305)}.

Sample Collection and Analysis

Goat milk samples were collected from research farm and field properly at varied environmental conditions (throughout the seasons, viz Summer (April – June)

Rainy (July – Sept.) Winter (Nov. – Feb.)) and stages of lactation (I. Early lactation (10 to 40 days), II. Middle lactation (41 to 90 days) and III. Late lactation (91 to 150 days)). The composition was determined by Electronic Milk Analyzer (Lactoscan SA, Milktronics Ltd. Bulgaria) before the analysis of each sample was thawed at 30° C to melt the fat and then cooled to 20° C. During the entire study, the fresh goat milk samples were collected from local goats in I, II and III lactations with n=4 goats in each lactation.

Statistical Analysis

Data were recorded as means +/- standard deviation to compare and analyze using randomized block design, ANOVA and Fisher's least significant difference procedure in software SAS Institute Inc. (1990). A 95% level of significance was used for all analyses.

RESULTS AND DISCUSSION

The specific gravity in the milk of Jakhkana goat and Jamunapari goat under field and farm rearing conditions in early middle and late lactation was significantly higher ($P < 0.05$) in farm samples than field rearing samples in all lactation stage (Table. 1). The overall average specific gravity of above all stage of lactation in above 1215 samples of milk was 1.0295 ± 0.00038 . The highest specific gravity was recorded in late lactation in both breeds' samples either field or farm rearing conditions. It may be due to higher total solids content in late lactation. Specific gravity was significantly higher (at 1% level of significance) specific gravity was in the Jakhkana goat than Jamunapari goat milk under field and farm conditions in all stage of lactation. This increase in specific gravity in late stages of lactation could be due to protein content which increases density as lactation advances. Specific gravity in different late stage of lactation had fair agreement with the findings of Bhosale et al., (2009) reported that stage of lactation can increase fat, protein, ash, TS, SNF, titratable acidity and viscosity of milk. The reason may also be due to nutritional factor from their basal diet.

Table 1: Effect of stage of lactation and rearing conditions on goat milk composition.

Sr. No.	Breeds	Field	Farm	Test of significant
Specific Gravity				
1.	Jakhrana			
	(i) Early	1.0284±0.00037(30)	1.0296±0.0004(251)	3.264**
	(ii) Middle	1.0294±0.00038 (53)	1.0306±0.00038(75)	3.761**
	(iii) Late	1.0304±0.00039(22)	1.0316±0.00036(305)	2.986**
2.	Jamunapari			
	(i) Early	1.028±0.00039(26)	1.0284±0.00037(30)	4.062**
	(ii) Middle	1.0284±0.00037(58)	1.0294±0.00038(70)	3.866**
	(iii) Late	1.0294±0.00038(18)	1.0304±0.00039(277)	3.696**
	Overall mean	1.029±0.00038(207)	1.030±0.00038 (1008)	
Fat%				
1.	Jakhrana			
	(i) Early	4.37±0.041(30)	4.54±0.044(251)	6.643**
	(ii) Middle	4.50±0.044(53)	4.76±0.047(75)	4.792**
	(iii) Late	4.78±0.048(22)	4.98±0.049(305)	5.684**
2.	Jamunapari			
	(i) Early	4.62±0.047(26)	4.78±0.048(30)	5.124**
	(ii) Middle	4.83±0.047(58)	4.96±0.045(70)	6.391**
	(iii) Late	5.01±0.049(18)	5.17±0.049(277)	8.502**
	Overall mean	4.69±0.046(207)	4.84±0.047(1008)	
Protein%				
1.	Jakhrana			
	(i) Early	3.19±0.032(30)	3.08±0.031(251)	3.74**
	(ii) Middle	3.30±0.030(53)	3.17±0.033(75)	3.29**
	(iii) Late	3.50±0.028(22)	3.32±0.036(305)	4.96**
2.	Jamunapari			
	(i) Early	3.10±0.026(26)	3.00±0.038(30)	2.610**
	(ii) Middle	3.20±0.027(58)	3.08±0.037(70)	2.961**
	(iii) Late	3.32±0.025(18)	3.19±0.038(277)	3.109**
	Overall mean	3.275±0.03(207)	3.14±0.036(1008)	
Lactose%				
1.	Jakhrana			
	(i) Early	4.60±0.016(30)	4.54±0.013(251)	3.210**
	(ii) Middle	4.50±0.017(53)	4.43±0.010(75)	4.346**
	(iii) Late	4.38±0.015(22)	4.29±0.010(305)	4.642**
2.	Jamunapari			
	(i) Early	4.55±0.014(26)	4.47±0.011(30)	2.761**
	(ii) Middle	4.44±0.017(58)	4.39±0.013(70)	2.541*
	(iii) Late	4.33±0.017(18)	4.28±0.010(277)	2.410*
	Overall mean	4.47±0.016(207)	4.40±0.012(1008)	
Ash%				
1.	Jakhrana			
	(i) Early	0.70±0.006(30)	0.66±0.007(251)	4.23**
	(ii) Middle	0.78±0.007(53)	0.75±0.012(75)	3.19**
	(iii) Late	0.88±0.006(22)	0.86±0.012(305)	1.94 ^{NS}
2.	Jamunapari			
	(i) Early	0.66±0.007(26)	0.62±0.011(30)	4.32**
	(ii) Middle	0.75±0.008(58)	0.70±0.010(70)	4.98**
	(iii) Late	0.81±0.008(18)	0.78±0.011(277)	2.77**
	Overall mean	0.76±0.007(207)	0.73±0.011(1008)	
TS%				
1.	Jakhrana			
	(i) Early	12.86±0.030(30)	12.80±0.036(251)	2.11*
	(ii) Middle	13.06±0.030(53)	13.13±0.038(75)	2.56*
	(iii) Late	13.56±0.031(22)	13.46±0.036(305)	1.83 ^{NS}
2.	Jamunapari			
	(i) Early	12.94±0.032(26)	12.87±0.039(30)	2.69**
	(ii) Middle	13.21±0.033(58)	13.13±0.039(70)	2.82**
	(iii) Late	13.46±0.034(18)	13.40±0.039(277)	2.09*
	Overall mean	13.185±0.03(207)	13.11±0.038(1008)	

