

# The Study of Biochemical Markers of Goat Milk in Shirak Region, Republic of Armenia

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## Abstract

The aim of the research is to look into the biochemical markers of goat milk at various lactation stages from the perspective of quality and purpose to study the efficiency of the pasteurization process in the supply chain from raw materials to finished products and, from the point of view of shelf-life targeted to the future research. The goats have been bred in the Shirak region of the Republic of Armenia. Differences have been observed between lactations in relation to the quantity of urea and Lactatdehydrogenase activity, *i.e.* a decrease in the third lactation as opposed to the first lactation. During the three lactations, under standard milk pH (5.8-6.2) conditions, steady enzyme indices have been observed in Lactoperoxidase and Alkaline Phosphatase activity, *i.e.* 0.66-0.71 U/ml and 6.9-7.03 U/l respectively. These data indicate that the absorption of food proteins and carbohydrates intensifies with age, which is directly linked to the level of lactation, while the identified steady indicators of Lactoperoxidase and Alkaline Phosphatase enzymes set grounds for further research to establish their levels of activity at different stages related to pasteurization

**Keywords:** alkaline phosphatase, goat, lactoperoxidase, milk, urea.

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## 1. Introduction

Goat milk can be used both in manufacturing a wide range of dairy products and in confectionery production [1]. Goat milk is becoming more demanded among consumers due to its rich chemical composition and nutritional value, which has a positive effect on human health. Apart from the above stated, the biochemical indicators of milk can be considered as valuable diagnostic descriptors not only for the mammary glands of the animal, but also in the assessment of intensity of the metabolic processes of the organism, and also in the precise technological processing of milk.

Besides the animal species, breed, age and feeding terms, milk composition is also affected by the bacteria, fungi and viruses [2,3].

Regardless of feeding, lactation itself is a physiologically loaded period of the organism, which affects the homeostatic mechanisms of the organism, accompanied by fluctuations in biochemical processes, including formation of antioxidant systems, which affects the milk composition and activity of enzymes that catalyze the processes [1].

The current work aims to investigate the biochemical indicators of goat milk bred in Shirak region of the RA in different lactation periods, both qualitatively and later from the perspective of searching for effective pasteurization and shelf life indexes in the chain from raw materials to finished products.

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## 2. Materials and methods

The research was carried out on animals bred in the Krashen's goat breeding farm of Shirak marz/region, RA. The experimental animals were 2-, 3- and 4-year-old female goats of the Saanen breed. The milk samples were transported to the laboratory in frozen conditions from Shirak marz. Biochemical studies were carried out in the Food Quality Control Laboratory of the Armenian National Agrarian University and included 15 animals.

The enzyme activity of lactate dehydrogenase (LDH), lactoperoxidase (LP), alkaline phosphatase (ALP) in the goat milk, as well as urea level in the 1, 2 and 3 lactations have been investigated respectively. The hydrogen ion concentration of the milk was measured (pH). The daily food ration per an animal unit included 2 kg hay, 0.7 kg combined pelleted forage, which includes soybeans, sunflower meal, maize, barley and supplements. The outdoor/yard stall barn housing system was applied for the animals. The duration of lactation was 290 days, milk productivity was estimated for 25 units of female goats and the milking process was mechanical.

**Table 1.** Biochemical data of goat milk depending on the lactation

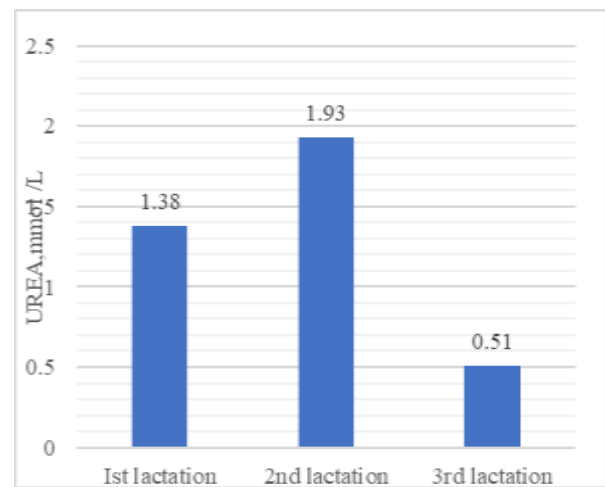
No.	Data	1 <sup>st</sup> lactation	2 <sup>nd</sup> lactation	3 <sup>rd</sup> lactation
1.	Urea, mmol/l	1.38±0.34	1.93± 0.18	0.51± 0.001
2.	LDH, Units/l	140.5±57.4	86.8 ± 36.7	60.1± 13.2
3.	ALP, U/l	6.90±0.08	6.94± 0.048	7.03± 0,05
4.	LP, U/ml	0.66 ± 0.04	0.67± 0.089	0.71± 0.04
5.	pH	5.8± 0.68	5.9± 0.85	6.2± 0.70
6.	Milk yield, kg	368.3± 48.9	395.5± 37.9	454.0±48.8

LDH activity was determined through the modified spectrophotometric method of R. Scopes (JENWAY 7315) [4]. The level of urea was examined by the amount of ammonia using the urease method [5]. Determination of ALP and LP activity was carried out using kits through a Food Lab Analyzer device. pH was measured via JENWAY 3540 conductivity meter.

The statistical data processing was implemented through GraphPad Prizm 6 software program.

