Influence of Farm Size on Selected Milk Quality and Hygiene Traits in Romanian Spotted Cows

Ligia Berzava, Alin Bucur (Prisecaru), Bogdan-Roberto Mihuța, Ludovic Toma Cziszter, Silvia Erina

Bioengineering Faculty of Animal Resources, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timișoara, Calea Aradului 119, 300645, România

Abstract

Researches were carried out on 1707 Romanian Spotted cows raised in farms from Hunedoara County that were under the official performance control scheme. According to the number of milking cows (farm size), farms were divided into three categories small (n≤10 cows), middle (n=11 to 25 cows) and large (n>25 cows). The influence of the farm size on the milk dry matter percentage, milk pH, urea content in milk, and milk somatic cell count was determined by using ANOVA, and lactation curve for these traits was drawn using the gamma incomplete function. Generally, the farm size had a significant influence on all studied milk traits ($p<0.01$). Dry matter percentage in milk varied from 11.6% in middle farms to 12.6% in large farms. The highest value for pH was found, on average, in small farms (6.61), while the lowest value was in large farms (6.57). Urea content of the milk Had higher values in middle farms (32.4 to 33.1 mg/100g), followed by small farms (29.5 to 32.5 mg/100g) and the lowest values were observed in large farms (28.0 to 295 mg/100g). Somatic cell count was, on average, higher in middle farms (652.33x1000), while the lowest value was observed in small farms (440.54x1000).

Keywords: cows, farm size, milk dry matter percentage, milk pH, milk urea, Romanian Spotted, somatic cell count.

1. Introduction

Secreted milk comes from blood filtering at the glandular tissue level, retention of the milk forming substances and synthesis of the milk components within the epithelial cells' metabolism [1].

Dairy cows diet changes lead to reduction of ilk fat percentage. Majority of these changes are associated with dets rich in concentrates and low in fibre [2].

Lactose metabolization determines the lactic acid formation and pH reduction. This milk acidification could occur even intra-mammary when mammary gland is infected with lactose-fermentative bacteria such as *Staphylococcus spp.*, *Streptococcus spp.* Right after milking, milk has an acid tint. If the mammary gland is infected with proteolytic bacteria such as *Mycobacterium spp.*, *Brucella spp.* Right after milking has an alkaline tint [3].

Urea concentration in milk differs from farm to farm, being determined by the protein content of the dairy cows' ration, as well as by the health status of the udder and by the cows' liveweight. The higher the protein content in ration ingested during 24 hours the higher urea content in milk. If the urea in milk drops under 9 mg, it is a sign that the ration has not enough digestible protein, and therefore the epithelial cells of the mammary gland do not receive the right number of precursors for producing milk and milk proteins [4].

The farmer that balances the protein content of the ration according to the urea level in milk will benefit from a 28-36% increase of protein transformation efficiency from feed to milk. Too much raw protein in ration result in large amount

* Corresponding author: Berzava Ligia, ligia_berzava@yahoo.com

of ammonia formation within the rumen, thus milk urea increase [2].
A ration poor in ruminal fermentable carbohydrates, such as starch, sugars, digestible fibres, have negative consequences on rumen microbes' growth and multiplication. In this case the milk urea will increase [5].
The type of feedstuff, the level of dry matter from the silage, as well as its content in rumen degradable protein or the level of chopping/processing the corn silage could have an influence on the milk urea content. Some studies show that cows with high somatic cell count in milk, cows right after calving, as well as cows that show an imbalanced content of protein and fat in milk could have an abnormal level of urea in milk [6].
Researches showed that each farm has a specific urea concentration in milk. This depends on the feeding technology (TMR or whole feedstuffs), on the time between the cow feeding and the milking [7,8].
The aim of this paper was to emphasize the effect of the farm size on some selected milk quality and hygiene indices (milk dry matter percentage, milk pH, urea content of milk and milk somatic cell count) during lactation, for one year, in Romanian Spotted cows from Hunedoara County. Also, we have studied the lactation curve for all traits, during normal lactation, according to farm size.

2. Materials and methods

Studies were carried out on 1707 Romanian Spotted cows raised in farms from Hunedoara County that were in the official performance control scheme.
According to the number of cows (farm size), the farms were divided into three categories: small (less or equal to 10 cows, n=572 heads), middle (between 11 and 25 cows, n=689 heads), and large (over 25 cows, n=446 heads).
The official performance control was done according to the National Authority legislation, respecting the official methodology (OM nr. 19/2006), updated and agreed by the international competent organization (ICAR).
During the test day, the milk from each cow was weighed, and milk samples were collected for qualitative control. Sampling was carried out using an on-line sampler, either a graduated pipette, after good homogenization of the whole milk from that milking.
The volume of the sample (at least 25 mL) was proportional with the amount of the milk from that milking. The milk samples were analysed for chemical composition, pH, urea and somatic cell count at the laboratory agreed by the National Authority.
Data was statistically analysed using STATISTICA software, the ANOVA/MANOVA procedure [9].
The incomplete gamma function [10] was applied to the database to obtain the lactation curve for each studied milk production trait.

