International Journal of Agriculture Innovations and Research
Volume 11, Issue 1, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy):
Received: 07/07/2022 | Accepted on: 21/07/2022 | Published: 30/07/2022

Physico-Chemical and Microbial Properties of Black Bengal Goat Milk

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***Abstract* – Goat milk is considered an ideal food due to its nutritious and medicinal values. This study aimed to evaluate the physico-chemical and microbial qualities of Black Bengal goat (BBG) milk. The study includes 120 BBG reared in six different goat farms in the Sylhet region of Bangladesh. A total of 120 different milk samples were collected. The laboratory examination was conducted at the Dairy Science Laboratory of Sylhet Agricultural University, Bangladesh, from January through February 2021. Milk samples that passed the organoleptic test and C.O.B. test mainly were (83.3 %) normal. The collected samples' physical parameters (color, flavor, and taste) were almost similar. Chemical composition of the analyzed raw milk sample was an average fat of 5.5±0.44%, protein 3.45 ± 0.13%, lactose 5.23 ± 0.24%, solids not fat (SNF) 8.23 ± 0.27%, and salt 0.78 ± 0.02%. Chemical composition of the analyzed milk from different farms was similar, whereas Total plate count (TPC) and the coliform count showed significant variation among farms. The farm-2 had a low microbial load due to good hygienic and sanitary practices followed in milking and milk transportation. The order of parity and lactation stage played a major role in influencing the fat percentage of BBG milk. Fat content increased with later parities and at the end of lactation. Protein and solids not fat (SNF) content were significantly ($P<0.05$) affected by parity order, whereas advancing the stage of lactation increased the protein, solids not fat (SNF), and decreasing the salt content. TPC and coliform count were not significantly affected by parity and lactation stage.**

***Keywords* – Black Bengal Goat, Milk, Physical Quality, Chemical Quality, Microbial Quality.**

I. INTRODUCTION

In Bangladesh, goats are reared by landless farmers and women to meet the milk requirements of their families and as a source of income [1]. Black Bengal goat is an indigenous goat breed are reared for dual (meat and milk) purposes. Black Bengal goat comprises more than 90% of the total goat population, and the rest 10% comprises of Jamunapari and different crossbred goats [2]. The annual milk production of Bangladesh is about 10.6 million metric tons, where goat milk contributes 2% of the total milk production [3]. Goat milk is of interest due to its nutritional composition and easily digestible to humans. Nutrients such as vitamins, minerals, trace minerals, electrolytes, enzymes, proteins, and fatty acids present in goat milk are easily absorbed by the human body [4]. Since the lactose in goat milk is smaller and has a larger surface area than the lactose in cow milk, it is more digestible. Goat milk proteins are more easily digested, and their constituent amino acids are processed more quickly than cow milk proteins [5]. However, hygienic standard rules for productions and distributions seem to be more relaxed than cow milk. Also, the local goat milk production is lack concern and y-

-et it is one of the potential industries to develop.

This study used raw goat milk samples that have not been pasteurized or homogenized. The nutritional composition of raw goat milk, which is different from raw cow milk, may have a different microbial load. The chemical and microbial composition of milk is influenced by several factors such as animals and their surrounding factors. Studies related to the chemical and microbiological quality of goat milk today are insufficient for the public. Only a few studies have been done on the meat quality of Black Bengal goat in Bangladesh, but on Black Bengal goat milk quality is merely absent. However, for quality control and optimizing safety concerns in goat milk and gaining consumer confidence due to the growing interest in goat milk, it is essential to verify the quality of Black Bengal goat milk [6]. Thus, the present study was aimed to evaluate the quality (physico-chemical and microbial) of raw Black Bengal goat milk from different goat farms in Sylhet, Bangladesh.

II. Materials and Methods

Farm Selection and Sample Collection

The study was conducted on 120 Black Bengal goats (avg. parity number: 1.75; avg. days in milk: 35.2 days) reared in six different small-scale farms located in the Sylhet region, Bangladesh. The farms represent the small scale goat rearing system in the Sylhet region. The goats grazed eight hours during the day in natural pasture land. Moreover, goats were received a concentrated mixture of crushed maize, wheat bran, mustard oil cake, vitamin-mineral premix, and salt according to their requirements considering the mean body weight and mean milk production by following the NRC (2007) recommendations [7].

