

Characteristics of milk production traits of Balkan goats raised under “low-input” production systems

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Summary

In order to analyse dairy production traits (milk yield in full lactation, milk fat content, daily milk yield and length of lactation) of Balkan goats raised under “low-input” production systems, data on 440 lactation records from 118 does raised on 9 farms in south-east part of Serbia were used. General linear model, used for analysing variability of lactation length, was consisting of following fixed effects: farm, year of birth, year of production and number of lactation. Model for milk yield in full lactation, milk fat content and daily milk yield was consisting of farms, year of birth, year of production and number of lactation as fixed effects and length of lactation as covariate. The highest milk yield (392 kg) and the highest milk fat content (3.89 %) were achieved in III lactation. Effects of farm, year of production and number of lactation were very significant sources of variation ($P < 0.001$) for milk yield, daily milk yield and milk fat content, while the year of birth as factor of phenotypic variation in these traits expressed no such consistency. Highly significant sources of variation ($P < 0.001$) for the length of lactation were farm and year of production, while the length of lactation had a significant influence ($P < 0.001$) only for total milk yield variability.

Key words: goat, milk traits, low-input production system, source of variation

Introduction

Balkan goat, besides ex-Yugoslavian countries, is being raised in almost entire region of Balkan Peninsula and south-eastern Europe. Moreover, very similar breeds of goats to that of Balkan goat are being raised in other countries too, especially Mediterranean European countries. These breeds include, among some others, the French Corse goat, Greek breed Skopelos, Italian breed Sarda Primitiva, Roccaverano and Valgerola and Portuguese breed Serrana. A principal feature of Balkan goat, like in the other similar breeds, is extremely good adaptability to modest conditions of nutrition, housing system and care, and this robustness represents one of its more important functional traits

which take more and more important place in contemporary breeding programmes (Barillet, 2007).

Goat raising and production of goat milk and dairy products in the last 10-15 years became more intensive not only in Serbia but also in other countries created after disintegration of the Socialist Federal Republic of Yugoslavia. In general, two major groups of production systems for goat raising can be distinguished. On one hand, it is the intensive production system in which highly-productive specialized breeds are being raised, such as Sannen or Alpine breeds, and on the other, the production system characterized by lower intensity in which, besides above mentioned noble breeds, some other breeds of goats are raised, such as Serbian (domestic) White goat, Balkan goat, as well as the cross-

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breeds produced by different crossing procedures (Žujović et al., 2006). The dairy traits of Balkan goat have not been the subject of scientific interest for a long time due to a well-known Law on prohibition of raising goats (Anonymous, 1954), which was fictionally in force all up to the '90s of the 20th century. However, only sporadic research attempts were made until that period have recently gradually become more serious scientific studies aiming to establish most important morphological, productive and reproductive traits in this breed. Thus Marković (1997) in her analysis of production results obtained from 6 private farms in Montenegro confirmed average milk production in Balkan goat of about 129 kg during somewhat shorter lactation of about 218 days. According to research by Memiši (2000), milk production of Balkan goat raised on the farms situated on different altitudes in the vicinity of the town Prizren, varied from 172 to 184 kg in lactation whose average length was about 237 days, while Bogdanović et al. (2008) confirmed average milk yield obtained by Balkan goat in semi-extensive production conditions to be 378 kg in lactation lasting 256 days.

When production traits of Balkan goat are being compared to other local or autochthonous goat breeds raised in the other parts of Europe and the world, it can be noticed that a dairy production trait pronounced in this breed falls within expected and biological frames for this group of goats (Bogdanović et al., 2008). In detailed analysis on the possibility of using high-productive goat breeds as meliorators for the breeding stocks of local, primitive breeds, Serradilla (2001) reported the milk yield of autochthonous Italian and Maltec goats to be in the interval of 135 to 360 kg, Greek from 100 to 180 kg and Turkish local breeds from 120 to 400 kg. Milk yield of local Spanish breeds in the interval from 425 to 650 kg in lactation period lasting from 200 to 260 days was reported by Haenlein (2007) in his critical review on the development of modern production of sheep and goat milk.

