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Impact of stages of lactation on the minerals of Jakhrana goat milk under field and farm rearing condition

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ABSTRACT : Goat milk as a source for minerals nutrition is an often overlooked benefit of this dairy treat. In fact, when it comes to calcium, potassium and selenium, goat milk is a real champ. It seems, however, that the amount of mineral is not the only nutritional factor. The study was conducted at the central institute for research on goats, Makhdoom, Mathura; under the division nutrition feed resources and products technology for the study of farm rearing condition. Milk samples were collected from Jakhrana goat under the farm and field rearing condition. Field samples were collected from different villages. The overall average calcium content was 0.146±0.0019 per cent. Phosphorus percentage in the milk of Jakhrana goat breed under field and farm rearing conditions in early, middle and late lactation 0.122±0.0011 and 0.124±0.0010 and 0.124±0.0012 and 0.126±0.0011 and 0.126±0.0010 and 0.128±0.0011 per cent, respectively. The potassium content in the milk of Jakhrana goat breed under field and farm rearing samples in early, middle and late lactation was 0.112±0.0006 and 0.113±0.0009, 0.111±0.0009 and 0.112±0.0008 and 0.110±0.0009 and 0.111±0.0008 per cent, respectively. The overall average magnesium per cent in all above samples either field or farm rearing conditions in all stage of lactation was 0.0146±0.00015. Chloride content in Jakhrana goat breed indicated that the effect of stage of lactation under field and farm rearing condition was found to be 0.100±0.00058 and 0.103±0.00050 and 0.104±0.00059 and 0.107±0.00054 and 0.114±0.00061 and 0.114±0.00054 in early, middle and late lactation, respectively. The selenium percentage in the milk of Jakhrana goat breed under field and farm rearing conditions in early, middle and late lactation was found to be 0.01681±0.000053 and 0.01641±0.000058, 0.01695±0.000055 and 0.01666±0.000060 and 0.01709±0.000057 and 0.01690±0.000060, respectively. The overall average selenium content was a 0.01667±0.000058. Stages of lactation had conspicuous effects on milk quality of goats under study.

KEY WORDS : Stages of lactation, Minerals, Jakhrana, Goat milk, Field, Farm

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INTRODUCTION

Goats are more often poorly managed and this is attributed to their ability to survive under harsh conditions and also because most people in rural areas rear goats for their subsistence purposes to support their families. This explains why goat farmers seldom consider the possibilities of increasing production through either cross-breeding 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. Under such conditions, animals that are hardy against the vagaries of droughts, disease and poor management are more attractive options than more productive breeds that are vulnerable to these conditions (Braker *et al*., 2002).

Goats play a vital socio-economic role in Asian agriculture, particularly for resource-poor people living

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in harsh environments. Non-cattle milk accounts for approximately 15 per cent of the total milk consumption by humans worldwide. Asia contributes approximately 59 per cent to world goat milk production. The global goat population currently stands at 921 million, of which over 90 per cent are found in developing countries. Asia is home to about 60 per cent of the total world goat population and has the largest goat breed share of 26 per cent (FAOSTAT, 2011).

Jakhrana goat breed derives its name from the name of a village Jakhrana where it is found in the most pure form. The breed is distributed in the area around Jakhrnaa village near Behror in Alwar districts of Rajasthan. The population of the breed is small which is localized in few villages only. It is a large sized breed with compact body and long legs. The coat colour is predominantly black with typical white speckles on the ears. The coat is short and lustrous. Face is straight and forehead is narrow and raised. Both sexes have strong and thick stumpy horns. Ears are of medium length and drooping. Wattles are found in some animals. Udder is large and well developed with long conical teats. The average body weight of adult male and female is 43.50+1.16 and 39.29+0.40kg, respectively. The average body length, body height and heart girth is 84.1+2.11, 90.40+1.61 and 86.0+1.91 cm, respectively in male and 77.7+79, 79.1+0.29 and 79.1+0.31 cum, respectively in females. Average age at first kidding and kidding interval is 574 and 319 days, respectively with a twinning rate of 41.0 per cent. Triplets are 2-3 per cent. This breed is famous for its milk production potential and used at many places as an improver breed for increasing the milk production. The location yield is 121.8+8.8 kg in a lactation period of 115 days with a daily average of 1060 g. The death rate is very small under village conditions ranging to 2-3 per cent in kids and 1-2 per cent in adult goats. The goats are raised under extensive conditions and flocks are stationery.

