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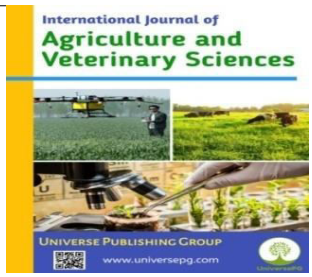

The Impact of Seasonal Changes on the Composition of Cow Milk in Jalalabad City, Afghanistan

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ABSTRACT

The study investigated the impact of seasonal variations on the components of cow milk in Jalalabad City, Afghanistan. A total of 80 milk samples were collected from six different local points within the city from January to August 2023. The research spanned two distinct periods: winter (January-February-March) and summer (June-July-August). During the winter, cows were fed hay, while in the summer; they grazed on green grass in pastures. Analysis revealed significant differences in fat content and titratableacidity between the winter and summer periods, with both factors being significant at the $p<0.05$ level according to paired t-test results. The study concluded that seasonal variations significantly affected the protein content, total solids, fat, and titratableacidity, with significance levels of $p<0.05$ and $p<0.01$, respectively.

Keywords: Seasonal variation, Cow milk composition, Cow milk, Hay, Green grass, and Pasture.

INTRODUCTION:

Milk yield and its composition within a species are influenced by numerous factors, including genetics, stage of lactation, daily fluctuations, parity, diet, age, udder health, and season (Carroll *et al.,* 2006). In Afghanistan, there are four breeds of cattle: Kandahari, Kunari, Watani, and Sistani. The larger breeds, such as Kandahari and Sistani, are primarily found in the Herat region in the north and the Kandahar area. These breeds are renowned for their dairy production, with an estimated lactation yield of 1,000 to 2,000 kg, respectively. The most prevalent breed is the Watani, which means "native." Watani cattle are typically black with white spots or may have multiple colors, and they produce about 3.5 kg of milk per day (FAO, 2003). Seasonal variations present both challenges and opportunities for dairy producers. For instance, butter produced from summer milk fat tends to be more spreadable than that made from winter milk fat. However, research on these seasonal effects has often been limited in scope, typically involving small-scale studies that analyze milk from a limited number of cows within a single herd (Heck *et al.,* 2009). Seasonal factors such as district, climate conditions, and lactation periods significantly impact milk composition. Notably, there is an inverse relationship between environmental temperature and the levels of milk fat and protein. As temperatures rise, the amount of solid fat tends to diminish. Ng-Kwai Hang *et al.* (1984) and Lacroix *et al.* (1996) Studies have indicated that seasonal variations affect the percentages of fat, protein, casein, and all nitrogen fractions in milk.

(Barron *et al.,* 2001) High ambient temperatures have been found to negatively impact milk yield and its cheese-making properties by increasing clotting time, altering the rate of clot formation, and reducing clot firmness. Additionally, the ratio of light to darkness can significantly affect both milk yield and composition (Casati *et al.,* 1998). A high light-to-dark ratio actually reduces the fat and protein content of milk, likely due to increased prolactin secretion, which is higher in the summer compared to the winter (Tucker, 1989). Lactation period moved forward progressing and when the environmental heat degree increased, the fat content decreased (Lock and Garnsworthy, 2003; Sekerden, 1999; Kurdar *et al,* 2017). Research indicates that the levels of short-chain fatty acids in milk fluctuate significantly with the seasons, peaking in the summer and reaching their lowest in the winter. Additionally, some studies have found that the amount of α-tocopherol increases from winter to summer (Kabil *et al.,* 2015).

Seasonal climatic changes have been found to influence the abundance of volatile compounds in milk. During winter and spring, terpenes are not the predominant class of these compounds, but they become significantly more abundant in the summer (Fedele *et al.,* 2005). A lot of researchers realized about different breeds and region of cow milk composition in Turkey (varnam and sutherland, 2001; carroll *et al.,* 2006; barron *et al.,* 2001; Hassen *et al.,* 2022). This research focuses on a significant region of Jalalabad City, Afghanistan, selected for its milk yield, dairy products, plant coverage, and geographic location. The study aims to analyze the composition of cow's milk and examine the impact of seasonal variations on this composition.

MATERIALS AND METHODS:

Cow's milk samples were gathered from six different local points in Jalalabad City, Afghanistan, namely Arbaban, Angor Bagh, Farm-e-Hada, Qasaba, Darunta, and Jalalabad City regions. The study was conducted over two periods: winter (January-February-March) and summer (June-July-August). Initially, 40 milk samples were collected from these six local points during the winter period. Subsequently, another 40 milk samples were obtained from the same locations during the summer period, resulting in a total of 80 cow's milk samples analyzed. Samples were collected based on the season, ensuring that milk samples were obtained from cows fed with hay during the winter months (January-February-March) and from those grazed on green grass in the area during the summer period. A total of 40 samples were collected for each period, resulting in 80 cow's milk samples analyzed in total. The milk samples were directly collected from homogenized bulk milk at specific local points, and then placed into 200 ml sterile plastic containers, stored at 4°C, and promptly transported under refrigeration to the laboratory for analysis.

The analysis of milk samples included the determination of total solids, fat, non-fat solids, protein, minerals, titratable acidity, and specific gravity, following the procedures outlined by Kurt *et al.* (2003). The pH value of the samples was measured using the method suggested by Kosikowski, (1972) and kurt *et al*. (2003), employing the Hana Inst. 8521 pH-meter. Statistical analysis was conducted using the SAS package program (Anonymous, 1997). Effect of Seasonal Variation on the Composition of Cow Milk.

