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The Effect of Different Seasons on the Milk Quality in Central Highlands of Ethiopia

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Abstract: Raw milk is a valuable food which its quality is important regarding both milk consumption itself and manufacturing of other dairy products. The aim of this study was to investigate the effect of different seasons on the variations of raw milk composition. To do so, different samples of raw milk were taken during summer and winter from DebreBerhan milk shed, Central Highlands of Ethiopia and their physicochemical properties including the contents of fat protein and sugar as well as microbial load were examined. The results showed that winter milk had significantly higher total solids (TS) while summer milk had better microbial quality as compared to winter milk.

Key words: Season · Chemical Component · Milk · Ethiopia

INTRODUCTION

Milk is an important source of nutrient required for growth in infants and children and for maintenance of health in adults. Milk is a perfect food, readily digested and absorbed. It is the sole natural food for infants and children. It is chiefly a valuable source of good quality protein, fat, carbohydrates, vitamins and minerals. Protein in diet supplies the amino acids required for growth of infants and children. It is also required for maintenance of tissues in adults [1].

Fresh milk is considered as acomplete diet because it contains the essential nutrients such as lactose, fat, protein, minerals and vitamins in a balanced ratio rather than the other foods [2]. Moreover, milk can be considered a source of macro and micro-nutrients and contains a number of active compounds that play a significant role in both nutrition and health protection [3]. The milk fat and protein constitute the major solid components that make milk an economically and nutritionally important asset [4]. Between the environmental factors, the feeding of cows and season of the year has a considerable influence on milk components and properties. This seasonal variation in cows' diets confirms that milk properties such as fat content and total solids [5]. The effects of the various season of the year have been studied by different authors for the reason that climate and geographic and conditions that cannot be affected should be considered. The different seasons of the year are often related to different food regimes for cows. Food intake, kind and quality of fodder are connected to the food regime. This regime offers different possibilities to the breeder because using suitable diets that contain mineral and nutritional component according to the needs of the cows and the structure of the diets that enables good digestion, adequate intake and metabolism are enabled which on the other had affected the milk composition [6]. Lyatuu and Eastridge [7] approved that changes in milk component are more correlated to feeding quality rather than to genetic ones. For the better correlations among different composition, the food regimes have the pronounced effect than the level of a nutrient in a diet. Nevertheless, the season of the year affects the food intake. Azad [8] studied about quality and quantity of milk production along different months in a year and revealed that the lowest milk production was during September (6.46%) and the highest one was during February (10.01%) and added that the

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increased milk production from September to February showed an especial production trend throughout the year. Solid including solid not fat and fat content of milk was insignificant increase from December to April. When effects of hot season on milk protein component were studied during mid-lactation in Holstein, the decreased milk protein level observed during the hot mouths was referred to the decrease in the main components of casein in the β-casein and αs-casein [9]. Frelich *et al.* [10] investigated relation about feeding system and seasonal difference in the fatty acid composition of milk. The seasonal decreased in saturated fatty acids against the unsaturated fatty acids omega-6 against omega-3 polyunsaturated fatty acid confirmed that the cow's milk in summer is more beneficial to human health than that cow's milk in winter.

According to the importance of the effect of season on milk component, the aim of this study was investigated about a chemical change of milk during summer and winter seasons.

MATERIALS AND METHODS

To investigate the seasonal variations of milk, different raw milk samples were taken from different parts of DebreBerhan milk shed, Central Highlands of Ethiopia during summer and winter. Then different chemical properties including percentages of fat, protein, solids, total solids, add water and sugar were compared.

Milk Sample Collection: The study conducted a laboratory-based investigation aimed to assess the quality of raw cow's milk collected. Before sampling the milk was thoroughly mixed with equipment (plunger and diaper) were sanitized with running water and operator hands with alcohol (70 percent); milk bulk stirred; 25 ml of milk sample was collected sample collected and poured into a sterile container then properly labeled; immediately the samples were kept in icebox (0-4°C) until transport to the Ethiopian Meat and Dairy Industry development Institute laboratory for physical and chemical analyses in the same day.