Sr. No.	Breeds	Field	Farm	Test of significant
SNF%				
1.	Jakhrana			
	(i) Early	8.47±0.056(30)	8.28±0.050(251)	6.39**
	(ii) Middle	8.56±0.054(53)	8.35±0.051(75)	9.68**
	(iii) Late	8.69±0.052(22)	8.48±0.053(305)	10.81**
2.	Jamunapari			
	(i) Early	8.31±0.053(26)	8.10±0.054(30)	9.86**
	(ii) Middle	8.38±0.054(58)	8.17±0.053(70)	10.11**
	(iii) Late	8.45±0.055(18)	8.24±0.051(277)	10.80**
	Overall mean	8.49±0.054 (207)	8.27±0.0.52(1008)	

Table value (t) 5% = 1.960; Table value (t) 1% = 2.576; P value were <0.05 for significant (+) and <0.01 for highly significant (**) values; Note: Figure in parenthesis indicated number of samples; + = Significant at 5% level of significance; ** = Significant at 1% level of significance; NS = Non Significant

Fat and protein percentage in the milk of Jakhrana goat and Jamunapari goat under field and farm rearing samples in early, middle and late lactation was variable (table 1). The overall average fat percentage of all samples in all lactation stage was 4.76±0.046. The results of the present investigation on fat content of Jakhrana and Jamunapari goat breed's milk in different stage of lactations are in agreement with the observations of Pal et al., (2011). Authors reported that the composition of goat milk varied widely and this variation was attributed to stage of lactation, geographical location, health and management of goats. High levels of fat, total solids and protein in milk have been reported for the West African dwarf goat, pygmy goats of Oregon, Black Bengal and Barbari of India. Similarly, with the advancement of lactation period fat, ash and total solids have been found to increase; whereas, the lactose content decreased.

The overall average protein per cent of all samples in all stage of lactation was found to be 3.205±0.031. Agnihotri and Rajkumar (2007) studied variations in daily milk composition and stage of lactation at fortnightly interval from seventh day after kidding up to 90 days of lactation in Sirohi, Marwari, Kutchi and Jakhrana breeds. Similar trend was observed for fat content; whereas, the TS content was higher in the last stages of lactation, SNF and ash remained unaffected. Other research by Kala and Prakash (1990), Prasad et al., 2002 and Prasad et al., (2005) reported higher values. Remaining milk in the udder after milking may also contain some fat. It is known that fat globules have tendency to cluster and thus it could be trapped in the alveoli. Therefore, after incomplete milking, milk fat content will be lower than normal.

