

Original scientific paper - Izvorni znanstveni rad

UDK: 637.112.2

Effect of temperament on milk production, somatic cell count, chemical composition and physical properties in Lacaune dairy sheep breed

doi: 10.15567/mljekarstvo.2017.0403

Gábor Tóth¹, Péter Póti¹, Enikő Hamar Abayné¹, László Gulyás², Akos Bodnar^{1*}, Ferenc Pajor¹

¹Szent Istvan University, Institute of Animal Husbandry, Páter K. 1., H-2100 Gödöllő, Hungary

²Széchenyi Istvan University, Institute of Animal Husbandry, Vár 2, H-9200 Mosonmagyaróvár, Hungary

Received - Prispjelo: 29.11.2016.

Accepted - Prihvaćeno: 27.09.2017.

Abstract

Effect of temperament on milk yield, lactation length, physico-chemical properties and somatic cell count of Lacaune ewes were evaluated. The investigation was carried out at a sheep farm in the county of Győr-Moson-Sopron. The temperament of 106 Lacaune ewes was measured by the temperament 5-point-scale test (1=very nervous, 5=very quiet) during milking. Furthermore, 42 ewes were randomly selected from a herd of 106 animals for the analysis of milk composition (fat, protein and lactose), pH, electrical conductivity as well as somatic cell count. It was found that the temperament had a significant effect on lactation length and lactation milk production, lactose, electrical conductivity and somatic cell count. Calm ewes had significantly longer lactation (4 score: 220.7 day; 5 score: 201.4 day) as well as higher milk production (4 score: 207.9 kg; 5 score: 193.3 kg) compared to more temperamental animals (2+3 scores: 166.5 day and 135.5 kg; $P < 0.05$). The content of lactose was significantly lower (4.32) in the more temperamental group, while electrical conductivity was higher (4.81 mS cm⁻¹) compared to calmer animals (4.69 % and 4.16 mS cm⁻¹). Additionally, significant differences were found in milk somatic cell count among the temperament categories. Calmer ewes had a lower somatic cell count in milk (5.17 log cm⁻³) than more temperamental ones (5.67 log cm⁻³; $P < 0.05$).

Key words: ewe milk, temperament, milk yield, somatic cell count, electrical conductivity

Introduction

The research on the temperament of domesticated animals became more important in the recent years. Several production traits were linked to temperament scores: calmer animals have better production parameters (higher weight gain, more favourable meat quality) compared to more temperamental animals (Dodd et al., 2014; Bokor et al., 2016). Temperament is generally defined in terms of the behavioural response to human handling or to a novel environment (Sutherland et al., 2012). Several authors reported that milking temperament such as stepping behaviour at milking is a main characteristic of dairy animals that indicates the level of stress during milking (Szentléleki et al., 2015).

Animals' temperament has been often evaluated by subjectively scoring where authors generally use 1-3, 1-4 or 1-5 scoring scales to identify animals' temperament during milking in a milking parlour (Szentléleki et al., 2015). Previous studies reported correlations between temperament and lactation milk production in dairy sheep (Murray et al., 2009; Pajor et al., 2010, Pajor et al. 2013). According to these results, calmer animals produced more milk than nervous ones. Earlier studies have focused on the differences in milk production traits related to distinct temperament scores. However, in some published papers there was no available information about relationship between the temperament score and somatic cell count in milk. Some authors found

*Corresponding author/Dopisni autor: E-mail: bodnar.akos@mkk.szie.hu

relationship between these traits in cattle and buffalo, more temperamental animals have higher somatic cell counts (Orbán et al., 2011; Carvalho et al., 2017). Hypothesis of this study was that the more temperamental animals have higher somatic cell count in milk during the whole lactation period compared to the calmer ones.

The somatic cell count (SCC) in the milk of healthy ewes does not reach 250.000 cells cm^{-3} , but SCC between 250.000-1.000.000 cells cm^{-3} often occurs in the milk of ewes which does not show the symptoms of mastitis (Paape et al., 2007). In some cases, the temperament has been influenced also by parities so that the multiparous dairy animals were calmer than primiparous animals (Szentléleki et al., 2015).

The aim of this study was to investigate the effect of temperament on milk yield, lactation length, milk chemical and physical parameters, pH, electrical conductivity and somatic cell count in Lacaune ewes.