Laboratory Analysis of Raw Milk

Physical and Chemical Analysis: Ekomilk analyzer (Model: Bulteh 2000, Bulgaria) reliable, automated multi-parameter milk analyzer providing rapid test results for chemical composition of milk (fat, protein, lactose and solid not fat) and physical characteristics (milk density, freezing point and added water) of the milk samples according to manufacturer's instructions.

Microbial Analysis: The microbial analysis including total bacterial count (TBC), total coliform count (TCC) and somatic cell count (SCC) were considered following standard procedures [11].

Standard Bacterial Count (SBC): The standard plate count of raw milk samples was performed by putting one ml of milk sample into a sterile test tube having 9 ml of peptone water. After mixing, each sample was serially diluted up to $1:10^{-7}$and duplicate samples. Each culture was constituted of one ml of the diluted solution poured on a Petri dish, on which 12-15 ml of "Standard Plate Agar" was added. When the solution in the Petri dish solidifies, it was put into the incubator at 32°C for 48 hours. Bacteria (or clusters) that grew and became visible colonies were counted using a colony counter and expressed as the number of colonies forming units per milliliter (CFU/ml) of milk. When the colonies were found to be too many, compromising the accuracy of counting, the same procedure was repeated using higher dilution levels [12].

Coliform Count (CC): The coliform count was the test used to estimate the number of bacteria that originate from manure or a contaminated environment. One ml of milk sample was added into a sterile test tube having 9 ml of peptone water. After mixing, the sample was serially diluted up to 1: 10^{-7} and duplicate samples (1ml) were pour plated using 12-15 ml Violet Red Bile Agar solution (VRBA). After a thorough mixing, the plated sample was allowed to solidify and directly incubated at 30°C for 24 hours. Finally, colony counts were made using colony counter [13]. The corresponding total coliform count (TCC) and total bacteria count (TBC) were computed from duplicate plates containing between 25-250 colonies. Plates containing less than 25 colonies were taken as less than 25 estimated counts and plates containing greater than 250 colonies for all dilutions were recorded as too numerous to count (TNTC) [14].

For both tests, the media were prepared according to the guidelines given by the manufacturers as indicated by American Public Health Association [12]. After counting and recording bacterial colonies in each Petri dish the number of bacteria in milliliter milk was calculated by the following formula given by APHA [12].

$$N = \Sigma C/[(1xn1) +(0.1xn2)]d$$

where:

N = Number of colonies per milliliter of milk
ΣC = Sum of colonies on plates counted,
n1 = Number of plates on lower dilution counted,
n2 = Number of plates in next higher dilution counted and
d = Dilution from which the first counts was obtained.

Somatic Cells Count: Somatic cells count was conducted following the procedure described by Francesconi [11]. About 0.01ml milk was spread homogeneously over a microscope slide by using a sterile-standardized loop. Once the milk layer has dried up, Ethanol 96% was added. After waiting for 15 minutes, Tolouidin Blue 0.2% was added. The slide was then kept on open air for 5 minutes, after which it was washed with tap running water, dried and then observed by using a microscope at 100 times magnification. Somatic cells in twenty different fields (A) were counted. Given the dimension of the microscope zoom (F; in this case = 0.0346) and the somatic cells count (N). N= A x 10000/F

Statistical Analysis: Data obtained from laboratory milk analysis was collaborated, then entered in Microsoft EXCEL and then exported to SAS, Version 2004. Results were expressed as mean and standard error. The significant differences between means were calculated by a one-way analysis of variance (ANOVA) statistical analysis for comparison of the parameters variation at P<0.05.

