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Study of Milking Efficiency, Biochemical Milk Composition and Hormonal Blood Parameters of Armenian Goat Breeds for the Second Lactation Period

Research Article

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ABSTRACT

The purpose of the given work was to study the dairy efficiency of the delivered, local and crossbreed goats in three different generations (F_1, F_2 and F_3), derived from their crosses, as well as the biochemical composition of milk and some blood plasma hormones, participating in the process of lactopoez. For the biochemical tests of milk we have selected casein and serum proteins, iron in lactoferrin and xanthine oxidase activity as one of the enzymes of protein catabolism together with lysozyme activity. Delivered goat breeds surpass the locals in milk production. Cross-breeds F_1, F_2, and especially F_3 occupy an intermediate position, and the latter ones even surpass Toggenburg breed, but are inferior to Alpine and Zaane breeds. It is stated a direct correlation between milk production of goat breeds and their crossbreeds and the level of prolactin in blood. It is noted the inverse correlation on the content of insulin.

KEY WORDS casein, goat, lactoferrin, lysozyme, xanthine oxidase.

INTRODUCTION

Productivity of farm animals is conditioned by their genotype and its realization in interaction with environmental factors (as feeding, maintenance, geo-environmental conditions, etc.). At the heart of improvement on animals productivity lies the selective crossing of low-yield breeds with highly productive ones to stabilize the productive qualities in generations that primarily affects the metabolism and identification of metabolic parameters of productivity may be useful both for its estimation and purposeful breeding. To improve the conditions of dairy goat breeding in Armenia in 2000 high-yield breeds of goats (as Zaane, Alpine and Toggenburg) were delivered from the USA and since then an intensive crossing of the above mentioned breeds of goats both by a thoroughbred way and with low-yield local breed has been carried out with the expect of future efficiency. The purpose of the given work was to study the dairy efficiency of the delivered, local and crossbred goats in three different generations (F_1, F_2 and F_3), derived from their crosses, as well as the biochemical composition of milk and some blood plasma hormones, participating in the process of lactopoez. The experiment covered female-goats of three years (2^{nd} lactation), because it is the most optimum period for milk productivity and intensity of metabolic processes. The study of biochemical tests and hormonal levels were carried out at the beginning of the 5^{th} month of lactation as lactation period of goats lasts 9-10 months and the 5^{th} is the most expedient, this also agrees with other studies (Nevada *et al.* 1976; Bulatov, 2004; Galochkina and Galochkin, 2008). The genetic potential of goat dairy efficiency is defined by the number of differentiated cells of a

mammary gland as well as availability and the way of usage for milk synthesis. Both factors are realized with the assistance of hormones Apparently, there are species distinctions in hormonal requirements for the maintenance of lactopoez (Cocorina, 1996; Fedosimov and Cocorina, 2000). As the biochemical tests of milk we have selected casein and serum proteins, iron in lactoferrin, xanthine oxidase activity as one of the key enzymes of purine catabolism together with the analysis of lysozyme activity. The last stimulates phagocytosis of neutrophiles, macrophages, antibody synthesis and it is capable of destroying lipopolysacharide superficial layers of cell walls in gram-positive bacteria. Reduction or disappearance of lysozyme activity in blood lowers the immune status of the organism and leads to occurrence of infectious diseases.

Since prolactine stimulates growth and lactation of mammary gland, we have firstly determined its concentration in the blood from different species of goats. Besides prolactine it is considered as an activator of the immune activity its receptors revealed on the macrophages and neutrophiles membranes. As regards insuline, it has real regard to anabolic processes particularly to protein synthesis. Insuline stimulates protein synthesis on the level of translation and stimulates amino acids transport into cells simultaneously to an inhibition in gluconeogenesis at the liver and inhibition amino acids release from muscle. In this ground, we have studied the level of these two hormones in blood of goat species.

