

# THE EFFECT OF THE LACTATION STAGE ON MILK YIELD, COMPOSITION AND RENNETING PARAMETERS OF MILK IN SHEEP REARED UNDER INTENSIVE NUTRITION

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## Abstract

The aim of our experiment was to assess changes in milk yield, composition and renneting parameters (pH, titratable acidity, coagulation time and curd quality) of sheep milk in the course of lactation and their relationships in the Lacaune ewes (n = 8), reared under intensive nutrition. The stage of lactation (SL) had a conclusive effect on the daily milk yield (DMY) and contents of all basic milk compounds. The DMY and fat content were relatively high during whole lactation. In our opinion these trends were influenced by the quite intensive nutrition. The SL had inconclusive effect on pH. In contrast, the SL had a conclusive effect on titratable acidity (TA) of milk. The correlations between the pH and all other indicators, with the exception of the coagulation time (CT), were inconclusive. Also most correlations between the TA and all other indicators monitored were inconclusive. The SL had inconclusive effect on the CT and curd quality (CQ). In our opinion, relatively balanced values of the CT and CQ during lactation indicate on the good health state and correct nutrition of ewes.

Keywords: stage of lactation, sheep milk, milk composition, coagulation time, curd quality, Lacaune breed

## INTRODUCTION

In the last decade, the numbers of milk sheep farms and reared sheep there have increased relatively considerably in the Czech Republic. This fact is a reflection of the growing interest of domestic consumers in sheep dairy products while the highest demand is for sheep cheese. Domestic milk sheep farms are mostly organic and the nutrition of sheep is relatively extensive (Kuchtík *et al.* 2017). Currently, Lacaune breed (L) is the most widespread milk sheep in the Czech Republic. This breed is also often crossed with the East Friesian sheep or the Improved Wallachian sheep with the purpose to increase milk yield and content of protein in milk.

Milk yield (MY) and composition of sheep milk can be affected by a lot of factors such as nutrition, stage of lactation, breed and health (Sevi *et al.*, 2004; Pulina *et al.*, 2005). Milk coagulation properties and curd quality (CQ) of sheep milk are also influenced by a lot of factors, while the most important ones are the contents of protein and casein, calcium concentration, pH, titratable acidity and also somatic cell count (Pellegrini *et al.*, 1997; Jaramillo *et al.*, 2008).

As mentioned above, the nutrition of milk sheep on Czech farms is relatively extensive and pasture is very often the main component of their feed ration while the supplement of concentrate or grain mixtures is usually very low. Also different kinds of silage in the nutrition of dairy sheep are used very sporadically. The majority of domestic studies focusing on MY, composition and renneting parameters of sheep milk were carried out in sheep when applying the extensive nutrition. Due to this fact, the aim of our experiment was to assess changes in MY, composition and renneting parameters of milk in the course of lactation in the Lacaune ewes ( $n = 8$ ) reared under the intensive nutrition.

## MATERIAL AND METHODS

The experiment was carried out on sheep farm in Horní Dvorce, located in South Bohemian Region of Czech Republic. Eight ewes of the L breed in the second lactation were used in the study. After weaning of lambs, which was done at mean age of 40 days, all sheep began to be machine milked.

During our experiment the daily feed ration of ewes was quite intensive and consisted of grass-clover silage (2.00 kg/ewe), concentrate mixture for milking sheep (0.6 kg/ewe), barley (0.40 kg/ewe), whole maize (0.20 kg/ewe) and

organic mineral lick (*ad libitum*). The sheep also had free access to permanent pasture. Throughout our experiment, all ewes were clinically healthy and reared in one flock without any differences in their management and nutrition.

Recording and sampling of milk were carried from May to September, on the mean 62, 94, 129, 161 and 195 day of lactation. Recording of milk was carried out both in the morning (7 a.m.) and in the evening milking (7 p.m.). Milk samples were collected only in the course of the morning milking. Subsequently, after cooling to 5–8 °C, all samples were transported in a thermobox to the special laboratories at MENDEL in Brno.

The contents of TS, F and I and the values of pH and TA were determined by the method described by Kuchtík *et al.* (2017). True protein (TP) content was determined according to the ČSN EN ISO 8968-1 using a Kjeltac (Foss Electric, Denmark). Coagulation time (in seconds) and curd quality were also determined using the method described by Kuchtík *et al.* (2017). The curd quality was assessed according to a scale from 1 (best) to 5 (worst).

