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PREDICTION OF TEST DAY MILK YIELD BY AC METHOD IN INDIGENOUS BALKAN GOATS IN MACEDONIA

Nikola Pacinovski[1], Vladimir Dzabirski[2], Georgi Dimov[3], Koco Porcu[2], Elena Eftimova[1], Nedeljka Nikolova[1], Natasha Mateva[1], Bone Palasevski[1], Goce Cilev[4], Milan P. Petrovic[5], Milan M. Petrovic[5], Ana Palasevska[1]

[1] Ss Cyril and Methodius University in Skopje, Institute of Animal Science, Bul. Ilinden, 92A, 1000, Skopje, Macedonia
[2] Ss Cyril and Methodius University, Faculty of Agricultural Sciences and Food, Bul. Aleksandar Makedonski, BB, 1000, Skopje, Macedonia
[3] AgroBioInstitute, 8, Blvd Dragan Tsankov, 1164, Sofia, Bulgaria
[4] St. Kliment Ohridski University, Veterinary Faculty, Prilepska, BB, 7000, Bitola, Macedonia
[5] Institute for Animal Husbandry, Autoput 16, P. Box 23, 11080, Belgrade-Zemun, Serbia
Corresponding author: npacinovski@yahoo.com
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Abstract. Accurate and precise milk recording is one of the most important moments for a successful selection of milking goats. In this context, breeders are constantly making efforts to find the most suitable and cheapest methods for conducting of tests for milk production. The goal of this research was to compare the A4 method (as referent method) with AC method (as alternative method), for determination of milk production, on the day of recording of the indigenous Balkan goat, in the period of 2014-2016 with milking of goats in the morning and evening. It was determined that the difference between the predicted daily milk yield with one milking (in the morning or evening) and the measured milk yield using the A4 method is too low and almost negligible. With the analysis of all factors (year, lactation and number of milk tests), it was determined that the prediction of total daily milk yield, based on the evening milking, provides more accurate result, in relation to the prediction during morning milking, in cases when using the AC method.

Key words: Balkan goat, daily lactation, method A4, method AC, predicted lactation

Introduction

Goat breeding in Republic of Macedonia, for the last two decades (2000-2017), although with small oscillations, is stable, especially if we take into consideration the number of goats (70.000-80.000 goats). This is due to the interest of dairies for purchase of goat milk for processing as well as the interest of certain slaughter houses for purchase of lambs, as raw material for the production of goat meat. This purchase, although difficult, still maintains the branch in some way on a relatively stable basis.

In the past period there have also been certain attempts by the state for genetic improvement of the goat population (reproduction), with the import of more productive goat breeds from abroad (import of French Alpine in 1999). According to the data of the Food and Veterinary Agency, the Department for identification and registering of domestic animals, there are 6 genotypes of goats in R. Macedonia: Domestic Balkan goat, Alpine, Saanen, Alpine crossbreed, crossbreeds with Saanen goat and population registered under the term of Other.
According to this agency, the most represented goat breed in the country is Domestic Balkan goat, with a number of around 38.378 goats, goats registered as *Other* with a number of 21.772 goats, the number of crossbreeds with Alpine is 6330, Saanen with 6256 goats, Alpine is represented with 4193 and crossbreeds with Saanen is represented with 2735 goats *(Pacinovski et al., 2012).*
Balkan goat is well adopted to the existing climate conditions in the country as well as to the existing nutritional resources especially in the hilly-mountainous areas of Republic of Macedonia, which are not suitable for other domestic animals.
It is the shrubbery vegetation which is especially attractive to goats. The excellent adaptability of the breed is due to the excellent health condition of goats manifested during the whole year. Compared to the other breeds (Alpine, Saanen and crossbreeds between the same with other breeds), Balkan goat is extremely resistant to many diseases (chronic, bacterial etc.) They are especially resistant to emergent climate changes that affect the goat health.

As an indigenous goat breed, Domestic Balkan goat has been protected in order to preserve the breed, having in mind the growing pressure for its crossbreeding with more productive breeds such as Alpine and Saanen breeds of goats. This is the reason why some of the Balkan goats are tested in milk production, hence it is logical to search for the most accurate and cheapest methods.