Besides phenotypically expressed traits, it is also important to analyse the most significant non-genetic sources of variation that affect the goat production traits. On the basis of research performed by Mavrogenis and Papachristoforou (2000), Ciappesoni et al. (2004), Güney et al. (2006), Carnicella et al. (2008) and Mioč et al. (2008) a

significant influence on the milk production traits in goat, regardless whether it is a specialized or autochthonous breed, is being induced by the farm, year of birth, year of production, number of lactation and age.

Although in Serbia there are still no functional associations of breeders of Balkan goat, and therefore neither clearly defined breeding goal nor programme for this breed, more and more farmers are being interested in its raising since this breed has been associated with organic, traditional or "low-input" livestock production systems which contribute to added value of final product. Having in mind the importance which Balkan goat has in the development of specific livestock production systems, as well as the need for even more detailed knowledge about production traits of this breed, the objective of this paper was to analyse the milk production traits in Balkan goat raised in "low-input" production systems, and also to establish the influence induced by the most important sources of variation on studied traits.

Material and methods

For this research the data obtained in regular milking controls in Balkan goat collected from 9 farms within the area of town Niš and the municipality of Aleksinac situated in south-east part of Serbia have been used. In total 440 lactation records taken from 118 does in different age were analysed. All analysed animals were born in the period from 1993-1999, while lactations were controlled from 1997-2002. The milking control was conducted in regular monthly intervals (28 ± 5 days) starting in average one and a half month after kidding and lasting until drying off about two months before the next kidding. Does were milked once in the morning period, while the milk chemical analysis was performed in authorized laboratories using the method of infrared spectrometry by Milkoscan.

Breeding and zootechnical conditions of goats raising on the farms included in this analysis can be characterized as "low-input". From a geographical point of view, all farms included in this research were situated in a hilly region. Housing of goats was usually organized in simple purposeful buildings, although on three farms the buildings were not well suited for goats keeping. During a longer part of ve-

getation period (from spring to autumn) goats were kept in combined housing system, that is, during the day they were on pasture, coming back to the stables in the evening. Outside vegetation period and during winter the housing of goats was organized in stables with the use of free range system whenever climate conditions made it possible. During summer the nutrition of goats was based primarily on quality hilly pasture or green mass, and in winter on quality meadow hay and alfalfa hay. Supplementary nutrition with concentrated diets was based mostly on cereals grits produced on the farm with addition of commercial mineral-vitamin mixtures while the silage or chopped hay was not used in the nutrition of goats. Goats reproductive cycle corresponded to a biological one, so the mating was performed during a prolonged time period from September to December, reaching peak in October and November. On the farms included in this research neither oestrus synchronization nor artificial insemination was used, reproduction being performed by the use of planned, individual mating with the use of licensed breeding bucks.

Among dairy production traits, following traits have been analyzed: the milk yield in full lactation in kg (MY, kg), milk fat content in percent (MF, %), daily milk yield in kg (DY, kg), and length of lactation in days (LL, d). It should be pointed out that the length of lactation was analyzed not only as dependent variable but also as the independent variable during establishing the variability of the first three production traits (milk yield in full lactation, milk fat percent and daily milk yield). For the analysis of present phenotypic variability several statistical models were used depending on the nature of studied trait. General linear model for analysis of variability of the length of lactation was defined by

following fixed factors: farm or herd (F=1, 2, 3, ..., 9), year of birth (BY=1993, 1994, ..., 1999), year of production/lactation (PY=1997, 1998, ..., 2002) and number of lactation (NL=I, II, III, ..., VI; Note: due to the insufficient number of records, the VI lactation includes the sixth and all succeeding lactations). Due to unbalanced records, the model also included an individual random effect ($n = 118$) with the purpose to obtain ever better solutions for fixed factors. In the analysis on production traits, besides already mentioned fixed and random effects, the length of lactation was also included as independent variable. Data processing was performed by the GLM procedure of the SAS statistical package (SAS 9.1.3, 2007).