RESULTS AND DISCUSSION:

Table 1 presents the mean results of the physico-chemical analysis conducted on the composition of cow's milk, along with the corresponding statistical analyses. As shown in **Table 1**, milk fat, protein, and total solids percentages were highest during the winter months and lowest during the summer months. Paired t-tests revealed that the difference in fat content between winter and summer periods was statistically significant at the $p<0.05$ level. Among the components analyzed, milk fat exhibited the greatest variability.

Numerous factors influence the fat content in milk composition, with seasonal variation and lactation period being particularly significant. Seasonal fluctuations have been observed in milk protein content, albeit to a lesser extent compared to milk fat content. This variation may be attributed to a higher light-to-dark ratio, resulting in decreased fat and protein contents in milk, likely due to increased prolactin secretion, which is more pronounced in summer compared to winter (Sevi *et al.,* 2004).

Table 1: Some general chemical and physical characteristics of cow's milk obtained from Jalalabad City, Afghanistan.

		Total Solid (%)	Fat (%)	Non-Fat Solid (%)	Protein (%)	Titratable Acidity (%)	pH	Specific Gravity	Minerals (%)
Period I	Minimum	9.9316	2.4	6.7983	2.431	0.19	5.76	1.026	0.711
	Maximum	12.6235	3.6	9.1135	3.716	0.36	6.72	1.033	0.891
	Average± Sx	11.5064± 1.022[a]	3.1± 0.682[a c]	8.4063± 0.988	2.867± 0.813[b]	0.25± 0.052[a c]	6.50± 0.202	1.030± 0.003	0.802± 0.105
Period II	Minimum	7.5161	1.3	5.3161	2.238	0.15	5.75	1.031	0.751
	Maximum	12.6288	3.5	9.316	3.707	0.36	6.73	1.038	1.024
	Average± Sx	10.8683± 1.840[a]	2.3± 0.937[a c]	8.5682± 1.701	2.793± 0.943[b]	0.22± 0.079[a c]	6.50± 0.470	1.031± 0.002	0.841± 0.160
General	Average± Sx	11.1874± 1.431	2.7± 0.810	8.4873± 1.344	2.830± 0.877	0.24± 0.0064	6.50± 0.336	1.031± 0.003	0.822± 0.132

[a]; Important at the level of $p<0.01$,[b]: Important at the level of $p<0.05$, [c]:According to t-test important at the level of $p<0.05$

The heightened seasonal variation can be attributed to the practice of outdoor grazing during the summer months and indoor bar feeding during the winter months. Notably, significant differences exist between the compositions of the feeds provided to the animals during these two periods (Mendia *et al.,* 2000). It is likely that the feed regimen, predominantly based on hay during the winter season when herbage is not readily available, plays a crucial role. Increased feeding frequency of low-fiber, high-grain diets has been associated with elevated milk fat levels (Lock and Garnsworthy, 2003).

When comparing milk composition with data from other countries, it's crucial to consider the year of sample collection, as significant changes in milk composition have occurred in many nations over past decades (Heck *et al.,* 2009). Isiklar and Kurdal, (1991) reported a fat content of 3.30% for milk marketed in Bursa city, while Kovacs *et al.* (1999) found a fat content of 4.94% for Hungarian Grey cattle. (Ozturan and Atasever, 2020) noted a fat content of 4.34% for Swedish dairy milk, and similar results were observed for Elazig/Turkey dairy milk by (Kurdar *et al.,* 2017). The mean protein content of cows' milk was 2.868% for the winter period and 2.794% for the summer period, indicating significant seasonal variation ($p<0.05$). Typically, milk protein percentage correlates positively with milk fat percentage, but both decrease in concentration due to hot weather. Milk protein generally exhibits less fluctuation than milk fat.

The mean total solid content of cows' milk was 11.1874 ± 1.431%, with statistically significant differences between winter and summer periods ($p<0.01$). High temperatures, humidity fluctuations, and decreased dry matter intake in the summer likely contributed to this decrease. Regarding milk acidity, initial acidity is attributed to casein phosphate, citrate, and carbon dioxide, while lactic acid produced by bacterial activity increases milk acidity over time. Excessive acidity is undesirable. Afghan dairy milk acidity values have ranged from 4.20 SH (0.09%) to 12 SH (0.27%), with results from this research aligning with these findings, showing statistically significant seasonal variation ($p<0.05$).

CONCLUSION:

The findings of this research align with previous studies, indicating that the composition of dairy milk in Jalalabad city, Afghanistan, is consistent with results from other regions. Specifically, it was noted that the fat content of Jalalabad city cows' milk is significantly affected by seasonal changes, whereas other milk constituents are less affected by this factor. Results suggest that higher milk fat content is associated with higher protein and total solid contents, with these percentages peaking during winter and declining during summer, which is consistent with literature findings. Seasonal variations in milk production, fat, and protein content have been observed in various countries and management practices. Typically, in the northern hemisphere, the lowest protein and fat percentages occur in the

summer months (June-August), while the highest percentages are observed between October and December (Sargeant *et al.,* 1998). Hence, strategies to mitigate the impact of high temperatures on lactating cows during summer, such as providing shade, improving ventilation, adjusting feeding times, and supplementing feed rations with appropriate mineral elements, are essential to maintain cheese yield and quality. Nutrition plays a significant role in milk yield and composition variability, but climatic conditions, seasonal fluctuations, and regional differences also contribute. The quality and composition of milk are crucial for the dairy industry and human health, as milk composition affects its process ability. Milk with higher protein content is typically processed into cheese, while milk with higher fat content is used for butter production.

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CONFLICTS OF INTERST:

Authors do not have any conflict of interest.

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