The aim of the study was to determine the accuracy of prediction of the actual daily milk yield in the Balkan goats, measured twice a day (method A4), in the morning and evening and predicted based on only one milking on the day of testing (method AC).

Such test are being conducted mostly in sheep, almost never in goat. Therefore the comparison of results was performed with data and analysis of milk tests conducted in sheep.

For example, the results obtained in Bulgaria, show that the total amount of milking milk is slightly decreasing with AC method for 120 days *(Ivanova, 2013).* Also some results from limited number of Awassi sheep in Macedonia show that the correlation between the two methods is high, with maximal variations in prediction from 1.9 to 3.4 L *(Gievski et al., 2006).*

Material and methods

We used a flock of Balkan goats as basic experimental material located on south-east Macedonia. The number of goats included in these tests was around 242 goats per year, in the period of three years (2014-2016). A total number of 726 goats (lactations) were monitored for three years of testing. According to the age range, goats were from first to ninth lactation (Table 1).

Table 1. Age range of tested goats per year

Year	Number of lactation									Total
	I	II	III	IV	V	VI	VII	VIII	IX	
2014	84	53	70	26	4	3	2	0	0	242
2015	0	84	53	70	26	4	3	2	0	242
2016	0	0	84	53	70	26	4	3	2	242
Total	84	137	207	149	100	33	9	5	2	726

During the first three years of production, total number of 4598 individual lactation tests were conducted or according to the age: 588 tests in the first, 882 tests in second, 1318 in third, 919 in fourth, 598 in fifth, 195 in sixth, 56 in seventh, 30 in eighth and 12 in ninth lactation (Table 2).

Table 2. Individual lactation tests in goats

Year	Number of lactation									Total
	I	II	III	IV	V	VI	VII	VIII	IX	
2014-2016	588	882	1318	919	598	195	56	30	12	4598

Mainly combined (barn-pasture) system of breeding is used on the farm, which is using of available vegetation during almost the entire year, whereas in a certain period of the year, especially in winter, goats are fed additionally with meadow hay (November - February) and concentrate (January - April). Kids stay with their mothers depending on the purpose. Kids intended for slaughter stay with their mothers until they are sold for meat (2-2.5 months old), whereas those intended for reproduction, stay little longer, or up to 3 months.

The production of milk in goats was monitored according to the standard A4 method *(ICAR, 2009, ICAR, 2012)*, which means measuring of daily production of milk per goat, in the interval of 28 to 34 days.
The recording of milk commenced after the weaning of kids (60 days) and lasted until the moment of drying in milk (end of October or mid-November). The total number of conducted milk recordings of milk was 7 tests in 2014, 6 tests in 2015 and 6 tests in 2016.

The data used were monthly test day yields of the goats in three consecutive years, 2014, 2015 and 2016. The actual yield per day is the sum of the morning and evening milk yield of each goat. The predicted milk yield per day is based either on the morning measurement or evening measurement. These measurements were weighted by the relative total amount of the milk in the flock, for the corresponding milking: morning or evening to the total milk yield for the day of test in the separate year-test days:
Predicted daily yield on morning milking = morning milk yield * K1,
Where K1 is the ratio of total daily milk yield for the flock to total milk yield in the morning.
Predicted daily yield on evening milking = evening milk yield * K2,
Where K2 is the ratio of total daily milk yield for the flock to total milk yield in the evening.
For the available in the study 20 year-test day yields these coefficients are presented in the Table 3:

Table 3. Total flock milk yield for the day of test and appropriate coefficients for prediction of test day yield based on the morning (K1) and evening (K2) milking