Milk Quality Tests

Milk samples (100 ml) were collected from each goat during the early morning milking. All raw milk samples were obtained under aseptic conditions from healthy goats, to avoid any contamination that could influence the analysis [8]. Samples were collected in a plastic bottle and then kept in an ice cooler box and delivered to the laboratory of Dairy Science, Sylhet Agricultural University, to perform analysis. Upon arrival, milk samples were divided into three groups to perform different tests, including physical, chemical, and microbiological analysis. Samples were tested and analyzed immediately upon arrival at the laboratory.

Milk samples were examined by evaluating the organoleptic (color, smell, and sediment observation) and C.O.B test. In the organoleptic test, the milk sample was smelled for any off or sour aroma, then followed by visually observing the appearance of the milk. In the C.O.B test, 10 ml of milk sample was boiled in a test tube in a water bath for 5 minutes. The milk sample was recorded as positive C.O.B test if there was clotting, coagulation, or precipitation. The milk sample was tested three times and examined by the organoleptic (color, smell and sediment observation) and C.O.B test [9].

Individual milk samples were analyzed for fat, protein, lactose, salt, and solids not fat content with a Milkoscan FT2 infrared analyzer (Foss Electric A/S, Hillerod, Denmark) calibrated according to reference methods: ISO 8968-2/IDF 20-2 for protein [10], ISO 1211/IDF for fat [11], ISO 26462/IDF for lactose[12], ISO 1738/IDFfor salt [13], and ISO 6731/IDFfor milk solids no fat [14].

The microbiological tests are considered to determine the microbial load in the raw goat milk. To assess the

microbial quality, Standard Plate Count (SPC) and Coliform Counts were performed according to American Public Health Association (APHA), using plate count agar for SPC and EMB agar for the Coliform count [15].

Statistical Analysis

Data were collected from six (6) different goat farms, and later, animals have classified for parity: 3 classes (1, 2, >3) and days in milk: 2 classes (DIM ≤ 30, 52 goats, and DIM> 30, 48 goats). Data were analyzed according to a linear mixed model (SAS 9.4, SAS Institute, Cary, NC, U.S.A.) that included the fixed effects of the parity, farm, and days in milk class and the random effects of the animal. All P-values of the least-squares means were adjusted with a Tukey adjustment.

III. RESULTS AND DISCUSSION

Organoleptic and C.O.B Test

The observation of organoleptic and C.O.B tests was presented in Table 1. In the first set of experiments, milk samples were evaluated for the organoleptic test; raw goat milk samples were 100% normal with a 95% milky white color and 5% yellowish color from the aspect of visualization. In general, goat milk is usually creamy white in color because beta-carotene pigment is transformed to colorless Vitamin A [16]. No sedimentation was found in any of the tested samples, which had a normal goaty flavor and a slightly sweet taste. In the C.O. B test, 81% of samples were detected normal out of 120 total samples, which did not show any precipitation after boiling in the water bath. Abnormal milk samples or sour milk developed acid (>0.2% acidity) and showed coagulation due to heat treatment which is the result of dissociation of calcium caseinate salt [17]. In the dairy industry, C.O.B test is used to test the acid for milk means samples failed in C.O.B test means cannot stand the heat treatment in milk processing and thus being disallowed.

Table 1. Organoleptic and Platform test observation in raw goat milk samples.

Organoleptic Tests	Examined all samples were normal with 95% white milky color and 5% yellowish color, good natural smell and no sediment found.
Platform (C.O.B) Tests	83.3% samples were detected normal by not showing any coagulation after heat.

Effect of the Farm on Chemical and Microbial Quality of Milk

The chemical and microbial properties of milk from different farm, are summarized in Table 2. The present study showed that the mean fat, protein, lactose and solids not fat (SNF) was 5.55, 3.45, 5.23 and 9.54%. Regarding chemical composition, no significant differences (P>0.05) were found among the farms. This might be why all of the farms are situated in the same region and follow almost similar feeding and management systems. The findings of the milk composition in the present investigation are in superior for fat content (5.55 vs 4.37), whereas other compositions were similar to the findings of Hossain et al.,[18].

Table 2. Chemical and microbial properties of milk from different farms.