Goat lactation is synonymous to an agricultural production function with three distinct production regions namely, early, mid and late lactation. It is characterized by an increase in milk yield in early lactation to a possible peak in the mid lactation and then a decline in milk yield as it reaches the end of lactation. However, the other milk constituencies (protein, fat, lactose, etc.) do not follow the same trend as total milk yield through the 3 lactation stages. Therefore, it is suffice to suggest that the understanding of the physiological changes in these stages of lactation is crucial in maximizing milk composition in goats. The present discussion explores the importance of different stages of lactation in milk production in influencing yield and milk composition. Milk composition is influenced by various factors; among these stages of lactation is very significant. The proportion of protein, lactose, fat and total solids declined slightly with advance in lactation. The significant stage of lactation effect in most studies may have practical implications in determining optimal feeding management to maximize milk composition (Assan, 2014).

Stage of lactation significantly affected milk constituents where fat and protein contents were negatively and lactose contents positively correlated with milk yield. The observed 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. According to Stojeviae *et al.* (2005) during the early stage of lactation the liver of high productivity dam undergoes extensive physiological and biochemical changes to counteract the adverse effects of negative energy balance. The correlations between protein, lactose, fat, and dry matter yields with liver metabolites activity. Determination of biochemical parameters in blood serum can provide valuable information regarding dairy dam nutrition and physiological status in relation to age and stage of lactation. Due to liver functionality blood biochemical attributes are important indicators of the metabolic activity in lactating animals (Karapehlivan *et al.*, 2007). During lactation, secretary cells of mammary gland utilize 80 per cent of the blood circulating metabolites for milk synthesis, depending on the speed of infiltration of precursors of milk compounds (*i.e.* free amino acids, glucose and fatty acids).

Some of the newer studies state that the contents of minerals in milk can be influenced by numerous factors, e.g. breed, lineage, system of feeding, milking, differences between individual animals, health status and age, seasonal changes, order and stage of lactation, life conditions and technology of keeping the animals, and processing the milk (Zeng and Escobar, 1996; Meschy, 2000; Soryal *et al.*, 2005 and Morand-Fehr *et al.*, 2007). Knowles *et al*. (1997) claims, that I and Se concentrations in cow milk can be quite easily manipulated

by supplementation.

MATERIAL AND METHODS

The study was conducted at the central institute for research on goats, Makhdoom, Mathura; under the division nutrition feed resources and products technology for the study of farm rearing condition. Milk samples were collected from Jakhrana goat under the farm and field rearing condition. Field samples were collected from different villages. The Jakhrana breed milk samples were from villages of Mathura and Agra, India (27° 10´N, 78-o 002´E and 169 m above MSL). Geologically the Institute is situated under Yamuna river 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 Motola (1997).

Experimental goats and management :

A total of 736 milk samples were collected from field and farm rearing condition 281 (field 30 and farm 251) early stage of lactation, 128 (field 53 and farm 75) middle stage of lactation and 327 (field 22 and farm 305) late stage of lactation. Determination of minerals was followed (Magnesium and Selenium) by Atomic Absorption Spectrophotometer (AAS) which is used for the qualitative and quantitative determination of chemical elements by absorbing the optical radiation by free atoms in the gaseous state. The electrons of these atoms jump to higher energy levels and, while coming to its ground state, release energy of a specific wavelength that is characteristic for each element. The AAS method is widely used due to its ability to give rapid results. Now-a-days, AAS instrument is capable of analysing more than one element at a time. In the present study, AAS was used for determination of magnesium and selenium in milk samples. Calcium and Potassium was determined by Flame Technique and Phosphorus and Chloride by chemical methods.

Sample collection and analysis :

Goat milk samples were collected from research farm and field properly at varied environmental conditions and stages of lactation (early, middle and late).

Preparation of sample :

The bulk sample was sufficiently homogenized to ensure that the aliquot/sub-sample which was taken for analysis was representative of the whole. The size of the sample was proportional to the bulk. Thoroughly mixing of sub-samples from a large bulk was preferred in representative sampling before the analysis of each sample was thoued at 30° C to melt the fat and cold to 20° C. The processing of milk sample for mineral analysis was done by dry ashing.