Evaluation of results was carried out according to statistical analyses described by Kuchtík *et al.* (2017).

## RESULTS AND DISCUSSION

The SL had a conclusive effect on DMY and contents of all basic milk compounds (Tab. I) which is in line with trends published by Sevi *et al.* (2004), Sari *et al.* (2015) and Pliško *et al.* (2016). The highest DMY in our experiment was found on the 94<sup>th</sup> day of lactation, thereafter the gradual decrease in DMY was recorded with advanced lactation. The same trends were also reported by Hernandez *et al.* (2014). The average DMY in our experiment was 1.68 l and the values of DMY ranged from 2.56 to 0.73 l. These values are higher than those reported by Mioč *et al.* (2009) and Kuchtík *et al.* (2017). In our opinion, the relatively high milk yield of ewes in our experiment was affected mainly by quite intensive nutrition.

Most studies show that as lactation progresses the contents of TS, F and TP increase. These trends were also found out in our experiment, while the correlations (Tab. II) between the DMY and the contents of TS, F and TP were conclusively negative in all cases. Both the average content of F and the individual contents of this milk compound during lactation were relatively high, nevertheless its contents are comparable to those published by Antunac *et al.* (2011) and Matutinovic *et al.* (2011),

I: The effect of the SL on DMY, contents of milk compounds and renneting parameters of sheep milk.

| Trait          | Mean day of lactation |                    |                    |                    |                    | Whole lactation | mean | range      | SE    |
|----------------|-----------------------|--------------------|--------------------|--------------------|--------------------|-----------------|------|------------|-------|
|                | 62                    | 94                 | 129                | 161                | 195                |                 |      |            |       |
| <b>DMY (l)</b> | 2.08 <sup>A</sup>     | 2.56 <sup>B</sup>  | 1.73 <sup>C</sup>  | 1.32 <sup>D</sup>  | 0.73 <sup>E</sup>  | ***             | 1.68 | 0.5–2.8    | 0.66  |
| <b>TS (%)</b>  | 17.68 <sup>a</sup>    | 17.57 <sup>a</sup> | 17.31 <sup>A</sup> | 18.16 <sup>a</sup> | 19.27 <sup>B</sup> | ***             | 18   | 16.2–20.99 | 1.07  |
| <b>F (%)</b>   | 7.1 <sup>a</sup>      | 6.96 <sup>a</sup>  | 7.18 <sup>a</sup>  | 8.05 <sup>b</sup>  | 7.89 <sup>b</sup>  | *               | 7.43 | 5.99–9.1   | 0.78  |
| <b>TP (%)</b>  | 4.92 <sup>A</sup>     | 4.98 <sup>A</sup>  | 5.08 <sup>A</sup>  | 4.72 <sup>A</sup>  | 6.6 <sup>B</sup>   | ***             | 5.16 | 4.07–6.92  | 0.65  |
| <b>L (%)</b>   | 4.87 <sup>a</sup>     | 4.78 <sup>a</sup>  | 4.31 <sup>b</sup>  | 4.71 <sup>a</sup>  | 4.68 <sup>a</sup>  | *               | 4.67 | 3.99–5.56  | 0.35  |
| <b>pH</b>      | 6.54                  | 6.61               | 6.59               | 6.55               | 6.64               | NS              | 6.59 | 6.45–6.91  | 0.09  |
| <b>TA (SH)</b> | 11 <sup>A</sup>       | 8.93 <sup>A</sup>  | 9.04 <sup>B</sup>  | 9.91 <sup>AB</sup> | 10.9 <sup>A</sup>  | ***             | 9.96 | 7.56–12.38 | 1.22  |
| <b>CT (s)</b>  | 117                   | 120                | 102                | 105                | 122                | NS              | 114  | 56–210     | 30.74 |
| <b>CQ</b>      | 1.75                  | 1.25               | 1.25               | 2.13               | 1.63               | NS              | 1.6  | 1–4        | 0.87  |

SL: stage of lactation, DMY: daily milk yield, TS: total solids, F: fat, TP: true protein, L: lactose, TA: titratable acidity, CT: coagulation time; CQ: curd quality.

a, b, Means within a row with different superscript letters differ significantly at  $p \leq 0.05$

a, b, c, d, e Means within a row with different superscript letters differ significantly at  $p \leq 0.05$

A trait within the whole lactation significantly differ at  $p \leq 0.05$ . \*,  $p \leq 0.01$  \*\*,  $p \leq 0.001$  \*\*\*