Parameter	Farm-1	Farm-2	Farm-3	Farm-4	Farm-5	Farm-6	*P* value
Fat%	6.02±1.69	6.01±2.78	4.95±0.35	5.55±1.48	5.16±1.93	5.62±1.80	0.26
Protein%	3.20±0.32	3.51±0.39	3.56±0.29	3.49±0.45	3.54±0.44	3.43±0.48	0.27
Lactose%	4.75±0.58	5.32±0.56	5.36±0.43	5.27±0.65	5.28±0.77	5.42±0.57	0.34

Parameter	Farm-1	Farm-2	Farm-3	Farm-4	Farm-5	Farm-6	*P* value
SNF%	9.03±1.27	9.70±1.01	9.75±0.79	9.59±1.18	9.49±1.24	9.69±1.27	0.34
Salt%	0.74±0.12	0.80±0.06	0.79±0.06	0.78±0.10	0.78±0.09	0.76±0.10	0.18
TPC (log cfu/ml)	3.8 ± 0.05^{ab}	3.5 ± 0.25^{b}	3.88 ± 0.13^{ab}	4.10 ± 0.58^{ab}	4.38 ± 0.13^{a}	3.97 ± 0.32^{ab}	0.06
Coliform count (log cfu/ml)	4.00 ± 0.50^{a}	2.10 ± 0.10^{c}	3.50 ± 0.25^{a}	3.90 ± 0.25^{a}	2.60 ± 0.15^{bc}	3.25 ± 0.23^{ab}	0.001

[a-c]Superscripts indicate differences between treatments ($P < 0.05$), Values in the same row not sharing a common letter differ significantly ($P < 0.05$).

However, Prasad et al., found an almost similar milk composition to our study where the experimental breed was Beetal×Black Bengal cross [19]. The mean value of the salt content of the tested milk sample were 0.78%, which was in the normal range. According to Turkmwn et al., the normal range of salt content of goat milk was0.75- 0.80% [20]. Nevertheless, several factors can influence the milk composition of a goat, including breed, parity, lactation stage, feed, and herd size [21]. According to Raynal-Ljutovac et al., the breed is an important factor that strongly affects goat milk composition [22]. The milk composition of a goat could be varied among breeds within a species or yet between each goat within a breed [9]. However, the management system has little effect on the milk compositions of goats [18].

The mean total plate count (TPC) and coliform counts were 3.94 and 3.23 cfu/ml of milk. In European and U.S. standard, normal range of total bacterial contains up to 4.5 and 5.0 log cfu/ml respectively in milk is allowable for human consumption [23-24]. The coliform standard for "grade a" milk should not exceed ten cfu/ml [25]. Based on this, the current findings indicated that the bacteria load detected in collected goat milk samples was within a safe and allowable range. In this study, there were no significant differences for TPC among the farms, but a tendency followed where Farm-2 had lower TPC (3.5 cfu/ml).

Regarding coliform count, the differences among the farms were significant ($P>0.05$). The highest coliform count was observed in milk sample from Farm-1 (4.00 log cfu/ml) and the lowest in milk samples from Farm-2 (2.10 cfu/ml). Coliforms may be omnipresent in faces, manure, and soil and easily disperse in milk from a complex farm environment. In addition, poor hygiene and sanitary practices on the farm may also play a role in transferring *E. coli* in milk. The hygienic and sanitary practices for milk transportation was better in Farm-2 compared to other experimental farms, which might be the reason for the lower coliform count in milk from Farm-2.

Effect of Parity and Days in Milk on Chemical and Microbial Quality of Milk

The least-squares means of parity classes for chemical and microbial quality of milk are summarized in Table 3. Moreover, except lactose and salt, all milk constituents were affected by parity order. Least squares means of parity classes showed that fat content had an increasing trend from the first to later lactation, whereas protein content was significantly affected due to parity class. The average protein and SNF content was increased up to second parity and decreased in third parity. These findings agree with the observations of others [19] [26]. Parity did not significantly affect the microbial quality of milk. Both the TPC and coliform count have been shown similar results for all parity classes. Zeng and Escobar reported that parity of milk did not affect the microbial quality of goat milk [27].

Table 3. Parity wise chemical and microbial Properties.