Dry ashing :

About 5 ml milk was taken in silica crucible, weighed and dried in oven. Then, the sample was placed in the muffle furnace and the temperature was brought to 550^0 C and held for 4 h. After cooling, the ash obtained was dissolved 50 per cent diluted HCl and then made upto suitable volume (100 ml). The resulting solution was used for mineral determination.

Selenium and magnesium were determined by Atomic Absorption Spectrometry (AAS), while calcium and potassium used to determine by flame photometer method. Phosphorus and chloride were determined by chemical methods.

Atomic absorption spectrometry :

In atomic absorption spectrometry, the sample solution was first vaporized and atomized in a flame, transforming it to unexcited ground state atoms, which absorb light at specific wavelengths. A light beam from a lamp whose cathode was made of the element in question was passed through the flame. Radiation was absorbed, transforming the ground state atoms to an excited state. The amount of radiation absorbed depended on the concentration of element in the sample. Absorption at a selected wavelength was measured by the change in light intensity striking the detector and was directly related to the amount of the element in the sample.

Determination of calcium and potassium by flame technique :

The technique was based on the fact that ground state metals absorb light at specific wavelengths. Metal ions in a solution were converted to atomic state by means of flame (Fig. A).

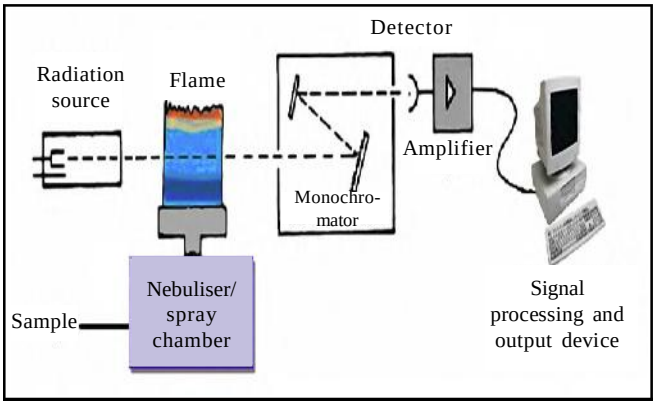

Fig. A : Minerals detection process from AAS

Principle :

The technique of flame atomic absorption spectroscopy (FAAS) was required a liquid sample to be aspirated, aerosolized, and mixed with combustible gases, such as acetylene and air or acetylene and nitrous oxide. The mixture was ignited in a flame whose temperature ranges from 2100 to 2800^0 C. During combustion, atoms of the elements of interest in the sample were reduced to free, unexcited ground state atoms, which absorb light at characteristic wavelengths. The characteristic wavelengths were elements specific and accurate to 0.01-0.1 nm.

Determination of phosphorus content in the milk :

25 ml. of the ash extract was pipetted out into a 150 ml. beaker. About 10-12 g. of solid ammonium nitrate was added and heated to 25-30^0 C. About 20 ml. of the ammonium molybdate reagent was added. It was stirred vigorously for 15 minutes and then occasionally for 30 minutes. It was set aside for one hour or preferably overnight, for precipitates to settle down. The precipitate was filtered and washed with cold 1 per cent Ammonium nitrate solution till nearly free of acid. The precipitate along with filter paper was transferred into the same beaker in which the precipitation was done. About 1 ml. of phenolphthalein indicator and 20 ml. of N/10 NaOH were added and stirred well with a glass rod. The filter paper was reduced to a pulp by crushing with the glass rod. If no pink colour developed, another 10 ml. of N/10 NaOH was added. It was kept aside for 30 minutes. It intense pink colour of phenolphthalein was decolorized, a further 5 ml. of N/10 NaOH was added. The total volume of N/10 Na OH added was noted. The excess of NaOH used was titrated against standard HCl or HNO_3. The volume of N/10 NaOH used up in the reaction was calculated. The phosphorus content milk was calculated as follows:

1 ml. of N/10 NaOH = 0.3088 mg. P_2O_5 or 0.1348 mg. P.

Determination of chloride content in the milk :

10 ml. of well mixed sample was transferred to a porcelain dish. About 1 ml of 5 per cent K_2CrO_4 indicator was added and mixed. It was then titrated against the standard $AgNO_3$ solution till a light permanent brick red precipitate was obtained.