Year / month	Morning, litres	Evening, litres	Total, litres	K1	K2
2014/1 Total	140.00	164.00	304.00	2.17	1.85
2014/2 Total	139.80	148.25	288.05	2.06	1.94
2014/3 Total	99.00	126.55	225.55	2.28	1.78
2014/4 Total	79.85	103.55	183.40	2.30	1.77
2014/5 Total	61.4	81.5	142.9	2.33	1.75
2014/6 Total	47	64.05	111.05	2.36	1.73
2014/7 Total	35.15	47.5	82.65	2.35	1.74
2015/1 Total	162.77	181.81	344.58	2.12	1.90
2015/2 Total	140.25	164.45	304.7	2.17	1.85
2015/3 Total	113.65	137.85	251.5	2.21	1.82
2015/4 Total	79	90.15	169.15	2.14	1.88
2015/5 Total	59.05	64.77	123.82	2.10	1.91
2015/6 Total	43.65	44.71	88.36	2.02	1.98
2016/1 Total	152.53	200.93	353.46	2.32	1.76
2016/2 Total	100.89	128.05	228.94	2.27	1.79
2016/3 Total	92.67	124.13	216.8	2.34	1.75
2016/4 Total	64.72	85.41	150.13	2.32	1.76
2016/5 Total	41.61	59.45	101.06	2.43	1.70
2016/6 Total	32.35	41.05	73.4	2.27	1.79

Actual yield, predicted yield and differences between the predicted and actual milk yield were analyzed for the effects of year, lactation and day of test effects by a fixed LS-model.
Regarding the statistic analyses, the characteristics of daily milk production (morning, evening and total amount of milk) were analyzed using the following model:

$$Y_{jklm} = \mu + Y_j + L_k + TD_l + e_{jklm}$$

where:
Y - is an individual observation of each trait during a test (daily) test (morning, evening and total amount of milk) of the m-th individual-test day measurement;
μ - is general mutual average for tested characteristics;
Y_j - effect of j-th year with (j=2014, 2015 and 2016);
L_k - effect of k-th lactation with (k=1,2,3,4,5,6,7,8,9);
TD_l - effect of l-th test day with (l=1,2,3,4,5,6,7);
e_{jklm} - residual influence

The influence of certain effects (year, lactation and number of test) was studied using the F-test, whereas the analyses were performed using the package programs SPSS *(SPSS, 1994).*

Results and Discussion

In order to minimize the error of predicting of daily milk yield, the influence on variations of certain factors was analyzed in predicting the morning and evening milking (Table 4).

Table 4. Influence of the certain factors on the measured and predicted daily milk yield

Factor	df	Morning	Evening	Total	Expected (morning)	Expected (evening)	Difference (morning)	Difference (evening)
Year	2	46.33***	18.24***	29.30***	23.23***	33.24***	0.78	0.71
Lactation	8	7.31***	9.12***	8.50***	7.43***	9.10***	2.50*	2.47*
Number of test	6	427.76***	535.29***	500.21***	406.28***	558.17***	0.00	0.00
R^2, %		37.3	41.9	40.5	35.7	43.2	0.4	0.4

During the analyses, it was determined that all three analyzed factors (year, lactation and number of milk test), had highly significant influence (P<0.001) on morning, evening and total amount of milk. The same factors also had highly significant influence (P<0.001) on the expected total amount milk, using morning and evening milk.

The lactation had significant influence (P<0.05) on the difference in the morning and evening milking, whereas the year and number of milk test had no significant influence (P>0.05), on this two traits.

The coefficient of determination, R^2, showed that the complex of the studied factors determine or explain from 35.7% to 41.9% of the variation of the measured milk yield, and of 0.4% of variation of the difference between the predicted and total TD milk yield.

Significant influence of the year on the determined and expected daily milk yield (using A4 and AC methods) has been determined in East-Frisian breed of sheep in Macedonia, but not on the differences determined between them *(Pacinovski et al., 2015)*.

During the analyses of the data for the three years of testing (2014-2016), it was determined that the average milk yield during morning, evening and total milk yield was 0.314, 0.391 and 0.705 liters, consequently (Table 5).

Table 5. Average milk yield L/day

Trait	Mean (L)	±SE
Morning	0.314	0.010
Evening	0.391	0.010
Total	0.705	0.019
Predicted morning	0.698	0.021
Predicted evening	0.710	0.018
Difference-morning	-0.007	0.005
Difference-evening	0.005	0.004

The average milk yield expected during morning milking is 0.698 liters, which is a difference or underestimation of – 0.007 liters. The same milk yield determined using the production of milk obtained during evening milking is 0.710 liters, which is overestimation for 0.005 liters.