Results and discussion

An average dairy production of 378 kg milk with milk fat content of 3.71% in Balkan goat (Table 1) is within expected and biological frames for the group of autochthonous goat breeds what can also be confirmed by the results of Analla et al. (1996), Mavrogenis and Papachristoforou (2000), Seradilla (2001), Galal (2005), Haenlein (2007) and Bogdanović et al. (2008).

Somewhat higher dairy production in autochthonous goat breeds such as Murciano-Granadina (460 and 531 kg) and Damascus (489.4 kg) was reported by Salama et al. (2003) and Güney et al. (2006), respectively, while lower milk yield in Maltec goats (288.2 kg) was recorded by Carnicella et al. (2008). In comparison with high-productive dairy breeds or improved local breeds, production traits in Balkan goat were more inferiorly displayed (Ciappesoni et al., 2004; Haenlein, 2007). Even besides poor display in comparison with specialized

Table 1. Descriptive statistics of analysed production traits of Balkan goats
Tablica 1. Osnovni statistički pokazatelji promatranih svojstava Balkanskih koza

Traits/Svojstvo	N	Mean/Prosjeak	SD	CV, %
MY, kg	440	378.46	93.78	24.78
MF, %	440	3.71	0.25	6.63
DY, kg	440	1.45	0.35	24.14
LL, days	440	256.33	22.41	8.74

SD: standard deviation/standardna devijacija; CV: coefficient of variation/koeficijent varijacije. MY, kg: total milk yield in lactation/proizvodnja mlijeka u punoj laktaciji; MF, %: milk fat/udjel mliječne masti; DY, kg: daily milk yield/proizvodnja mlijeka po danu; LL, days: length of lactation/dužina laktacije u danima

Table 2. Significance of models and factors for production traits of Balkan goats
 Tablica 2. Značajnost modela i utjecaja za promatrana svojstva Balkanskih koza

Traits/Svojstvo		MY, kg	MF, %	DY, kg	LL, days	
Source/Utjecaj	df	Significance level Stupanj značajnosti	Significance level Stupanj značajnosti	Significance level Stupanj značajnosti	df	Significance level Stupanj značajnosti
Model	25	***	***	***	24	***
R ²	---	0.35	0.20	0.27	---	0.38
F	8	***	***	***	8	***
BY	6	**	ns	**	6	ns
PY	5	***	***	***	5	***
NL	5	***	***	***	5	ns
LL	1	***	ns	ns	---	---

MY, kg: total milk yield in lactation/proizvodnja mlijeka u punoj laktaciji; MF, %: milk fat/udjel mliječne masti; DY, kg: daily milk yield/proizvodnja mlijeka po danu; LL, days: length of lactation/dužina laktacije u danima; F: farm/farma; BY: birth year/godina rođenja; PY: production year/godina proizvodnje; NL: number of lactation/redni broj laktacije; LL: length of lactation/dužina laktacije; R²: coefficient of determination/koeficijent determinacije modela; *** P<0.001, ** P<0.01, ns - not significant/nije signifikantno

dairy breeds, the results confirm that Balkan breed possesses a sufficient biological variability, typical for autochthonous breeds, what can be used both in further improvement of dairy traits and increase of production efficiency.

For all studied traits the applied models showed high statistical significance pointing to the fact that factors included in the models explained a significant portion of phenotypical variability of dairy traits (Table 2). The lowest determination of model was confirmed for the milk fat content ($R^2=0.2$) what was expected, taking into account that this trait is under more expressed breed effect which in this analysis could not be separated independently from the effect of other factors. On the other hand, highest determination of about 38% was displayed by the model applied for the analysis of the length of lactation what has been expected, since this trait is much more reflected by the applied farm management than being under the influence of so called biological factors.

