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Influence of Seasonal Variation in the General Composition of Black Bengal Goat (*Capra aegagrus hircus*) Milk

Abstract

Milk is one of the oldest foods known to human civilization. India has a good number of Black Bengal goat populations, which has an important role in the lives of local goat rearers. The goal of the present study is to determine the general composition of Black Bengal goat (*Capra aegagrus hircus*) milk and to find out the effect of seasonal variation on its constituents in the Purulia district of West Bengal. The highest mean value of temperature (42.6±1.5°C) has been reported during the month of April and May in the season of pre-monsoon. However, the lowest value of temperature (8.6±0.9°C) has been reported during the month of January in the season of post-monsoon. The parameter studied here are amount of fat, non fat solids, total solids, protein, minerals, pH and specific gravity of the Black Bengal goat milk in two different seasons. Data has analyzed for the effect of seasonal variation and the current findings implies that seasonal variation plays the major role to influence the milk constituents of Black Bengal goats.

Keywords: Black Bengal goat; Goat milk; Seasonal variation; Milk composition; Purulia

Research Article

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Introduction

Milk is one of the oldest foods known to human civilization and it is a complex mixture of fat, proteins, carbohydrates, minerals and vitamins as well as other different miscellaneous constituents dissolved in water [1]. The different breeds of the dairy goats have been producing about 15.2 million metric ton of milk, which has been about two percent of the total amount of milk produced by livestock in the world [2]. The developing countries have been producing roughly eighty three percent of the total milk amount of the world. In the European countries, most of the goat breeding programme has been done keeping the eye on the milk production [3]. Since 1990, attention in dairy goats has been increasing progressively. It has developed partially because of a tendency of self sufficiency by the rural people in several developing countries, where goat milk may have a major contribution towards the nutrition of the millions of people. For the rural world, most of the goat milk is taken for family consumption [4]. The largest amount of goat milk has been produced in India, followed by Bangladesh and Sudan. In India, marketing of goat milk and its products are in its early stages. Still, there have been little marketing efforts attempted on a broad scale. According to publication of the different workers less than five percent of the total goat milk production has been marketed [5].

The variation in the compositions of milk and the total yield of milk within a species depends on different factors. Some of these factors are physiological factors, genetical factors and climatic (or precisely micro-climatic) factors. Some physiological factors are stage of lactation, age, udder health and type of diet. Daily variation and season changes can be taken as the climatic factors [6,7]. Lactation periods as well as climatic conditions are generally termed as as seasonal changes which have a great influence on the milk constituents. Different amino acids, which are major building blocks of a polypeptide chain, are not synthesized in the animal hence; milk levels can be influenced by feed intake. These nutrients are essential for normal metabolism for the animals as well as for all the human beings. The goal of the present study is to determine the general composition of Black Bengal goat's milk and to find out the effect of seasonal variation on its constituents.

Materials and Methods

Study area

Planning Commission of India has demarcated the geographical area of India into 15 agro-climatic regions. The present studies have been carried out into Purulia, under Eastern Plateau and Hills region of India [8]. Thirty per cent of the area is classified as forest land and only about a quarter of the area is agriculture land. It obtains about 1,200 mm of rainfall annually. The typical weather is moist sub-humid to sub-humid and the soil is red loamy, red and yellow. Average annual rainfall of this district is varies from 1100 to 1500 mm. The humidity generally is higher in monsoon season, from 75% to 85%. But in hot summer it goes down from 25% to 35%. Temperature varies over a wide range from 7°C in winter to 46.8°C in the summer. Due to undulated topography just about fifty percent of the total rainfall flows away as run off [8].

Animal

The animals used in this study were clinically healthy Black Bengal does of 2-3 years of age and has an average body weight of about 15Kg showing no parasitic infestation. There are no feed

restrictions to the goats. Animals had been free to choose their feed requirements by foraging and grazing on natural vegetation and pasture lands. According to Nandi et al. [9] cent percent of goat in West Bengal have been reared through grazing. Animals were maintained in there ambient condition for four weeks prior to milking. All the does with only 3 to 4 deliveries and the milk sample has been collected after 60 days of lactation [10,11], using purposive sampling technique method [12].