MATERIALS AND METHODS

Investigations were carried out on the goats bred in "ARID" goat breeding center of Yeghegnadzor, situated in the Republic of Armenia. The experimental goats were divided on the basis of analogues into seven groups. The first three groups were high-yield delivered breeds-Zaane, Alpine and Toggenburg-while the fourth group consisted of goats from local breeds, and the latter was a cross of the three generations (F_1, F_2 and F_3), obtained by crossing local goats with delivered ones. Milk samples were frozen and transported to the laboratory where the biochemical tests determination were carried out. To determine lisozyme activity we have used a suspension of *Micrococcus lysodeiticus* in 0.05 M phosphate salt buffer, pH 7.4. Samples were incubated 6 h at 37 ˚C. Optical density measurements were performed at a wavelength of 450 nm (Selested and Martínez, 1980). Xanthine oxidase activity was determined by the output of uric acid by ultraviolet method according to the final point. We have used 0.05 M phosphate buffer pH 7.5. A unit of activity was that forming one micromole of urate per minute at 25 ˚C. Samples were centrifugated at 3000 x g. Recorded of initial absorbance was made at 290 nm and then recorded increase in absorbance was determined at ΔA_{290} after one hour. The molar absorbancy of uric acid was presented according to the expression= $1.22 \times 10^4 cm^{-1}$ (Waud and Rajagopalan, 1976). To identify iron in lactoferrin we have used o-phenanthroline, the optical density was measured at a wavelength of 520 nm (Scarlata, 1962). Isolation of casein and serum proteins were performed by the method of electrophoresis in polyacrylamide gel using tris-glycin, an electrode buffer of 0.1 M at a pH value of 8.3 (Deshmukh *et al.* 1989). Gel colouring was performed by kumassi brilliant blue G250. The content of prolactin and insulin in blood serum was determined by the method of immune enzyme analysis using ready-made commercial test kits of Syntron Bioresearch (USA). The final stage of measurement was colorimetry on FEK at a wavelength of 450 nm. The results were statistically processed by means of computer program Graph Pad.

RESULTS AND DISCUSSION

Milk formation by epithelial cells in the mammary gland is provided with the assistance of many organism systems: digestive, respiratory, reproductive, endocrine, nervous and circulatory. The unity of all organism systems is provided by the nervous system with its higher division - the brain. Under the influence of neurohumoral mechanism with the onset of lactation increases nervous system tone, activates the endocrine system, increases the intensity of metabolites absorption in the mammary gland which it is involved in the synthesis of milk components (Grachev, 1995). We have selected to study prolactin-the basic lactogenic hormone involved in the regulation of lactation function of a body, including lactogenesis and lactopoez, and insulin, involvement of which in lactogenes is due to its effect on protein synthesis in the epithelium of the alveoli and the processes of RNA transcription. Prolactin has a multifunctional effect on the processes in the lactating body: slows the release of follicle-stimulating hormone in the pituitary gland, affects the activity of glandular epithelium in the mammary gland, has a direct influence on the secreting cells of the mammary glands and it also activates lipoprotein lipase. We can assume that prolactin stimulates the absorption of four fractions of glycoproteins by the mammary gland where they serve as a source for milk components synthesis (Taranenco, 1997). Taking into account the above-said, our task was to study the relationship between milk production, hormones level and milk biochemistry by considering the peculiarities of the breed. To study the hormonal profile of the delivered goats we have selected Zaane breed distinguished by the highest rate in milk production (576 l per lactation). The results of our studies showed the superiority of Zaane goats in comparison with

the local ones by the level of prolactin in blood (Figure 1), which was 69.30±18.0 and 38.40±18.3 ng/mL, respectively.

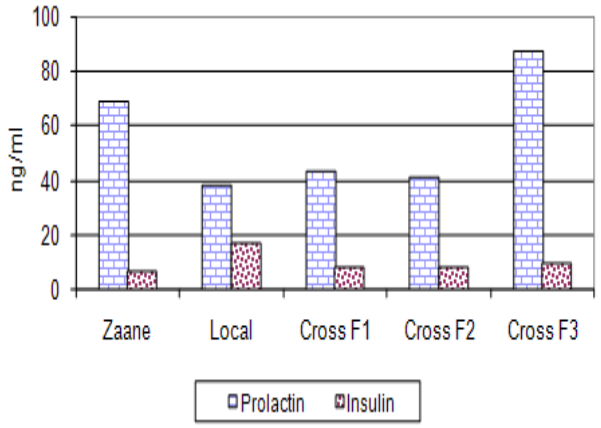

Figure 1 Level of hormones in blood of goats for the second lactation

As for the crossbred goats, the highest figure is recorded in the third generation -87.6±6.4 and for the goats of the first and second generations the background of prolactin is practically at the same level and makes up correspondingly 44.20±12.0 and 42.00±11.5 ng/mL.