Determination of model for milk yield in full lactation and daily milk yield was 0.35 and 0.27, respectively. Determination of model for milk yield in full lactation corresponds to biological characteristics for this trait, that is, it points to the fact that milk yield is the trait inheritable in a sufficient degree to be applied in a direct selection but that, at the same time, it is under a significant influence of the environmental factors (Bogdanović et al.,

2008). However, somewhat lower determination of model for daily milk yield points to the fact that this trait, although it represents a value derived between the milk yield and lactation duration length, includes also a certain “dose of distinction” what certainly must be borne in mind when analysing the course of lactation in goats in detail.

Obtained determination of all models is in harmony with the degrees of freedom allowed by the model and nature of analysed traits. Considerably greater determination of model for yield and composition of goat milk was obtained by Ciappesoni et al. (2004), but it must be taken into account that these authors had by far greater data base and possibility to include different, very complex individual factors, as well as factors interactions into their models.

The farm, year of production and number of lactation were very significant sources of variation ($P<0.001$) for milk yield, daily milk yield and milk fat content, while the year of birth as factor of phenotypic variation in these traits expressed no such consistency. Highly significant sources of variation ($P<0.001$) for the length of lactation were farm and year of production what concurs with the nature of this trait and the effect exerted on it by accepted raising technology, ie., farm management, while the length of lactation had a significant influence ($P<0.001$) only for total milk yield variability.

Table 3. The Least Square Means of analysed production traits according to number of lactation
 Tablica 3. Sredine najmanjih kvadrata za promatrana svojstva u odnosu na broj laktacije

Number of lactation Broj laktacije	n	MY, kg (LSM±Std.Err.)	MF, % (LSM±Std.Err.)	DY, kg (LSM±Std.Err.)	LL, days (LSM±Std.Err.)
I	52	344.62±10.05	3.77±0.03	1.35±0.04	251.75±2.33
II	100	354.87±15.30	3.77±0.04	1.39±0.06	254.73±3.56
III	100	392.24±25.45	3.89±0.07	1.53±0.10	258.87±5.92
IV	74	364.06±14.66	3.75±0.04	1.43±0.06	253.97±3.41
V	58	385.60±23.33	3.58±0.08	1.51±0.09	249.77±5.41
VI+	56	374.60±38.27	3.53±0.11	1.46±0.15	254.11±8.86

MY, kg: total milk yield in lactation/proizvodnja mlijeka u punoj laktaciji; MF, %: milk fat/udjel mliječne masti; DY, kg: daily milk yield/proizvodnja mlijeka po danu; LL, days: length of lactation/dužina laktacije u danima

In general, factors included into applied models are directly connected with accepted raising technology and production management including different husbandry and zootechnical effects, such as nutrition, housing system, care, availability and quality of pastures, seasonal changes in breeding management, etc. Since here there are farms where the conditions for production are mostly "low-input", and somewhere semi-extensive, not only mutually different but significantly influenced by the environmental factors, a high significance was displayed exactly by those factors related to accepted technology of raising and production. The significance of these factors, and the necessity of their being included into the analysis of variability of goats production traits was pointed out by Mavrogenis and Papachristoforou (2000), Ciappesoni et al. (2004), Güney et al. (2006), Carnicella et al. (2008) and Mioč et al. (2008).

The highest milk yield and highest milk fat content were realized by the goats in III lactation (Table 3), representing, for ruminants, a natural trend of increase in dairy production up to a certain age. Up to the third lactation a positive, almost linear trend in increasing milk yield is present, while after that the

milk yield varies from lactation to lactation but stays on higher level in comparison with the I and II lactation. Similar results regarding the influence of either age or lactation in order on dairy production in goats were obtained by Mavrogenis and Papachristoforou (2000), Ciappesoni et al. (2004), Güney et al. (2006), Carnicella et al. (2008) and Mioč et al. (2008).

