



**ВЛИЯНИЕ НА СТАДИЯ НА ЛАКТАЦИЯТА ВЪРХУ ФИЗИЧНИТЕ ПАРАМЕТРИ НА МЛЯКОТО ПРИ КРЪСТОСКИ  
НА МЛЕЧНАТА ПОРОДА ОВЦЕ ШАРИ  
THE EFFECT OF STAGE OF LACTATION ON PHYSICAL PARAMETERS OF CROSS BREED SHARRI SHEEP MILK**

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**Резюме\*\***

Млякото е комплексна колоидна система, като качеството му зависи освен от химичния състав и от физичните параметри. Тези параметри се влияят от различни фактори, сред които стадият на лактацията има важна роля. Проведено е изследване за определяне на влиянието на стадия на лактацията върху титруемата киселинност, плътността и точката на замръзване на млякото от кръстоски на породата овце Шари. Анализирани са индивидуални млечни проби от 25 овце, през интервал от един месец, в периода март-август 2007 г. Данните са обработени статистически с помощта на статистическата програма JMP-IN 5.1.2. Резултатите от изследването показват линейно нарастване на титруемата киселинност от началото към края на лактацията, когато киселинността достига максимална стойност (12.34 °SH), но разликите между месеците не са достоверни (P=0.1256). Стадият на лактацията е имал по-голям ефект (P<0.05) върху стойностите на рН, плътността и точката на замръзване. Плътността на млякото и точката на замръзване са били най-високи в края на лактацията. Резултатите от изследването потвърждават, че стадият на лактацията има голямо влияние върху анализираниите физични параметри на млякото от кръстоски на породата Шари.

**Abstract**

Milk is a complex colloidal system, the quality of which besides the chemical constituents depends on its physical parameters. These quality parameters are influenced by various factors, among which, the stage of lactation has an important role. A study was carried out to determine the effect of stage of lactation on titratable and active acidity, density and freezing point of cross bred Sharri sheep milk. Individual milk samples collected from 25 sheep at monthly intervals during March-August 2007 were taken and analyzed. Results were statistically analyzed using JMP-IN 5.1.2 statistical package. The results showed a linear increase of titratable acidity during stage of lactation, reaching the highest value (12.34 °SH) at its end, but differences between months were not statistically significant (P=0.1256). However, the stage of lactation had higher effects (P<0.05) on pH, density and freezing point value. From these results, most pronounced values of density and freezing point are observed in last month of lactation. In conclusion, results of this study confirm that the stage of lactation has high influence on all analyzed physical parameters of cross bred Sharri sheep milk.

**Ключови думи:** овче мляко, лактационен стадий.

**Key words:** Sheep milk, stage of lactation.

**INTRODUCTION**

Milk is a highly variable biological fluid. Beside the differences between species, the milk of any particular specie varies depending on the individuality of the animal, breed, health, nutrition, stage of lactation, age, interval between milking, etc. (Fox and Mcsweeney, 1992; Bencini and Pulina, 1997; Pavić et al., 2002).

Lactation in sheep lasts differently and depends on breed, individuality and way of animal exploitation. In most cases it lasts about 150 days, but there are sheep that can be milked up to 290 days. During this period, sheep can produce about 40–60 kg milk (Degen, 2007). In extensive conditions sheeps produce around 100 litres (without counting the amount of milk during lambing),

whereas in intensive conditions around 350 and more litres of milk (Antunac and Lukac-Havranek, 1999). Some breeds can give up to 1000 liters (Pokatilova, 1985) or even more (Haenlein, 2007). Yilmaz et al. (2004) concluded that yield of sheep milk can be improve by effective breeding programs.