Thus, the positive correlation between prolactin level and milk yield of investigated goats is observed. The highest milk yield per lactation is observed in goats of Zaane breed-576 liter (Table 2) and the lowest in local breeds-192 liter. The results of local goats showed that there was no milking in October. As for cross-breeds, the productivity of the first and second generations is almost at the same level (271.5 and 292.5 liters). Third-generation cross-breeds, which are genetically closer to purebred delivered goats have higher level of prolactin and milk yield than the previous two and make up 363.3 liters per lactation, which already exceeds Toggenburg by 27.6 l (335.7 liters). A positive correlation between prolactin level in blood plasma and milk productivity of cows was also noted by Mollett and Malva (1982). With regard to insulin level (Figure 1), the ruminant hormone secretion has the fundamental feature which is revealed in the fact that the initial induction of insulin secretion is realized by means of activated forms of short-chain fatty acids or glucose, not synthesized in the liver, but directly into the walls of the farding bag (Schoonmarker *et al.* 2003).

Insulin inhibits the secretion of milk and lactose, but increases the secretion of milk fat and casein that is explained by the fact that the higher dose of insulin on the basis of the feedback has a stimulating effect on the increase of discharge of somatotropic hormones that stimulate protein synthesis (Grachev, 1995). The obtained results show that the highest insulin level is present in the blood plasma of local goat breeds and makes up 17.1±3.8 ng/mL, the lowest-in high-yielding Zaane goats 7.0±0.8 ($P<0.02$). As for cross-breeds, insulin level in F_1 and F_2 generations is virtually identical 8.60±0.3 and 8.70±1.9, respectively and yields to F_3 9.70±2.5. The obtained results indicate an inverse relationship between insulin level and milk yield of goats. However, a direct link between insulin of blood and casein content in goat milk is observed. Thus, the level of casein (Table 1) in the milk of local goats is higher than that in the milk of delivered goats of high productivity and makes up 1.56±0.02 (local) and 1.23±0.05 g/L Zaane, ($P<0.001$).

Table 1 Milk biochemical indices of pure breed, local and cross-breed goats for the second lactation period

Breed. Breed group (in their 3-d year)	Lysozyme activity %	Fe in latoferin mg/mL	Xanthine oxidase activity U/mL	Casein g/L	Lactalbumins g/L	Lactglobulins g/L
Alpian	30.6±0.5	1.02±0.08	18.0±1.50	1.34±0.02	0.12±0.010	0.21±0.004
Zaane	28.1±1.3	1.30±0.08	16.3±1.44	1.23±0.05[a]	0.11±0.004	0.19±0.008
Toggenburg	29.2±0.4	1.10±0.06	17.1±1.30	1.34±0.01	0.12±0.004	0.20±0.008
Local	35.4±0.6	1.51±0.30	16.6±0.30	1.56±0.02[a]	0.14±0.004	0.24±0.007
Cross-breed F_1	44.6±3.0	1.10±0.17	16.0±3.60	1.96±0.13[b]	0.18±0.010	0.31±0.020
Cross-breed F_2	38.8±2.6	0.90±0.08	23.6±3.70	1.71±0.10	0.16±0.009	0.27±0.020
Cross-breed F_3	36.6±2.7	0.98±0.05	18.2±2.30	1.61±0.10	0.15±0.012	0.25±0.020

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

Table 2 Daily milk productivity of pure breed, local and cross-breed goats during second lactation period (control milking)