Milk collection and clinical analysis

The research was carried out in two seasons. The first season has been the pre monsoon season covering March to June and the second one has been post monsoon season covering November to mid of the February. 25 ml of milk has been collected directly from the lactating does by hand milking and quickly put in to the marked sterile plastic container (Tarsons) sealed and stored at 4˚C and analyzed in the laboratory. The udder has been cleaned prior to taking the sample to keep away from contamination. The goat milk samples have been collected from five different local points of the Purulia districts of West Bengal. Those local points have been Brindabanpur (23˚20′5′′N, 86˚3′29′′E); Chatambari (23˚20′36′′N, 86˚4′4′′E); Jaharhatu (23˚21′6′′N, 86˚2′36′′E); Lakshmipur (23˚15′N, 86˚5′5′′E) and Murguma (23˚21′11′′N, 86˚31′34′′E).

Fat content of the milk was determinate through the Gerber method following the procedure given by Marshall [13] using 92% H_2SO_4 (MERCK) (specific gravity 1.825) and Isoamyl alcohol (MERCK). Total solids, non fat solids, protein, minerals, specific gravity of milk sample have been determined according to the method depicted by Kurt et al. [14]. The pH values of the milk samples have been determined using (OAKTON® PC Testr 35) pH meter.

Climatological measurement

The three year data on temperature of the study area has been collected from the state meteorological department and the mean of the three years with standard deviation was calculated using MS-Excel 2007 and shown here in a tabular form (Table 1).

Statistical analysis

The statistical analysis of the data was performed using SPSS 21.01 (IBM. SPSS, 2012). Analysis of variance (ANOVA) test was used to determine the effects of seasons on the Black Bengal goat milk parameters studied here [15]. Least significant difference (LSD) test as critical difference (C.D.) has been carried out as a post hoc analysis with the help of Fischer equation [16], describing means with 95% confidence. Mean separation and standard error has been calculated using MS-Excel 2007.

Results and Discussion

Results obtain from the present study have been reveal that the data (expressing as mean±standard error) from physico-chemical analysis of Black Bengal goats' milk composition and statistical analyses (Table 2). It can be seen that milk fat, non-fat solids, protein and total solids percentages were the lowest during the pre-monsoon and the highest during the post-monsoon (Table 2).

According to the results (ANOVA), the fat content (Figure 1A) of the Black Bengal goat milk is significantly ($p<0.05$) lower in pre-monsoon season (2.35 ± 0.25%) than the pot-monsoon (3.12±0.2%) also showing critical difference of 0.687 (95% confidence) (Table 2). Generally milk fat has been the most inconsistent element among the milk constituents. The quantity of milk fat can be affected by numerous factors. The seasonal inconsistency and the period of lactation have been the most noteworthy factors among them [17]. The effects of seasonal variations have been observed for milk protein as well as milk fat content in the lactating goats [18]. This may be allocate a high light-to-dark ratio which leading to a decrease in fat and protein contents of milk [19], most likely as an effect of a good amount of prolactin secretion, which concentration in plasma is higher in the pre-monsoon than in the season of post-monsoon [20].

The total non fat solids (Figure 1A) in the Black Bengal goat milk has been found 7.89 ± 0.63 %, during the season of pre-monsoon which has been found lower than the value of total non fat solids (8.125 ± 0.33%) found in goat milk during the season of post-monsoon but there are no significant difference in between (Table 2).

The total protein in the goat milk (Figure 1A) has been found 2.69 ± 0.17 %, during the season of pre-monsoon which has been found significantly ($p<0.05$) lower than the value of protein (3.21±0.17 %) found in goat milk during the season of post-monsoon also showing critical difference of 0.511 (95% confidence). Generally it is known that milk protein (%) value is directly proportional with the milk fat (%) value. The result of the present work has been concord with this general belief. In the present work, goat milk protein value (%) changes along with the seasonal variation showing more or less similar trends as the milk fat value (Table 2). It is assumed that reduction in fat and protein concentration in goat milk has been a result of hot or warm ambient temperature [21].

The seasonal variation in the composition of milk is a well established fact. Milk fat is most susceptible to dietary variations and can vary over a range of nearly three percent (%). According to some previous workers dietary variations result in milk protein concentration varying at about 0.60 percent [22]. Milk fat and protein percentages are higher during post-monsoon seasons and lower in pre-monsoon seasons [23]. Higher ambient temperature has a negative effect on the total milk production as well as alters the milk properties, during in the cheese making process [20]. Increased ambient temperature reduced the dry matter intake that condensed both quantity and quality of milk and varied the milk composition [24,25].