Among other factors, the quality of milk and its products is highly influenced by its physical properties (Chandan and Kilara, 2011), therefore, proper determination and good knowledge of these properties, enable the technologist to rationally organize and regulate the process of processing (Vujičić, 1985). Physical parameters of sheep milk varies during the stage of lactation like chemical parameters do. By physical parameters, the density of milk ( $D_{20/4}$ ) varies from less than 1.032 (early lactation) until 1.040 (end of lactation), with an average value of 1.035 (Vujičić, 1985). Sheep milk has a lower pH and titration acidity in the early stage of lactation compared to its end. Krajinović and Savić (1992) noted that the titration acidity of sheep milk in the first half of the stage of lactation ranges from 8 to 9.6 °SH, while the second part of 9.6 to 12 °SH, reaching the maximum value of about 14.4 °SH. Petričić (1984) states that the acidity reaction in fresh milk is made from proteins (mainly casein, into smaller amounts of albumins and globulins), salts (monophosphates and citrates), alkalic carbonates,  $\text{CO}_2$ , etc., while the phosphates and carbonates gives the alcaly character to the milk. High acidity titration appear at the end of stage of lactation due to the greater presence of casein. According to Vujičić (1985) the freezing point of sheep milk is lower than cow's and goat's milk and mostly ranges from -0.59 to -0.66 °C. Freezing point of milk, although depends on the concentration of dissolved substances, is the most stable constant, but very sensitive, even to very small amounts of added water, on the basis of which can be controlled regularity of milk in terms of falsification with water (Tratnik, 1998; Golc-Teger, 1985; Carič et al., 2000; Crombrugge, 2003), therefore most of countries use the freezing point as one of the quality parameters on the milk payment scheme. A study was carried out to determine the effect of stage of lactation on titratable and active acidity, density and freezing point of cross bred Sharri sheep milk.

## MATERIALS AND METHODS

In the Sharri area, on a commercial farm, 25 cross breed Sharri sheep were selected. From each sheep, the milk samples were obtained in March, April, May, June, July and August in the amount of 300-500 ml. The total of 150 milk samples were analyzed in these physical parameters: density (specific weight), with lactodensimeter (Ndoja and Ramadani, 1996); titration acidity (°SH) in accordance of the modified method of Soxhlet-Henkel by Morres (Bajt et al., 1998); active acidity (pH) with pH-meter GLP 21-, „Crison” (Ndoja and Ramadani, 1996) and the

freezing point by "Lactostar" - Funke Gerber apparatus, according to the combined thermo-optic method (Ndoja and Ramadani, 1996). Statistical processing of the milk physical parameter values were performed by JMP-IN 5.1.2 statistical package and has included determining of the average value, minimum and maximum values, standard deviation and coefficient of variation.

## RESULTS AND DISCUSSION

### The titration acidity movement

Titration acidity in the 150 analyzed samples of the Cross bred Sharri sheep milk throughout the whole stage of lactation showed a positive development. In the March, milk had the lowest value (10.86 °SH) and its maximum had reached in the August (12.34 °SH), but differences between months were not statistically significant ( $P=0.1256$ ). (Table 1.).

According to the literature data for this parameter during the stage of lactation, Manfredini et al. (1993) found that sheep milk had higher titration acidity values at the beginning (8.78 °SH) compared with the end of stage of lactation (5.97 °SH). Pavić et al. (2002) in 202 sheep milk samples have found the average value of titration acidity (9.29 °SH) and the significant effect ( $P \leq 0.01$ ) of the stage of lactation in this parameter, who in the beginning (10.01 °SH) and midpoint (9.30 °SH) has been higher, compared to it's end (8.39 °SH).

Our research results for the average value of titration acidity are considered a little bit higher than those reported in the literature and this can be explained as a result of bad hygienic conditions during milking and milk handling. The movement of this parameter during stage of lactation is in opposite direction to the dynamics reported by the above mentioned authors.

### The active acidity movement

Our research results for the pH parameter performance and its movement in 150 samples of Cross breed Sharri sheep milk are presented in Table 2.

Examined milk during stage of lactation from March to August showed characteristic variations. The pH showed slight variation, but always have been within normal values. In March have had the highest value (6.83). In two following months its value had decreased and then again increased up to July (6.80), whereas in the August slightly decreased in 6.76. However, the lactation month have had statistically significant effect ( $P<0.05$ ) for this parameter.

The influence of stage of lactation in the pH value of Awassi sheep has been studied by Nuray et al. (2005). Morning milk from 150 sheep showed the main values of pH 6.72. The statistical processed results showed significant effect of stage of lactation on the pH value ( $P < 0.05$ ). Antunac et al. (2007) during 2004 and 2005, at 100 East-Friesian sheep, had found significant effect ( $P<0.001$ ) of the stage of lactation in the pH value, the lower value of



**Таблица 1.** Титруема киселинност на млякото на кръстоски на породата овце Шари по време на лактационния период  
**Table 1.** The titration acidity value of the cross breed Sharri sheep milk during the stage of lactation