Materials and methods

Experimental design

This study was carried out in a Hungarian dairy sheep farm (Mórichida: 47°29'10.5"N 17°25'18.4"E). Data were collected from 106 multiparous (parities: 2-5 lactations; n= 45, 18, 27 and 16) Lacaune ewes which had neither signed clinical mastitis symptoms (swelling, heat, redness or pain) nor foot-health problem. Individual milk production (milk yield and lactation length) of the ewes has been calculated on the basis of monthly monitoring made by the Hungarian Sheep and Goat Breeder Association. Moreover 42 ewes (parities: 2-4 lactations; n= 23, 7 and 12) were randomly selected from a herd of 106 animals for the analysis of milk traits: chemical composition (fat, protein and lactose), pH, electrical conductivity and somatic cell count.

The study and milking period started in mid-March. The animals in the same lactation stage were kept free in the stable and were milked in 2×24 Hungaro Lact milking parlour two times per day. Nutrition of the animals was based on pasture during the whole study. The grazing period started in mid-April. The main grassland species were

Lolium perenne, *Poa pratensis*, *Festuca rubra*, and the main legume was *Lotus corniculatus*. Additionally, all animals were fed by 400 g day^{-1} concentrate (NE_1 : 7.1 MJ kg^{-1} DM; crude protein: 180 g kg^{-1} DM, containing vitamins A, D₃, E) and *ad libitum* alfalfa hay (NE_1 : 5.1 MJ kg^{-1} DM; crude protein: 189 g kg^{-1} DM). Commercial trace-mineralized salt blocks (*ad libitum*) were an integral part of the nutrition.

The temperament of ewes was evaluated on the 48th, 74th and 103th day of their lactation during the morning and evening milking. Behaviour of animals was evaluated by a 5-score system during the whole duration of udder preparation and milking procedure (Budzynska et al., 2005) by direct scoring:

- 1) very nervous, continual and vigorous stepping and kicking;
- 2) continual and vigorous stepping but there is no kicking;
- 3) occasionally vigorous leg movements;
- 4) quiet standing with few slight leg movements;
- 5) very quiet, no leg movements.

Milk samples were collected in a triplicate immediately after temperament scoring in the morning and evening. Milk composition (fat, protein and lactose) was determined using a LactoScope™ (Delta Instruments Ltd., Netherlands) device. The pH and electrical conductivity values of the sheep milk were measured by Extech EC500 (Extech Instruments, Nashua, NH, USA) pH and conductivity meter. The milk somatic cell count was determined by Bentley FCM device at Livestock Performance Testing Ltd (Gödöllő, Hungary).

Statistical analysis

Statistical analysis was performed by the SPSS 23.0 software package. The Kruskal-Wallis test was used to assess the differences among temperament scores during experimental period, and to study the differences in the mean temperament scores within the parities, too. Before analysis, Shapiro-Wilk's test was used for testing the normality distribution. The somatic cell count data were transferred to logarithm (with logarithm base 10) before statistical evaluations. The numbers of ewes with temperament scores 2 and 3 were relative low therefore they have been merged into a group (2+3). Statistical analysis was carried out in order to determine the effect of temperament and parity (fixed factors) on

milk chemical and physical properties, somatic cell count and production as dependent variables. The multivariate general linear model (GLM) procedure was used to analyse variance. The statistical model was as following:

$$Y_{ij} = \mu + A_i + B_j + e_{ij}$$

where Y_{ij} is the value of the dependent variable, μ is the overall mean, A_i is the effect of parity, B_j is the effect of temperament score and e_{ij} is the random error. Statistical significances between groups were calculated with Tukey HSD post-hoc test.

Results and discussion

The descriptive statistics of milk production traits are showed in Table 1. The average value of somatic cell counts was 580000 cells cm^{-3} , fat and protein content was 7.03 % and 5.65 %, and average milk yield was 193.70 kg. Values of milk parameters were in line with reports of several authors (Park et al., 2006; Paape et al., 2007; Makoviczky et al., 2013 and 2014). The Lacaune ewes' milk production was higher compared to data published by Hungarian Sheep and Goat Breeder Association (average milk yield: 145.1 kg; length of lactation: 129.7 day) (HSGBA, 2013).