The total solid content of the Black Bengal goat milk (Figure 1A) has been obtained 11.38±0.66 (%), during the season of pre-monsoon which has been significantly ($p<0.05$) lower than the value 13.2±0.29 (%), obtained during the post monsoon season with critical difference of 1.55 (95% level of confidence). Because of hot weather and high humidity dry matter intake severely decreased in the pre-monsoon [26]. Different workers have reported that the solid content of Malawi goats 13.8 % [27] Saanen goats 13.5% [28] Jakhrana breed 13.55% [29]. It can be said that there is a similarity between these values (%) and the results obtained from this study.

The acidity in milk is commonly due to the presence of casein phosphate, citrate and carbon-dioxide [5]. However, due to the bacterial activity the lactic acid has been formed which resulting the increased acidity of the goat milk [30].

Generally milk pH values does not change with the seasonal variation, similar result obtained during the present work, pH value of the Black Bengal goat milk (Figure 1B) has been found 6.35±0.14 during the season of post-monsoon which has been found higher than the pH value (6.13±0.16) of the goat milk in the season of pre-monsoon but there are no significant difference in between (Table 2). The present work can be supported by the work of Cimen et al. [31] on cattle.

The minerals contents in the goat milk (Figure 1B) has been found 0.918±0.039 %, during the season of pre-monsoon which has been found significantly ($p<0.05$) higher than the value of minerals (0.8±0.023 %) found in goat milk during the season of post-monsoon also showing critical difference of 0.097 (95% confidence) (Table 2). Result obtained from the present study has been found similar with the work on Greek breed of goat, where lesser amount of Ca, P, K, Cu, Zn and Mn values (in mg/100 g) are obtained during pre-monsoon season than pre-monsoon season [32]. Similar kind of result can be seen also from the work on the Commingled goat in North America [18].

During the season of pre-monsoon the specific gravity of the milk (Figure 1C) of Black Bengal goat has been obtained 1.032 ± 0.0014, which has been significantly ($p<0.05$) higher than the value of the specific gravity of the milk (1.028±0.0008) obtained during the season of post-monsoon, showing critical difference of 0.004 (95% confidence). Similar sort of outcome can also be obtained from the work of Guo et al. [18] on the Commingled goat (Table 2).