Parameter	1st parity	2nd parity	3rd parity	P value
Fat%	4.98±1.72	5.64±2.86	6.99±3.05	0.08
Protein%	3.42±0.40[b]	3.63±0.41[a]	3.24±0.33[b]	0.01
Lactose%	5.17±0.57	5.47±1.13	5.13±0.93	0.79
SNF%	9.37±1.05[b]	10.03±0.10[a]	9.08±0.07[b]	0.01
Salt%	0.78±0.08	0.80±0.10	0.73±0.07	0.37
TPC (log cfu/ml)	3.45±0.30	3.83±0.30	3.8±0.28	0.473
Coliform count (log cfu/ml)	2.80±0.35	3.25±0.35	3.08±0.32	0.512

[a-b]Superscripts indicate differences between treatments (P < 0.05), Values in the same row not sharing a common letter differ significantly ($P< 0.05$).

The variation during the lactation period was significant for all the traits analyzed (Table 4). In the case of fat and lactose, there was a tendency to significant differences among the different stages of lactation, whereas other milk constituents (protein, SNF and salt) showed significant differences among the different stages of lactation. The average value of the fat and protein contents of milk were lower in the sample collected at the early lactation period (<30 days) compared to mid-lactation period (> 30 to 75 days).

Table 4. Lactation wise chemical and microbial Properties.

Parameter	Early Lactation (≤30 days)	Mid lactation (30-75 days)	P Value
Fat%	4.62±1.94	6.62±2.13	0.08
Protein%	3.34±0.44	3.60±0.35	0.01
Lactose%	5.37±0.58	5.28±0.65	0.08
SNF%	9.33±1.15	9.94±0.98	0.01
Salt%	0.80±0.09	0.77±0.08	0.01
TPC (log cfu/ml)	3.33±0.24	3.83±0.12	0.101
Coliform count (log cfu/ml)	3.083±0.48	3.383±0.24	0.568

The lactose and salt contents of milk exhibited an opposite pattern to fat and protein. The higher value was observed at the early lactation period (<30 days) compared to mid-lactation period (> 30 to 75 days). Similarly to the fat and protein, SNF content was lower in the samples collected at the early lactation period (<30 days) compared to mid-lactation period (> 30 to 75 days). These results were in partial agreement with Kuchtik et al., in sheep milk [28]. Variation in milk production and milk composition with the stage of lactation followed the general pattern observed in goats and sheep [29-31]. There is a tendency for milk composition, especially fat, SNF and TS to increase as lactation advanced.

Both TPC and coliform counts were not significantly different in various stages of lactation. The mean TPC in milk samples taken at the early stage of lactation was 3.33±0.24 log cfu/ml, while it was 3.83±0.12 log cfu/ml at mid-stage of lactation. Regarding coliform counts in milk, the average coliform count were 3.083±0.48cfu/ml for the early stage of lactation, where it was 3.383±0.24 cfu/ml for mid-stage of lactation. Similar to our results,

Tona et al., did not find significant differences in coliform bacteria in milk taken in early and mid-stages of lactation milk samples of dairy cows [32].

IV. Conclusion

In this study, microbial quality of milk showed significant variation among farms. All of the milk samples of selected farms had nearly identical physical and chemical properties. Protein and solid not fat levels of collected goat milk were significantly affected by parity order. In the later parities, the fat percentage of milk was increased, whereas higher protein and SNF were recorded in second parity. Maximum fat, protein and SNF were recorded in mid-lactation stage, which means advance the lactation length has a positive correlation with fat, protein and SNF quantity. Salt percentages of milk were negatively affected by the lactation stage. Only the fat content gradually increases as lactation progresses. The parity and lactation stage did not affect microbial quality of milk.

V. Author Contributions

Sudeb Saha: Conceptualization, methodology, data and sample collections, data processing and statistical analysis; Faija Sadia Pory: data and sample collections, laboratory analysis; Syed Sayeem Uddin Ahmed: methodology, data processing and statistical analysis; Mohammad Mehedi Hasan Khan: methodology, data processing and statistical analysis. All authors have been involved in developing, writing and commenting on the manuscript. All authors read and approved the final manuscript.

Acknowledgments

The authors thanks to the Black Bengal Goat farmers in Sylhet region of Bangladesh.

Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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