RESULTS AND DISCUSSION

It is found to see from Table 1 that the calcium percentage in the milk of Jakhrana goat breed and field and farm rearing conditions in early, middle and late stage of lactation was 0.138±0.0016 and 0.144±0.002, 0.140±0.0018 and 0.146±0.0022 and 0.142±0.0018 and 0.148±0.002, respectively. The overall average calcium content was 0.146±0.0019 per cent in all above 736 samples. Our investigation on calcium which observed from table indicated that difference in calcium per cent under field and farm rearing conditions in all above stage of lactation was significant ($p < 0.05$) in milk samples. The above observation further indicated that the highest calcium per cent was found to be late stage of lactation under field as well as farm rearing samples. It is observed from above ANOVA Table 1 that lactation stage have significant (5%) effect of calcium content in all stages under field or farm rearing samples. It is due to increasing the mineral matter as increasing the stage of lactations.

The results laid down in Table 1 indicated that the phosphorus percentage in the milk of Jakhrana goat breed under field and farm rearing conditions in early, middle and late lactation 0.122±0.0011 and 0.124±0.0010 and 0.124±0.0012 and 0.126±0.0011 and 0.126±0.0010 and 0.128±0.0011 per cent, respectively. The overall average phosphorus content of above all stage of lactation in above 736 samples of milk was 0.1233±0.0010 per cent. It is observed from Table that phosphorus content was significantly greater in farm samples than field rearing samples in early and middle stage of lactation but some was insignificance in case of late lactation stage. The highest phosphorus percentage was recorded in late lactation in milk samples either field or farm rearing

conditions. The statistical analysis also revealed that the effect of stage of lactation on phosphorus content was significantly different in Jakhrana goat breed milk under field and farm rearing conditions at 5 per cent level of significance. Our results in the phosphorus content in the present study of above goat breeds in different lactation stage are similar with the findings of Pal *et al.* (2011).

The potassium content in the milk of Jakhrana goat breed under field and farm rearing samples in early, middle and late lactation was 0.112±0.0006 and 0.113±0.0009, 0.111±0.0009 and 0.112±0.0008 and 0.110±0.0009 and 0.111±0.0008 per cent, respectively. The statistical analysis revealed that potassium content was slightly higher in farm rearing samples than that of field rearing samples in all stage of lactation in milk samples but it was insignificant. ANOVA Table 2 on these data revealed that the effect of stage of lactation on potassium content in the milk of Jakhrana goat breeds was significant at 5 per cent level of significance. Potassium per cent was observed higher in early stage and lower in late stage of lactation. The observations obtained on potassium percentage in the present investigation are lower than that of finding reported by Pal *et al.* (2011).

Perusal of Table 1 indicated that the magnesium percentage in the milk of Jakhrana goat breed under field and farm rearing conditions in early, middle and late stage of lactation was 0.0137±0.00014 and 0.0143±0.00016, 0.0140±0.00011, and 0.0146±0.00014 and 0.0143±0.00012 and 0.0149±0.00018, respectively. The overall average magnesium per cent in all above samples either field or farm rearing conditions in all stage of lactation was

Table 1: Effect of stage of lactation on the percentage of milk minerals components of Jakhrana goats under field and farm rearing conditions

Sr. No.	Component of goat milk	Field	Farm	Overall average	Test of signific	Table value (t) 5% and 1%	
1.	**Calcium**						
	Early	0.138±0.0016	0.144±0.002	0.1410±0.0018	2.06*	1.960	2.576
	Middle	0.140±0.0018	0.146±0.0022	0.1430±0.0020	2.13*		
	Late	0.142±0.0018	0.148±0.002	0.1450±0.0019	2.11*		
2.	**Phosphorus**						
	Early	0.122±0.0011	0.124±0.0010	0.1230±0.0010	2.106*	1.960	2.576
	Middle	0.124±0.0012	0.126±0.0011	0.1250±0.0012	1.998*		
	Late	0.126±0.0010	0.128±0.0011	0.1270±0.0010	1.791NS		
3.	**Potassium**						
	Early	0.112±0.0006	0.113±0.0009	0.1125±0.0007	1.431NS	1.960	2.576
	Middle	0.111±0.0009	0.112±0.0008	0.1115±0.0009	1.063NS		
	Late	0.110±0.0009	0.111±0.0008	0.1105±0.0008	1.812NS		
4.	**Magnesium**						
	Early	0.0137±0.00014	0.0143±0.00016	0.0140±0.00015	3.106**	1.960	2.576
	Middle	0.0140±0.00011	0.0146±0.00014	0.0143±0.00012	3.869**		
	Late	0.0143±0.00012	0.0149±0.00018	0.0146±0.00061	3.691**		
5.	**Chloride**						
	Early	0.100±0.00058	0.103±0.00050	0.1015±0.00057	2.963**	1.960	2.576
	Middle	0.104±0.00059	0.107±0.00054	0.1055±0.00056	3.069**		
	Late	0.114±0.00061	0.114±0.00054	0.1140±0.00058	1.346NS		
6.	**Selenium**						
	Early	0.01681±0.000053	0.01641±0.000058	0.01661±0.0000555	5.391**	1.960	2.576
	Middle	0.01695±0.000055	0.01666±0.000060	0.01680±0.0000575	6.763**		
	Late	0.01709±0.000057	0.01690±0.000060	0.01699±0.0000585	4.963**		