	Stage of lactation / Стадий на лактация					
	March	April	May	June	July	August
Average / Средно (n=150)	10.86 <sup>ab</sup>	11.17 <sup>ab</sup>	11.33 <sup>a</sup>	11.59 <sup>a</sup>	11.70 <sup>b</sup>	12.34 <sup>ab</sup>
Min (%)	7.80	9.00	8.00	7.20	9.00	9.60
Max (%)	14.80	13.80	14.20	15.60	14.20	15.60
StDev	1.45	1.14	1.53	1.79	1.58	1.70
CV (%)	13.35	10.23	13.51	15.44	13.53	13.80

Levels not connected by same letter in superscript are significantly different (P<0.05)

Нивата, които не са свързани с една и съща буква, се различават достоверно (P<0.05)

**Таблица 2.** рН на млякото на кръстоски на породата овце Шари по време на лактационния период  
**Table 2.** The pH value of the cross breed Sharri sheep milk during the stage of lactation

	Stage of lactation / Стадий на лактация					
	March	April	May	June	July	August
Average / Средно (n=150)	6.83 <sup>a</sup>	6.79 <sup>a</sup>	6.56 <sup>c</sup>	6.71 <sup>b</sup>	6.80 <sup>a</sup>	6.76 <sup>ab</sup>
Min (%)	6.54	6.59	6.41	6.52	6.35	6.45
Max (%)	7.14	7.00	6.78	7.13	7.20	7.10
StDev	0.12	0.08	0.08	0.15	0.20	0.18
CV (%)	1.70	1.23	1.17	2.31	2.91	2.59

Levels not connected by same letter in superscript are significantly different (P<0.05)

Нивата, които не са свързани с една и съща буква, се различават достоверно (P<0.05)

which (6.59) was recorded at the end. The opposite development reports Pavić et al. (2002), who on 202 samples of sheep milk has gained pH average in the value of 6.78, which in midpoint (6.81) and at the end (6.89) was significant higher (P<0.01) compared with the beginning (6.66) of the stage of lactation. The similar conclusions gave Manfredini et al. (1993), who in his research on sheep milk gained lower values of pH in the early stage of lactation compared with the end (6.57; 7.01). Antunac et al. (2004) in 680 milk samples of sheep from Pag, investigated the effect of the farms and stage of lactation on composition and properties of milk and have found the pH value on average of 6.59. Also, Mehaia, (1994) has analyzed milk samples obtained from 3 different breeds of sheep (Najdi, Australian and Najdi x Australian) in the central region of Saudi Arabia gaining average results and  $\pm$ SD of the pH value: 6.63 $\pm$ 0.1%; 6.64 $\pm$ 0.02%, and 6.63 $\pm$ 0.02%, for the analyzed breeds.

Our research results for the average of pH value of the cross breed Sharri sheep milk are substantially consistent with those reported in the literature for this parameter. However, related to the movement of this parameter during the stage of lactation, the changes are

observed in comparison with the results provided in their work of the above mentioned authors.

#### The specific weight movement

On the table 3 is presented the value of specific weight of 150 milk samples of cross breed Sharri sheep. This parameter has had a small variation during the stage of lactation. The highest value showed in the March (1.039). In next four months, this parameter was slightly lower, but always within the limits of normal values (1.038 and 1.035), to be raised again in the August in value of 1.039. The higher value of this parameter is associated due to high content of solids non fat in the analyzed samples. Results of this research have shown that the stage of lactation had the highest effect (P<0.05) in specific weight. According to these results, it is clear that significant values of this parameter were observed in the last month of the stage of lactation.

The effect of the stage of lactation in value of specific weight has been studied by Nuray et al. (2005). They studied the chemical and mineral composition of 150 Awassi sheep milk and the statistical processing results showed an average of 1.0334 $\pm$ 0001 g/cm<sup>3</sup> and significant effect of stage of lactation on the value of this parameter (P<0.05).