The parity significantly affected daily and lactation milk yield ($F= 5.70$ and 10.45 ; $P < 0.001$ in both), which was in line with past studies (Oravcova et al., 2006) (not presented in Table). However, temperament scores of ewes were not affected by parity ($KW=0.226$, $P=0.973$). Therefore, the temperament score data of animals of different parity were merged in this experiment. Results of lactation length and lactation milk production traits of Lacaune ewes by temperament scores are presented in Table 2. The temperament of individual animals was constant ($KW=2.064$, $P=0.356$) during the investigation. In our study, 45.4 % of Lacaune ewes got score "5" (calm animals), 39.1 % of ewes got score "4", 8.2 % of ewes got score "3" and 7.3 % of animals got score "2". Animal with score "1" was not found in this investigation. Similar results had been reported earlier by Szentléleki et al. (2015) who found that approximately 90 % of dairy cows were calm in their studies. Based on our results, proportion of Lacaune ewes with unfavourable temperament score during milking was low.

The average daily milk yield of ewes did not show significant difference among the temperament categories. However, calm ewes had higher ($P < 0.001$) lactation length (4 and 5 score: 210.78

Table 1. Basic descriptive statistics of milk chemical parameters, milk production and somatic cell count in Lacaune herd (n=106)

Investigated traits	Mean	SD	SEM	Minimum	Maximum
Milk fat, %	7.03	0.95	0.15	4.92	8.11
Milk protein, %	5.65	0.23	0.03	5.21	6.14
Lactose, %	4.64	0.29	0.04	3.18	5.09
Lactation length, day	204.38	37.17	3.61	115	259
Milk yield, kg	193.70	43.49	4.23	54.70	380.40
SCC log cm^{-3}	5.80	0.52	0.08	4.58	6.78

Table 2. Least squares means of ewes' milk production traits by temperament categories

Investigated traits	Temperament ⁺			SEM	P-values
	2+3	4	5		
n	13	43	50		106
%	12.2	40.6	47.2		100
Lactation length, day	166.47 ^a	220.66 ^b	201.39 ^c	4.130	<0.001
Milk production, kg	135.52 ^a	207.90 ^b	193.25 ^b	4.414	<0.001
Average daily milk yield, kg	0.82 ^a	0.94 ^b	0.97 ^b	0.016	0.001

+2: continual and vigorous stepping but there is no kicking; 3: occasionally vigorous leg movements; 4: quiet standing with few slight leg movements; 5: very quiet, no leg movements
abc $P < 0.05$ different letters indicate significant differences in a row

and 199.82 day) as well as milk production ($P < 0.001$; 201.73 and 194.15 kg) compared to the more temperamental animals (83.67 day and 80.07 kg).

Our results suggested that temperament had great effect on milk production and lactation length. It was already reported that calmer animals tend to have higher milk production level compared to temperamental ewes (Murray et al., 2009; Pajor et al., 2010, 2013), but there were not any earlier data reported about the effect of temperament on lactation length. In contrast, no relation had been found between average daily milk yield and temperament score, which is correspondent with Murray et al. (2009); Pajor et al. (2010) and Pajor et al. (2013).

In other group, parity had no significant effect on the physico-chemical properties and somatic cell count of the milk which was in concordance with the literature reports (Králíčková et al., 2011). Results considering the composition and characteristics of Lacaune ewes milk (fat, protein and lactose content, pH, electrical conductivity, somatic cell count) were related to temperament scores are presented in Table 3. There were no differences in milk fat and protein composition and pH among the temperament categories. Nevertheless, some previous reports showed differences in milk protein content among temperament categories. Higher protein content was found in calm Merino sheep milk rather than in nervous ewes' milk (Murray et al., 2009). On contrary, the temperament significantly affected both, lactose content ($P < 0.05$) and electrical conductivity ($P < 0.05$). The more temperamental group ("2" and "3" scores) had lower lactose content and

higher electrical conductivity than the calmer one. Electrical conductivity of milk was well documented as a good indicator for the detection of mastitis, as well as increasing conductivity with increasing somatic cell count, which corresponded to earlier literature data (Diaz et al., 2011). Nowadays, it is often used in practice, especially in large-scales dairy farms.