The standard error ranges from 0.004 for the difference in total amount of milk determined by evening milking, to 0.021 for predicted total amount of milk by morning milking.

While predicting the daily milk yield of East-Frisian breed of sheep using milk obtained at morning, using the AC method, an underestimation of 0.3% of daily milk yield has been reached as well as overestimation of 0.3% using milk obtained at evening.

The influence of each year on the analyzed characteristics of daily milk production separately is presented in Table 6.

Table 6. Effect of the year on the measured and predicted milk yield, L

Year	N	Morning	Evening	Total	Predicted - morning	Predicted-evening	Difference-morning	Difference-evening
2014	1694	0.338	0.421	0.760	0.750	0.768	-0.0103	0.0076
2015	1452	0.342	0.392	0.735	0.730	0.738	-0.0047	0.0034
2016	1452	0.260	0.358	0.618	0.611	0.622	-0.0061	0.0047
SE		0.011	0.011	0.022	0.025	0.020	0.005	0.004

According to the same table, the predicted morning, evening and total amount of milk during 2014 was 0.34 liters, 0.42 liters and 0.76 liters, consequently. These values, in 2015 and 2016 were 0.26 liters, 0.36 liters and 0.62 liters, consequently. The prediction of total production of milk per day using milk yield obtained during morning and evening milking was 0.75 or 0.77 liters, which was underestimation for -0.0103 liters during morning milking, or overestimation for 0.0076 liters during evening milking.

The standard error ranged from 0.004 for the difference in total amount of milk determined by evening milking, to 0.025 for predicted total amount of milk by morning milking.

The influence of age i.e. lactation on tested characteristics of daily production of milk are presented in Table 7 separately.

Table 7. Effect of the lactation on the measured and predicted milk yield, L

Lactation	N	Morning	Evening	Total	Predicted-morning	Predicted-evening	Difference-morning	Difference-evening
1	588	0.30	0.35	0.65	0.66	0.64	0.01	-0.01
2	882	0.35	0.43	0.79	0.79	0.79	0.00	0.00
3	1318	0.35	0.43	0.78	0.79	0.78	0.00	0.00
4	919	0.34	0.42	0.76	0.75	0.77	-0.01	0.01
5	598	0.37	0.46	0.83	0.83	0.83	0.00	0.00
6	195	0.37	0.44	0.81	0.82	0.80	0.01	-0.01
7	56	0.23	0.32	0.55	0.52	0.57	-0.03	0.02
8	30	0.25	0.32	0.56	0.54	0.58	-0.02	0.02
9	12	0.27	0.35	0.61	0.59	0.63	-0.03	0.02
SE		0.006-0.06	0.006-0.06	0.01-0.13	0.01-0.14	0.01-0.12	0.003-0.03	0.002-0.02

The highest value of total milk production per day was determined in goats in fifth lactation (0.83 liters), whereas the lowest value was determined in goats in seventh lactation (0.55 liters). During morning milking, the highest value of total milk production per day was determined in goats in fifth and sixth lactation (0.37 liters), whereas the lowest value in goats in seventh (0.23 liters). During evening milking, the condition is almost the same i.e. the highest value of milk production was determined in goats in fifth lactation and the lowest value was determined in goats in seventh and eighth lactation. It is interesting to be mentioned that after the

seventh lactation, an increase of total milk production per day was determined in goats in eighth and ninth lactation, which generally is a fact that goats of this breed have longer period of milk production. However we consider this small increase as a result of the selection carried out, than due to biological features.

The results obtained during the prediction of total milk yield per day in the morning or evening were almost identical. More precisely, the most accurate prediction of total milk production per day in the morning and evening was obtained in goats in second, third and fifth lactation. In goats at other ages, there was deviation performed during the prediction. For example, during the prediction of total milk production per day in the morning, the biggest deviation was performed in goats in seventh lactation (underestimation for -0.03 liters), whereas during the prediction of total milk production per day in the evening, the biggest deviation was performed in goats in seventh, eighth and ninth lactation (overestimation for 0.02 liters).