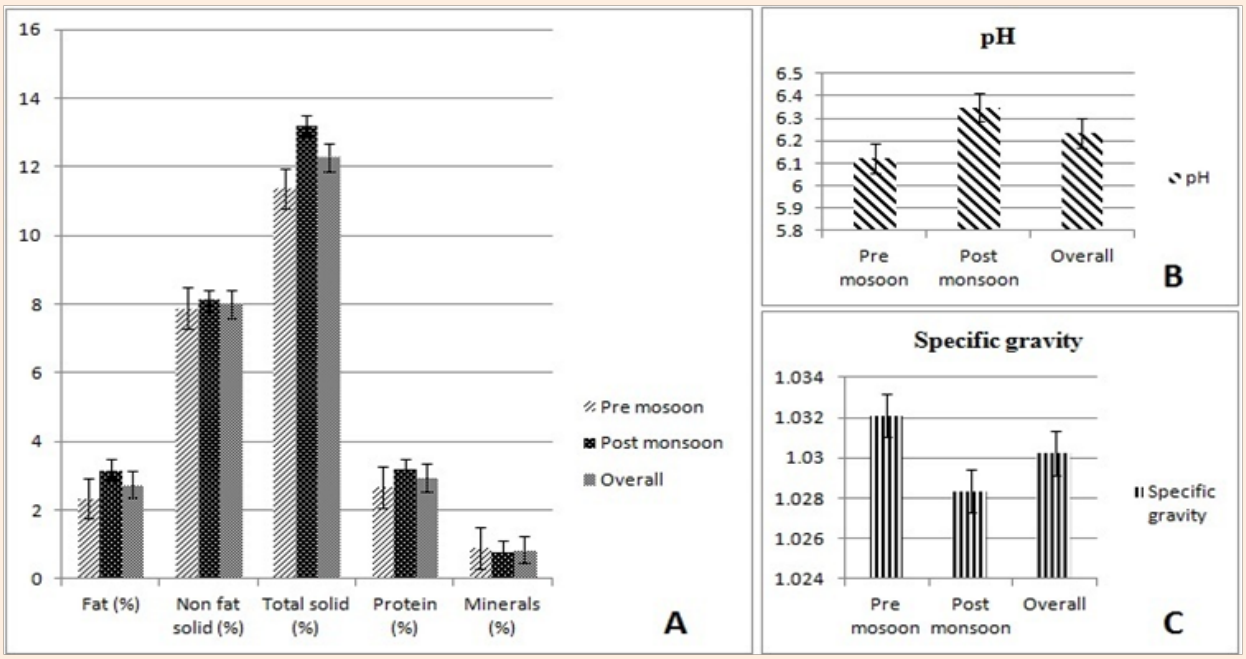

Figure 1: Seasonal variation in milk fat, non-fat, total solid, protein and minerals (A); milk pH (B) as well as specific gravity (C) of the Black Bengal goat milk in Purulia.

Table 1: Mean temperature of last three years.

		Temperature	
Season	**Month**	**Max (°C)**	**Min (°C)**
	March	40.4 ± 2.3	21.6 ± 10.9
	April	42.6 ± 1.5	21 ± 0.7
Pre-Monsoon	May	42.6 ± 1.5	22.4 ± 1.1
	June	38.6 ± 5.0	23.2 ± 0.8
	November	32.0 ± 1.0	13.6 ± 1.1
	December	30.8 ± 2.2	9.4 ± 1.7
Post-Monsoon	January	30.0 ± 2.5	8.6 ± 0.9
	February	34.6 ± 2.5	11 ± 2.5

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Table 2: Effect of the seasonal variation on the Black Bengal goat milk constituents.

	Fat (%)	Non Fat Solid (%)	Total Solid (%)	Protein (%)	Minerals (%)	pH	Specific Gravity
Pre-Monsoon	2.35 ± 0.25	7.89 ± 0.63	11.38 ± 0.66	2.69 ± 0.17	0.918 ± 0.039	6.13 ± 0.16	1.032 ± 0.0014
Post-Monsoon	3.12 ± 0.2	8.125 ± 0.33	13.2 ± 0.29	3.21 ± 0.17	0.8 ± 0.023	6.35 ± 0.14	1.028 ± 0.0008
Overall	2.76 ± 0.187	8.01 ± 0.345	12.28 ± 0.42	2.95 ± 0.133	0.86 ± 0.027	6.24 ± 0.107	1.03 ± 0.0009
F value	6.623	0.102	6.347	4.859	6.711	1.11	5.089
P value	0.022*	0.747	0.025*	0.039*	0.021*	0.31	0.041*
$C.D._{(0.05)}$	0.687	NS	1.55	0.511	0.097	NS	0.004

*: P < 0.05; NS: Not Significant; C.D. $_{(0.05)}$: Critical Difference at 95% confidence level

Conclusion

The composition of Black Bengal goat milk and its contents determined in the present work has been going concord with other studies' in this similar field. It has been determined that the different milk constituents of Black Bengal goat milk such as fat (%), total solids (%), protein (%) and minerals (%) have been affected significantly by the seasonal changes.

According to the results obtained from the present study, it is likely to say that when the milk fat content has been elevated, protein and total solid contents were also elevated as well as milk fat, protein and total solid percentages have been in their highest during the post-monsoon and the lowest during the pre-monsoon season. Seasonal outlines in the production of goat milk, fat and protein has been examined in different countries with different agro-climatic condition as well as under different livestock management practices [33,34]. During a work on the cattle, Sargeant et al. [35] suggested the lowest protein and fat percentages during the pre-monsoon season (June to August), and the highest percentage during post-monsoon season (October to December). Therefore during in the pre-monsoon season, a collective need based approach to diminish the impact of heat stress on lactating goats is necessary.

Conventional methods of animal cooling systems can be applied, such as provision of chilled drinking water, watering, misting, showering, passive or forced convection through provision of electrical fans, mechanical wind blower are to be precisely regulated based on meteorological input and findings on production performances [36].

Nutrition may be considered as an imperative source of the variation in the yield and constituent of milk, but micro-climatic conditions, seasonal variation as well as regional differences may also play an important role [25].

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