## 3. Results and discussion

The resulted data indicate that the urea amount in the female goats of the 2<sup>nd</sup> lactation grows up as compared to that of recorded in the animals of the 1<sup>st</sup> lactation while in the 3<sup>rd</sup> one it decreases making  $1.38\pm0.34$ ;  $1.93\pm0.18$  and  $0.51\pm0.001$ mmol/l, ( $P<0,05$ ), respectively (Figure 1). A similar trend was recorded in other studies, where the author observed changes in the level of urea in the milk of Saanen goats bred in Vayots Dzor, RA, depending on lactation:  $1.59\pm0.3\mu\text{m}$  and  $5.8\pm0.3\mu\text{m}$  [6]. In the studies of D. Hojman et al., an increase in the level of urea in the cattle milk was also recorded depending on the age of the animal and the period of lactation [7].The urea amount in the milk of ruminants is mainly the index of fermentation level and food monitoring [8,9], whereas its key affecting factors are diet and protein-energy balance in the food ration [9].



**Figure 1.** Goat milk urea level depending on lactation

Research of LP (Table 1.) system is perspective in view of its application in dairy food production. In this context, LP is one of the most heat-resistant enzymes of raw milk, whose activity is a test to verify the efficiency of pasteurization and to extend the shelf life of food [10-12]. The results of the study confirm that although there is no difference in raw milk LP activity between lactations  $0.66\pm0.045$ ;  $0.67 \pm 0.089$  and  $0.71 \pm 0.04$  Units/ml, however, it is positive that they are stable and create a premise for future studies at different stages of pasteurization. The results of

the research are also consistent with the literature data [13,14] and testify that it is necessary to study the LP activity of goat's milk in manufacturing milk and dairy products in the raw stuff-food chain, as a quality indicator, in order to observe the index of accurate pasteurization and shelf life of the product. Research shows that it can also serve as an animal intestinal antibacterial and mammary diagnostic test [14]. Based on literature data that LP shows its maximum activity when pH is 6.0, it can be concluded that the activity index obtained in our research is close to the maximum threshold of enzyme activity, since the pH of milk ranges from  $5.8 \pm 0.68$  and  $6.2 \pm 0.70$  [14].

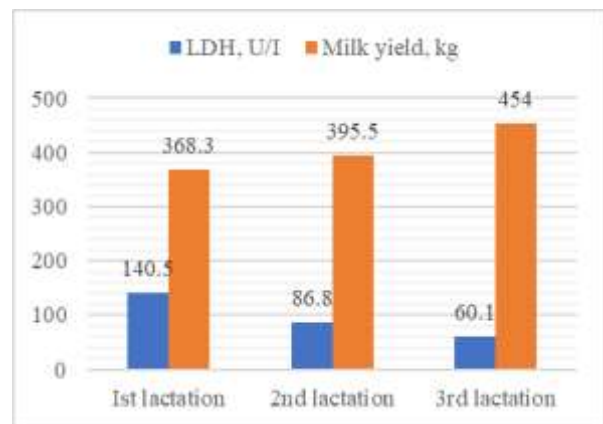
Research shows that goat milk can also get contaminated with *Escherichia coli* [16], brucellosis [17], encephalitis viruses [18].

The microbiological safety of milk depends on effective pasteurization, which in addition to LP can be also validated via ALP activity. Scientists confirm that ALP can serve as an indicator of effective pasteurization of goat milk, taking into account the fact that the heat resistance of the enzyme is higher than the heat resistance of pathogens present in milk (18,19). Moreover, the activity should be measured both in raw milk and after pasteurization. ALP activity varies depending on the animal species and the specificity of the organism. High enzyme activity is also recorded in case of mastitis [20, 21]. According to the ISO standard, the ALP activity in pasteurized cow milk should be  $\leq 350$  mmol/L. Though the available research proves that the enzyme activity in goat milk is much lower than that of cow milk, still the standard has not been stated. In this regard, the European Food Safety Authority (EFSA) urges scientists to conduct research in this direction [22].

In this context, our research outlines the ALP activity of raw goat milk in RA depending on lactations, which will be further supplemented with data obtained after pasteurization. Research shows that, as in the case of LP, enzyme activity is stable between lactations. Considering the fact that there are no pathogenic bacteria and viruses in milk, it can be concluded that ALP activity in raw goat milk is within the norm making  $6.90 \pm 0.087$ ,  $6.94 \pm 0.048$  and  $7.03 \pm 0.05$  U/l, respectively.

LDH activity in the second and third lactations significantly decreases by 1.5 and 2.3 times compared to the first lactation ( $P < 0.05$ ) and

makes  $140.5 \pm 57.4$ ;  $86.8 \pm 36.7$  and  $60.1 \pm 13.2$  U/l, respectively.



**Figure 2.** Variations of goat milk productivity and LDH activity

The decrease in milk LDH activity parallel with lactations is accompanied by a gradual increase in milk yield from  $368.3 \pm 48.9$  kg (1st lactation) to  $454.0 \pm 48.8$  kg (3rd lactation) ( $P < 0.05$ ), which indicates about the higher energy costs for the organism in parallel to milk productivity (Figure 2).

Data from the literature indicate that both LDH and ALP activity in ruminant milk increases during pathological phenomena and reaches up to 329.0 and 362.6 M/L, respectively [23].

#### 4. Conclusions

The results of scientific experiments confirm that there is a difference between lactations in case of urea changing amount and LDH activity. Besides, in case of urea a considerable increase and in case of LDH up to 2,3 times decrease is recorded. The data point to the higher energy expenditures of the organism along with the increase in milk yield. The activity of LDH, ALP, LP enzymes in raw goat milk varies within normal limits. It is positive that ALP and LP activity is stable during three lactations. It creates a background for studying the activity of enzymes in different stages of pasteurization in the near future and to complete the research in order to consider it as an index of accurate pasteurization and shelf life of food in the raw material-food chain.

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