Although in sheep, similar results about the influence of lactation on daily milk production were obtained in Awassi and East-Friesian sheep in Macedonia *Dimov et al. (2005) and Djabirski et al. (2006).*

The influence of the milk test on analyzed characteristics of daily production of milk is presented in Table 8, separately.

Table 8. Effect of the test day on the measured and predicted milk yield, L

Test day	N	Morning	Evening	Total	Predicted-morning	Predicted-evening	Difference-morning	Difference-evening
1	726	0.60	0.72	1.32	1.31	1.32	-0.0071	0.0053
2	726	0.49	0.58	1.07	1.06	1.08	-0.0071	0.0053
3	726	0.39	0.50	0.89	0.89	0.90	-0.0071	0.0053
4	726	0.28	0.35	0.63	0.62	0.64	-0.0071	0.0053
5	726	0.19	0.25	0.45	0.44	0.45	-0.0071	0.0053
6	726	0.14	0.18	0.31	0.31	0.32	-0.0071	0.0053
7	242	0.10	0.15	0.26	0.25	0.26	-0.0071	0.0053
SE		0.01	0.01	0.02-0.04	0.03-0.04	0.02-0.03	0.006-0.008	0.005-0.007

The highest value of milk yield during morning, evening and total milk production was determined during the first milk test (0.60 liters, 0.72 and 1.32 liters consequently), whereas the lowest value was determined during the last test (0.10, 0.15 and 0.26 liters consequently). The general conclusion is that, the production of milk decreases continuously from the first to the last milk test and during morning and evening milking, which, on the other hand shows the necessity of paying special attention to the beginning of the lactation in order to obtain greater amount of milk (commercial) thus bigger financial effect.

During the prediction of total milk production in all milk tests, almost identical results were obtained during morning i.e. evening milking. More precisely, during the prediction of total milk production per day in the morning, in all seven milk

test, there is an underestimation for 0.007, whereas during the prediction of total milk production in the evening, there was an overestimation for 0.0053 liters in all milk tests.

Conclusions

Based on the conducted tests, the following can be concluded:

- Evening milking predicted TD milk yield slightly more accurate, but for the breeding purposes both measurements are reliable enough in the breeding programs,
- The difference of predicted and measured TD milk yield is less than 10 ml for different lactations and test days,
- Such results indicate the fact that the quite cheap AC method as well as the referent A4 method can be used, with significant precision of prediction.

Predviđanje prinosa mleka domaćih balkanskih koza u Makedoniji korišćenjem dnevne test AC metode

Nikola Pacinovski, Vladimir Dzabirski, Georgi Dimov, Koco Porcu, Elena Eftimova, Nedeljka Nikolova, Natasa Mateva, Bone Palasevski, Goce Cilev, Milan P. Petrovic, Milan M. Petrovic, Ana Palasevska

Rezime

Precizna i tačna kontrola mlečnosti je jedan od najvažnijih trenutaka za uspešan izbor koza za mužu. U ovom kontekstu, uzgajivači konstantno pokušavaju da pronađu najprikladnije i najjeftinije metode za sprovođenje testova za proizvodnju mlijeka. Cilj ovog istraživanja bio je upoređivanje metoda A4 (kao referentnog metoda) metode i AC (kao alternativnom metodom), za određivanje proizvodnje mleka, na dan evidentiranja, kod autohtone balkanske koze, u periodu 2014-2016. godine, sa mužom koza koja se izvodila ujutru i veče. Utvrđeno je da je razlika između predviđenog dnevnog prinosa mlijeka sa jednom mužom (ujutro ili uveče) i izmerenim prinosom mlijeka metodom A4 bila mala i skoro zanemarljiva. Analizom svih faktora (godina, laktacija i broj ispitivanja testova) utvrđeno je da predviđanje ukupnog dnevnog prinosa mlijeka, zasnovano na večernjoj muži, daje tačniji rezultat, u odnosu na predviđanje tokom jutarnje muže, u slučajevima kada se koristi AC metod.

Ključne reči: balkanska koza, dnevna laktacija, metod A4, metod AC, predviđena laktacija

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