RESULTS AND DISCUSSION

The results from conducted tests on the milk samples taken during summer and winter are presented in Table 1. One of the most important components of milk is milk protein which was affected directly by the nutritional value. The protein content of summer and winter milk samples did not differ significantly (P<0.05). The amount of protein contained in summer milk tended to be lower than winter milk as its amounts in summer and winter milk were 3.1% and 3.19%, respectively. This result is similar to that reported by Kabil *et al*. [15] indicating that the effect of seasonal variation on the chemical composition of Cows milk produced along a year in Egypt and these results are lower by Ayub *et al*. [16]. The higher milk protein in winter could be attributed to the diet containing high digestible protein content from the forage feed and concentrate feed, whereas the feeding during summer produce the lowest milk protein due to ration containing low protein.

Fat content in raw milk is so important that many factories tend to estimate the price of milk based on its fat content. The amount of fat in winter and summer milk was reported as 4.05% and 3.81 respectively and statistically showing a significant difference (P<0.05). Its level was lower in summer season comparing to any other season but winter showed the highest amount of milk fat. These results agreed with other studies [15, 16]. The fat is the most variable parameter among the major milk components and its synthesis is affected by many factors-especially dietary and environmental factors [17]. Milk fat synthesis depends on the supply of acetate from the rumen and is depending largely on the feeding regime which has to avoid the high grain feeding which lowers the production of rumen acetate which in turn lower the milk fat content during summer season [18].

One of the important parameters when evaluating the quality of milk is total solids (TS) content. In other words, it represents the amount of water contained in milk. The higher TS content the better nutritional quality of milk meaning that it contains more valuable compounds

Table 1: Physico-chemical properties of raw milk samples according to the season of collection

Milk constituents	Summer (N=119)	Winter (N=124)	Overall	P-value
Fat%	3.81±0.08	4.05±0.08	3.93±0.05	**
Density %	1.027±0.00	1.029 ±0.00	1.028±.000	**
Lactose %	3.79±0.0.04	3.81±0.04	3.80±0.03	NS
SNF%	7.53±0.07	7.65 ±0.07	7.59±0.05	NS
Protein %	3.10±0.03	3.19±0.03	3.15±0.02	**
Add water %	6.90±0.68	4.65±0.66	5.78±0.47	**
Freezing point %	-0.52±0.01	-0.51±0.01	-0.51±0.01	NS
Ash%	0.64±0.01	0.65±0.01	0.64±0.00	NS
Total solid %	11.34±0.12	11.70±0.12	11.52±0.08	**
TBC (cfu/ml)	7.58 ±0.07	6.78±0.09	7.18±0.08	**
CC(cfu/ml)	5.29 ±0.10	5.46 ± 0.13	5.38±0.12	NS
SCC (sc/ml)	5.78±0.12	5.41±0.39	5.60±0.26	NS

** = showed significant difference, TBC=Total bacterial count; CC= Coliform count; SE=Standard error, cfu= colony-forming units; SCC= Somatic cell count, NS means non significant

including proteins, fats, minerals and other micronutrients. The results of the statistical analysis suggest that summer milk has significantly ($P<0.05$) lower TS content than winter milk as its content in summer and winter milk were 11.34% and 11.70% respectively. Milk total solid % was higher in winter than summer. These results agreed with the reports [15, 16, 19]. Microbial load of raw milk being directly dependent on the hygienic conditions of the farm and is a very important parameter with respect to milk quality having great effect on its price. Microbial load of winter milk was significantly higher than that of summer milk as the microbial load of summer and winter milk were 6.78±0.09 and 7.58 ±0.07 CFU/ml respectively suggesting that summer milk was produced under more favorable hygienic conditions. These results agreed with the results obtained by Nateghi *et al*. [20].

CONCLUSION

It will conclude that seasonal variations result in the varied composition of milk mostly due to animal feeding. In summer animals feed on fresh pasture while in winter they feed on dry forage. Therefore feeding on dry forage has a direct effect on the nutritional value of milk but a microbial load of raw milk is higher in winter due to a higher temperature in the winter season.

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