Breed and breed groups (in their 3-d year)	Months								
	March l/d	April l/d	May l/d	June l/d	July l/d	August l/d	September l/d	October l/d	Lactation period l (per eight months)
Alpian	2.87±0.04	2.69±0.06	2.95±0.06	2.07±0.05	1.58±0.06	1.72±0.08	1.10±0.07	0.77±0.07	472.5
Zaane	3.02±0.07	3.15±0.08	3.51±0.09	2.56±0.08	2.15±0.07	1.88±0.07	1.62±0.05	0.96±0.05	576.0
Toggenburg	1.85±0.06	2.00±0.06	2.12±0.07	1.76±0.05	1.30±0.07	0.95±0.06	0.70±0.05	0.51±0.05	335.7
Local	1.12±0.07	1.22±0.06	1.31±0.06	1.05±0.08	0.80±0.05	0.60±0.06	0.30±0.03	0.00	192.0
Cross-breed F_1	1.41±0.18	1.57±0.19	1.90±0.17	1.32±0.16	1.11±0.14	0.83±0.10	0.65±0.07	0.27±0.02	271.5
Cross-breed F_2	1.70±0.09	1.62±0.09	1.81±0.11	1.60±0.10	1.10±0.09	0.90±0.07	0.60±0.04	0.42±0.04	292.5
Cross-breed F_3	1.95±0.03	2.01±0.04	2.18±0.04	1.90±0.04	1.52±0.03	1.11±0.02	0.81±0.02	0.63±0.02	363.3

The means within the same column with at least one common letter, do not have significant difference (P>0.01).

As for the F_1 generation, then here, due to heterosis the highest level of casein 1.96±0.13 g/L is stated, that is later, in the second and third generations, almost equalized with the index of local goats and makes up F_2 1.71±0.1 and F_3 1.61±0.1 in cross-breeds.

Adapted to piedmont natural climatic conditions of Armenia local goats exceed imported by lysozyme activity but the difference is minimized in the third-generation cross-breeds. The results are consonant with the data on the stimulation of lysozyme antibody synthesis and increase of the immune status of the organism. As it is known, lysozyme along with lactoferrin is one of the antibacterial proteins of animals blood, eggs and milk. In recent years, due to the much higher concentration of lysozyme in breast milk compared to the animal milk, transgenesis methods have been developed to ensure the expression of human proteins, particularly lysozyme in cow and goat milk that increases the protective properties of the organism (Brundige *et al.* 2008; Wolchover, 2011).

As for Fe in lactoferrin and xanthine oxidase activity in the milk of goats, no particular crossbred difference was noticed. Fe in lactoferrin varies from 0.9 to 1.51 mg/mL and the activity of xanthine oxidase from 16.0 to 23.6 U/mL (µmol/min.mL). In the content of milk serum, proteins are recorded for their superiority to locals and, in particular, crossbred goats over delivered high-yield ones. Analysis of milk production per lactation period indicates that the highest figure is recorded in female-goats of Zaane breed (Table 2) -576.0 l. Alpines are inferior to Zaane breed by 18%, to locals by 77.7% and by 59.4% to Alpines, respectively. Rewrite this sentence or delete it. It should be also noted that the third generation of the cross-breeds excels the locals by 89% in milk productivity and Toggenburg by 8.2%. It should be also highlighted that the peak of milk yield of all breeds and breed groups are reached in May.

CONCLUSION

1. Delivered goat breeds surpass the locals in milk production. Cross-breeds F_1, F_2 and especially F_3 occupy an intermediate position and the latter ones even surpass Toggenburg breed, but are inferior to Alpine and Zaane breeds.
2. It is stated a direct correlation between milk production of goat breeds and their crossbreeds and the level of prolactin in blood. It is noted the inverse correlation on the content of insulin. However, high level of insulin in the local goats is accompanied by an increased content of casein.
3. In relation to the content of lactalbumin and lactaglobulin the significant differences between the breeds are not identified. Local goats surpass the delivered ones in lactalbumin content and are inferior to cross-breeds, especially F_1.
4. In xanthine oxidase activity and lactoferrin content significant interbreed differences are not observed.

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