Lactose content of Jakhrana and Jamunapari goat has been given in table 1. The overall average of lactose content was 4.433±0.014 per cent. The observations indicated the level of lactose content in above goat milk in different stage of lactation are fully corroborated by the findings of Bhosale et al., (2009) and Pal et al., (2011). However Kala and Prakash (1990) reported lower value. Kala and Prakash (1990) examined records of Jamunapari and Barbari goat milk constituents. Stage of lactation significantly affected milk constituents. Fat and protein contents were negatively and lactose contents positively correlated with milk yield. Heritability estimates of milk yield and constituents in the two breeds ranged from medium to high (0.22 for SNF to 0.48 for TS). This trend of milk yield could have resulted due to proliferation of myoepithelial cells of the mammary gland especially at the early stage of lactation. Knight and Wilde (1993), reported that mammary cells multiplied during early lactation and declines as lactation progresses.

Chamberlain (1989) had reported that milk production gradually declines after reaching its peak. The decline in milk yields as lactation stage increases is attributed both to loss of secretory tissues and fall in the rate of secretion per cell. Prasad et al., 2002 reported higher level of lactose content.

The ash percentage (table 1) in the milk of Jamunapari goat and Jakhrana goat in different stage of lactations are equal with the findings of Agnihotri and Rajkumar (2007) and Bhosale et al., (2009). Overall average ash percentage of all samples was 0.745±0.009. Total solids percentage in the milk of Jakhrana goat and Jamunapari goat under field and farm rearing conditions for aforesaid state of lactation conditions compared favorably with Zahraddeen et al., (2007). The overall average total solids percentage of all above samples of milk in all stage of lactations was 13.15±0.034. Zahraddeen et al., (2007), had observed that the percentages of crude protein, fat and lactose contents were significantly (P<0.01) different in the four stages of lactation (colostrum, early, mid and late), while the differences in the total solid and ash contents were not affected by the lactation stages. Agnihotri and Rajkumar (2007) reported lower values where as Prasad et. al. (2002) and Prasad et al., (2005) reported higher values of total solids content in above breeds and stage of lactations.

The solids-not-fat percentage in the milk of Jakhrana goat and Jamunapari goat under field and farm rearing conditions in early, middle and late stage of lactation was in fair agreement with the findings of Kala and Prakash (1990) and Bhosale et al., (2009). The overall average solids-not-fat content in all above samples in all stages was 8.38±0.053. However Agnihotri and Rajkumar (2007) reported lower level of solids-not-fat.

Table 2: ANOVA for the effect of stage of lactation on goat milk under field and farm rearing conditions

Contents for the source of variance	Variance ratio		F- Value table	
	Field	Farm	5%	1%
Specific Gravity	6.342**	7.946**	3.00	4.610
Fat	9.61**	11.26**	3.00	4.610
Protein	6.390**	7.810**	3.00	4.610
Lactose	8.71**	10.34**	3.00	4.610
Ash	7.98**	9.07**	3.00	4.610
Total solid	10.12**	13.01**	3.00	4.610
Solids-not-fat	4.63**	5.96**	3.00	4.610

P value were <0.05 for significant (+) and <0.01 for highly significant (**) values

ANOVA analysis indicated that milk collected from farm rearing goats was better in all parameter (Table 2). Variation in milk production for different months of the year and places might be due to eco-environmental condition, availability of feed stuffs, and so on. Causes behind this situation might be due to serious scarcity of feed especially green grasses during that period, and due to flood prevailing from April to June. While abundance of fodder and rearing facilities has a tendency to increase the fat value (Banerjee, 1991), protein content, specific gravity, solid non-fat (SNF) and total solid value (Azad et al., 2007). Also, there is an inverse relationship between milk yield with its SNF% and fat% (Banerjee, 1991).

CONCLUSION

The specific gravity, fat, calcium, phosphorus, potassium, magnesium and chloride percentage in the milk of Jakhrana as well as Jamunapari goat breeds under farm rearing conditions was significantly higher than that of field rearing conditions. Stage of lactation had conspicuous effects on milk quality of goats under study.

CONFLICT OF INTEREST

Authors do not have any conflict of interest to declare.

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