II: Correlations of all traits of the study

|            | DMY  | TPS    | F      | TP     | L     | pH    | TA     | CT    | CQ    |
|------------|------|--------|--------|--------|-------|-------|--------|-------|-------|
| <b>DMY</b> | 1.00 | –0.55* | –0.51* | –0.52* | 0.22  | –0.08 | –0.39* | 0.02  | –0.19 |
| <b>TPS</b> |      |        | 0.81*  | 0.77*  | –0.01 | –0.01 | 0.36*  | 0.06  | 0.18  |
| <b>F</b>   |      |        |        | 0.41*  | –0.29 | –0.25 | 0.31   | –0.19 | 0.16  |
| <b>TP</b>  |      |        |        |        | –0.26 | 0.27  | 0.15   | 0.22  | 0.14  |
| <b>L</b>   |      |        |        |        |       | 0.07  | 0.17   | 0.21  | 0.01  |
| <b>pH</b>  |      |        |        |        |       |       | –0.30  | 0.64* | –0.12 |
| <b>TA</b>  |      |        |        |        |       |       |        | –0.13 | 0.25  |
| <b>CT</b>  |      |        |        |        |       |       |        |       | –0.10 |

\*  $p \leq 0.05$ , DMY: daily milk yield, TS: total solids, F: fat, TP: true protein, L: lactose, TA: titratable acidity, CT: coagulation time, CQ: curd quality.

whilst in that studies were applied quite intensive nutrition of ewes. In contrast, the contents of TP in the course of our experiment were lower as compared to the those reported by Antunac *et al.* (2011). The contents of TP were also lower as compared to their values reported by Kuchtik *et al.* (2017) in the Lacaune ewes, while in this study the extensive nutrition was used. In our opinion, relatively low contents of TP in our experiment were affected by the relatively high milk yield of ewes. Although the content of lactose was conclusively affected by the stage of lactation, it can be stated generally that the contents of this milk compound were the most stable as compared to other monitored milk components during whole lactation. The content of lactose in the course of lactation ranged from 4.31 to 4.87 %, which is comparable with values reported by Kondyli *et al.*

(2012). All correlations between lactose content and the contents of all basic components of milk were inconclusively negative in all cases. In contrast, Mioc *et al.* (2009) and Kuchtik *et al.* (2017) found all these correlations to be conclusively negative.

The SL had inconclusive effect on pH which is in line with Barron *et al.* (2001). Average pH for the whole lactation was 6.59, which is a value comparable to that reported by Sahan *et al.* (2005). All correlations between the pH and all the other indicators observed, with the exception of CT, were inconclusive. The same trends were also reported by Kuchtik *et al.* (2017), however in their experiment the correlation between pH and CT was inconclusive. In contrast to pH, the SL had a conclusive effect on titratable acidity (TA), which is in line with Novotná *et al.* (2009) and Sajko-Matutinovic *et al.* (2012). Furthermore, it can

be stated that values of the TA gradually increased from the 94th day of lactation in the present study, which is in line with Pavic *et al.* (2002). In contrast, Sahan *et al.* (2005) reported that TA decreased during lactation. As for the correlation between the TA and all other indicators, most of them were inconclusive.

The SL had inconclusive effect on coagulation time (CT) and curd quality (CQ) which is consistent with Pokorná *et al.* (2010). In general, it is also possible to state that the CT and CQ values were more stable over the lactation than those reported by Kuchtík *et al.* (2017) in sheep of the same breed.

On the other hand Novotná *et al.* (2009) and Abilleira *et al.* (2010) found out a conclusive effect of the SL on CT and CQ. All correlations between the CT and other monitored parameters, with the exception of pH, were inconclusive, whereas the positive conclusively correlation between the CT and the pH indicates that the higher pH the longer CT. As opposed to the CT, the CQ was not affected by the SL, while the best CQ was found out in the middle of lactation. In our opinion relatively balanced values of CT and CQ during lactation indicate on the good health state and correct nutrition of ewes.

## CONCLUSION

The stage of lactation conclusive influenced the milk yield, contents of all milk compounds and titratable acidity. In contrast, the same factor had inconclusive effect on the pH, coagulation time and curd quality. The results of our experiment show that intensive nutrition of the Lacaune ewes led mainly to increase in their milk yield. Intensive nutrition of ewes also had positive effects on the stability of clotting time and good and stable curd quality in the course of lactation.

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