A regression coefficient of independent variable, that is, the effect of length of lactation was positive, and had a highly significant effect only on total milk yield and not on the milk fat content and daily milk yield (Table 4).

A high statistical significance of the length of lactation on milk yield was confirmed also by Ciappesoni et al. (2004). It should be noted that in preliminary statistical analysis a quadratic regression coefficient of the length of lactation was also calculated showing no statistical significance for milk yield in full lactation. However, taking into account that it bore a negative token it can be concluded that the length of lactation has a positive effect up to a certain period while after that period, as length of lactation increases the milk yield gradually decreases.

Table 4. Linear regression estimates of length of lactation for analysed production traits
 Tablica 4. Koeficijenti linearne regresije dužine laktacije za promatrana svojstva

Trait Svojstvo	n	MY, kg (Estim.±Std.Err.)	MF, % (Estim.±Std.Err.)	DY, kg (Estim.±Std.Err.)
Length of lactation Dužina laktacije	440	1.17±0.21***	-0.0007±0.0006 ^{ns}	-0.001±0.0008 ^{ns}

MY, kg: total milk yield in lactation/proizvodnja mlijeka u punoj laktaciji; MF, %: milk fat/udjel mliječne masti; DY, kg: daily milk yield/proizvodnja mlijeka po danu; ***P<0.001, ns - not significant/nije signifikantno

Conclusion

Phenotypic variability of dairy traits in Balkan goats reared in "low-input" production systems is expressed within biological and expected frames characteristically for autochthonous goat breeds. On the basis of the results of production traits in Balkan goats raised in "low-input" husbandry conditions, it can be concluded that these traits possess enough phenotypical variability in order that selection on them could be successfully conducted. Nature of variability of analysed traits means that this variability is not only under the influence of biological characteristics of breed but also under greater or smaller effect of husbandry and zootechnical conditions on the farm. Taking into account that, so far, this breed has not been subjected to serious selection pressure neither in Serbia nor in wider region of south-east Europe, it would be possible to attain certain breeding goals in a relatively short time if selection was realized according to previously defined breeding programme.

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Značajke proizvodnje mlijeka Balkanske koze uzgajane u "low-input" proizvodnim sustavima

Sažetak

U cilju istraživanja svojstava mliječnosti (proizvodnja mlijeka u punoj laktaciji, PM; udjel mliječne masti, MM; proizvodnja mlijeka po danu, DM; i dužina laktacije u danima, DL) balkanskih koza uzgajanih u "low-input" proizvodnim sustavima analizirano je 440 laktacijskih podataka 118 koza s devet farmi iz jugoistočnog dijela Srbije. U općem linearnom modelu za analizu varijabilnosti dužine laktacije, kao fiksni faktori, bili su uključeni utjecaji farme, godine rođenja, godine proizvodnje i rednog broja laktacije. U analizi proizvodnih svojstava, uz već spomenute fiksne faktore, kao nezavisno promjenjiva veličina bila je uključena i dužina laktacije. Maksimalna proizvodnja mlijeka (392 kg) i najveći udjel mliječne masti (3,89%) ostvaren je u trećoj laktaciji. Farma, godina proizvodnje i redni broj laktacije bili su vrlo značajni izvori varijabilnosti ($P < 0,001$) za proizvodnju mlijeka, dnevnu mliječnost i postotak mliječne masti, dok godina rođenja, kao faktor fenotipskog variranja, kod ovih svojstava nije pokazala takvu konzistentnost. Visoko značajni izvori variranja ($P < 0,001$) za dužinu laktacije bili su farma i godina proizvodnje, dok je dužina laktacije značajno utjecala ($P < 0,001$) samo na varijabilnost proizvodnje mlijeka.

Ključne riječi: koza, svojstva mliječnosti, "low-input" proizvodni sustavi, izvori varijabilnosti

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