* and ** indicate significance of values at P= 0.05 and P<0.05 NS=Non-significant

0.0146±0.00015. These data suggested that magnesium content was significantly ($p < 0.01$) higher in farm rearing conditions than that of field rearing condition in all above stage of lactation. The highest magnesium content was recorded in late lactation under field and farm rearing conditions. Analysis of variance for the effect of stage of lactation on magnesium content in the milk of Jakhrana goat breed under field or farm rearing condition was calculated and found significantly greater variation in all stage of lactation in milk samples at 5 per cent level of significance.

The Table 1 on chloride content in Jakhrana goat breed indicated that the effect of stage of lactation under field and farm rearing condition was found to be 0.100±0.00058 and 0.103±0.00050 and 0.104±0.00059 and 0.107±0.00054 and 0.114±0.00061 and 0.114±0.00054 in early, middle and late lactation, respectively. The statistical analysis on chloride content was revealed that variation in chloride under field and farm rearing samples was significant ($p < 0.01$) in all stage of lactation. The highest chloride content was observed in late lactation stage which due to increasing minerals in late lactation. The analysis of variance on these data revealed that the effect of stage of lactation on chloride content was significant at 1 per cent level of significance either field or farm rearing conditions. The results of present study on the level of chloride content in the milk of above goat breeds in different stage of lactations are fully agreement with the findings of Pal *et al.* (2011).

The result laid down in Table 1 indicated that the selenium percentage in the milk of Jakhrana goat breed under field and farm rearing conditions in early, middle and late lactation was found to be 0.01681±0.000053 and 0.01641±0.000058,0.01695±0.000055and 0.01666 ± 0.000060 and 0.01709±0.000057 and 0.01690±0.000060, respectively. The overall average selenium content in the milk of all above 736 samples in the all above stage of lactation was a 0.01667±0.000058. It is observed from table that selenium content was significantly greater in field samples than farm rearing samples in all stage of lactations. The statistical analysis also revealed that the effect of stage of lactation on selenium content was significantly different in Jakhrana goat breed milk under field and farm rearing conditions at 1 per cent level of significance. The results obtained on magnesium content from present investigation in the milk of Jakhrana goat breeds under field and farm rearing conditions under different stage of lactations are fully corroborated with the findings of Rozenska *et al*. (2013) who reported Selenium concentration in milk slightly increased in the course of the lactation period from 7.44 µg /kg to 11.10 µg /kg. Levels of selenium in goat milk were 7.32 ± 1.62 µg/ kg on average. The levels of selenium during the phases of lactation showed a significant difference between them ($P < 0.001$). In the late phase of lactation period, the levels of selenium were significantly higher ($P < 0.001$). The highest average content of selenium in milk was found in the farm using the mineral supplement richer in selenium than in the others.

Conclusion :

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

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Table 2: ANOVAs for the effect of stages of lactation on Jakhrana goat milk under field and farm rearing conditions

Contents for the source of variance	Variance ratio		F- value table	
	Field	Farm	5%	1%
Calcium	3.11*	3.65*	3.00	4.610
Phosphorus	3.1 26*	3.624*	3.00	4.610
Potassium	3.663*	3.931*	3.00	4.610
Magnesium	3.631*	3.964*	3.00	4.610
Chloride	5.961**	7.343**	3.00	4.610
Selenium	6.301**	5.646**	3.00	4.610

* and ** indicate significance of values at P= 0.05 and P<0.05

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