**Таблица 3.** Плътност на млякото при кръстоски на породата овце Шари по време на лактационния период  
**Table 3.** The specific weight value of the cross breed Sharri sheep milk during the stage of lactation

	Stage of lactation / Стадий на лактация					
	March	April	May	June	July	August
Average / Средно (n=150)	1.039 <sup>a</sup>	1.038 <sup>b</sup>	1.038 <sup>ab</sup>	1.035 <sup>c</sup>	1.035 <sup>c</sup>	1.039 <sup>d</sup>
Min (%)	1.035	1.036	1.037	1.031	1.030	1.036
Max (%)	1.046	1.039	1.042	1.038	1.038	1.040
StDev	0.00	0.00	0.00	0.00	0.00	0.00
CV (%)	0.24	0.10	0.12	0.17	0.19	0.11

Levels not connected by same letter in superscript are significantly different ( $P < 0.05$ )  
 Нивата, които не са свързани с една и съща буква, се различават достоверно ( $P < 0.05$ )

**Таблица 4.** Точка на замръзване на кръстоски на породата овце Шари по време на лактационния период  
**Table 4.** The freezing point value of the cross breed Sharri sheep milk during the stage of lactation

	Stage of lactation / Стадий на лактация					
	March	April	May	June	July	August
Average / Средно (n=150)	-0.663 <sup>a</sup>	-0.659 <sup>a</sup>	-0.670 <sup>a</sup>	-0.711 <sup>b</sup>	-0.742 <sup>b</sup>	-0.810 <sup>c</sup>
Min (%)	-0.699	-0.723	-0.714	-0.789	-0.822	-1.005
Max (%)	-0.620	-0.628	-0.620	-0.629	-0.692	-0.690
StDev	0.021	0.021	0.022	0.036	0.036	0.082
CV (%)	-3.16	-3.24	-3.24	-5.01	-4.87	-10.12

Levels not connected by same letter in superscript are significantly different ( $P < 0.05$ )  
 Нивата, които не са свързани с една и съща буква, се различават достоверно ( $P < 0.05$ )

The results of our research for specific weight have been slightly higher compared to results gained from Nuray et al. (2011). The movement of specific weight during the stage of lactation is not compatible by the dynamic of movement of this parameter reported in their paper the above mentioned authors.

#### The freezing point movement

The data presented in table 4 shows the linear movement of the freezing point. Results of this research have shown that the stage of lactation had the highest effect ( $P < 0.05$ ) in this parameter. Significant values of freezing point were observed in the last month of lactation. The highest value were in the first three months of lactation ( $-0.663^{\circ}\text{C}$ ,  $-0.659^{\circ}\text{C}$  and  $-0.670^{\circ}\text{C}$ ), while on the following months were decreased ( $-0.711^{\circ}\text{C}$  and  $-0.742^{\circ}\text{C}$ ). In August, freezing point has reached the lowest value ( $-0.810^{\circ}\text{C}$ ).

Data from the literature shows that many authors have analyzed quality of milk and its freezing point during the stage of lactation. Pavić et al. (2002) in 202 individual samples of sheep from Travnik has investigated chemical and physical composition of milk in different stages of lactation (early, midpoint, late). The average value of this parameter has been  $-0.566^{\circ}\text{C}$ . In midpoint ( $-0.566^{\circ}\text{C}$ ) and early lactation ( $-0.564^{\circ}\text{C}$ ) value of the freezing point has

been higher compared to the late stage of lactation ( $-0.570^{\circ}\text{C}$ ). Antunac et al. (2007) have studied the effect of farms, stage of lactation and the number of lactation in quantity and composition of 100 East Friesian sheep milk. They have found the significant effect of stage of lactation on the value of the freezing point, the lowest value ( $0.5734 \pm 0.001^{\circ}\text{C}$ ) was recorded at the end. Petrova and Nedelchev (2000) from February to August, 1999, studied the production and milk composition of 41 dairy sheep of East-Friesian x ¼ East-Friesian x Awassi breeds), determining the average of freezing point in value of  $-0.578^{\circ}\text{C}$ . These authors observed no changes in this parameter during the stage of lactation.

Results of this study for the freezing point shows the lowest average value in comparison with the results of various authors reported in the literature. The low value of freezing point in our study is as a result of very high content of milk lactose and total solids in general. The movement of this parameter is in accordance with results reported by Pavić et al. (2002).

#### CONCLUSIONS

1. Results of this study showed an linear increase of titration acidity during the stage of lactation, reaching



the highest value (12.34°SH) at the end of the stage of lactation, but differences between months were not statistically significant ( $P=0.1256$ ).

2. However, the stage of lactation had the highest effect ( $P<0.05$ ) in the pH value, specific weight and freezing point. From these results, it is clear that significant values of specific weight and freezing point are observed in the last month of the stage of lactation.
3. From this study, it can be concluded that the stage of lactation had great effect on all milk physical parameters of cross breed Sharri sheep milk.

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