We found that calmer ewes had lower somatic cell count. The calm animals ("5" score) had a lower somatic cell count ($5.17 \log \text{cm}^{-3}$) in comparison to the more temperamental ("2" and "3" scores) ewes ($5.67 \log \text{cm}^{-3}$, $P < 0.05$). Earlier studies did not supply detailed information about the relationship between the temperament and somatic cell count in ewe milk. Moreover, Orbán et al. (2011) found that cows with unfavourable temperament showed lower somatic cell counts. Most of the somatic cells of healthy animals are epithelial cells originating from the inner surface of the udder. Opposite to this, somatic cells of an infected organism are mainly leukocytes. These cells appear in increased amounts in milk as an immune response to an udder pathogen bacteria species. Leukocytes cells play an important role in the immune response acting as phagocytes (Lindmark-Mansson et al., 2006). Immune system has been reported to be influenced by temperament (Fell et al., 1999). Some authors reported that nervous animals had lower serum concentrations of IgG and lymphocyte proliferation compared to calm animals (Olfe et al., 2010). Our result suggested that the higher milk somatic cell can be caused by the declined immune system featured in the more temperamental animals.

Table 3. Least squares means of ewes milk chemical and physical parameters and somatic cell count by temperament categories

Investigated traits	Temperament ⁺			SEM	P-values
	2+3	4	5		
n	8	11	23		42
%	19.0	26.2	54.8		100
Milk fat, %	7.15	6.87	7.18	0.180	0.672
Milk protein, %	5.79	5.60	5.65	0.042	0.185
Lactose, %	4.36 ^a	4.61 ^b	4.67 ^b	0.052	0.032
pH	6.65	6.67	6.64	0.017	0.677
Electrical conductivity, mS cm ⁻¹	4.57 ^b	4.22 ^a	4.19 ^a	0.068	0.041
SCC log cm ⁻³	5.74 ^b	5.77 ^b	5.33 ^a	0.086	0.016

+2: continual and vigorous stepping but there is no kicking; 3: occasionally vigorous leg movements; 4: quiet standing with few slight leg movements; 5: very quiet, no leg movements

ab $P < 0.05$ different letters indicate significant differences in a row

Conclusions

In conclusion, the calmer ewes had lower somatic cell count in milk and higher milk production than temperamental ones. The temperament score also affected the electrical conductivity and lactose content. These results proved that the application of temperament score test was beneficial for breeders due to the fact that the calmer ewes produced more milk with reduced somatic cell counts than nervous animals.

Acknowledgements

The authors would like to say thank for assistance of Ede Sipos. This work was supported by the Research Centre of Excellence-1476-4/2016/FE-KUT project.

Učinak temperamenta na količinu mlijeka, broj somatskih stanica, kemijski sastav i fizikalna svojstva pasmine Lacaune ovaca

Sažetak

Istražen je utjecaj temperamenta na količinu mlijeka, duljinu laktacije, fizikalno-kemijska svojstva i broj somatskih stanica Lacaune pasmine ovaca. Istraživanje je provedeno na farmi ovaca u županiji Győr-Moson-Sopron. Temperament 106 ovaca pasmine Lacaune određivan je tijekom mužnje pomoću temperament testa s ljestvicom od 5 stupnjeva (1 = jako nervozne, 5 = vrlo tihe). Nadalje, 42 ovce nasumično su odabrane iz stada koje je sačinjavalo 106 životinja za analizu sastava mlijeka (masti, proteina i laktoze), pH, električne vodljivosti te broja somatskih stanica. Utvrđeno je da temperament ima značajan utjecaj na duljinu laktacije i proizvodnju mlijeka u laktaciji, laktozu, električnu vodljivost i broj somatskih stanica. Smirene ovce imale su značajno dulju laktaciju (4 boda: 220,7 dan, 5 bodova: 201,4 dan), kao i veću proizvodnju mlijeka (4 boda: 207,9 kg, 5 bodova: 193,3 kg) u usporedbi s temperamentnim životinjama (2 + 3 bodova: 166,5 dan i 135,5 kg, $P < 0,05$). Sadržaj laktoze bio je znatno niži (4,32 %) u temperamentnijoj skupini, dok je električna vodljivost bila veća (4,81 mS cm⁻¹)

u usporedbi sa smirenim životinjama (4,69 % i 4,16 mS cm⁻¹). Dodatno, značajne razlike utvrđene su u broju somatskih stanica u mlijeku različitih temperamentnih kategorijama. Smirenije ovce imale su manji broj somatskih stanica u mlijeku (5,17 log cm⁻³) od onih temperamentnih (5,67 log cm⁻³, $P < 0,05$).

Ključne riječi: ovčje mlijeko, temperament, količina mlijeka, broj somatskih stanica, električna vodljivost

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