3. Results and discussion

Table 1 presents the averages, dispersion indices and statistical significance for the milk dry matter percentage by farm size. During the whole year of performance control, there was a highly significant influence ($p<0.001$) of the farm size on the milk dry matter content, among all three farm sizes.
The lowest variability along the lactation was observed in small farms (Figure 1). Thus, at the beginning of lactation the dry matter percentage in milk was 12.1%, with a nadir point of 12.07% at 30 days after calving, and then a slow increasing trend was observed reaching a value of 12.25% at the end of the normal lactation.
For large farms and middle farms, a different shape of the lactation curve for dry matter percentage in milk was observed. In large farms, the highest value of dry matter percentage was observed at the beginning of lactation (12.65%), then an abrupt decrease to 12.0% during the first month of lactation, value that was decreasing continuously until de end of the normal lactation, reaching 11.4% dry matter. In middle farms, the dry matter percentage in milk was the lowest among the farm sizes. The beginning value was 11.59%, and was continuously decreasing until the end of lactation to reach 10.79% at the end. Thus, we can state that farm size had a significant influence on the shape of the lactation curve for dry matter content of the milk.
Chemical reaction of the milk could be determined as direct pH or as titratable acidity. Cooled milk has a pH between 6.33 and 6.59 and as a titratable acidity (Thörner method) varies between 16.5 and 18.3 °T [4].

Table 1. Average (%), standard error of the mean and statistical significance for milk dry matter percentage according to the farm size

Control	Farm size			Significance		
	Small	Middle	Large	Small vs. Middle	Small vs. Large	Middle vs. Large
1	13.03±0.07	13.23±0.05	13.69±0.06	***	***	***
2	12.21±0.07	12.29±0.05	13.09±0.07	***	***	***
3	12.19±0.05	12.11±0.05	13.17±0.06	***	***	***
4	11.79±0.05	11.73±0.04	12.73±0.04	***	***	***
5	12.05±0.06	12.02±0.05	12.60±0.05	***	***	***
6	12.23±0.05	12.45±0.05	12.49±0.05	***	***	***
7	11.93±0.03	11.83±0.06	11.80±0.04	***	***	***
8	12.63±0.06	12.51±0.04	12.57±0.05	***	***	***
9	12.42±0.05	12.35±0.04	12.76±0.05	***	***	***
10	12.97±0.06	12.68±0.04	12.62±0.06	***	***	***
11	13.35±0.07	12.90±0.06	13.29±0.05	***	***	***
12	12.99±0.32	15.59±0.72	12.55±0.08	***	***	***
13	13.12±0.08	12.90±0.06	13.19±0.08	***	***	***

ns = $p>0.05$, $p\leq0.05$*, $p<0.01$**, $p<0.001$***

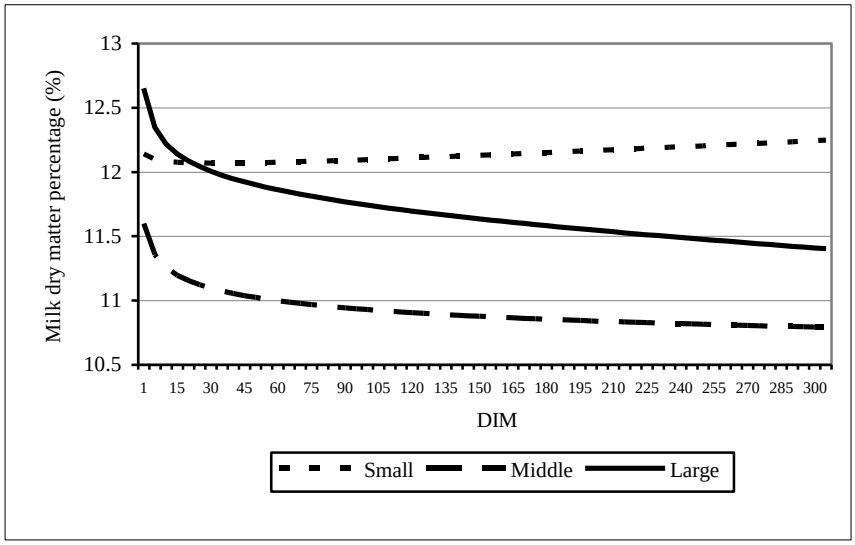

Figure 1. Lactation curve for milk dry matter percentage in Romanian Spotted cows, by farm size, after applying the incomplete gamma function

As seen in Table 2, the farm size had a significant influence on the milk pH. Thus, except for the controls 2 and 7, where the differences among the three farm sizes were not significant ($p>0.05$), a high statistical assurance was obtained among the farm size groups in all controls ($p<0.01$).

The shape of the lactation curve for pH was similar for all three farm size groups (Figure 1), but the initial value was different. Thus, the lowest pH values along the whole normal lactation were observed in large farms, and the highest values in small farms. Generally, the pH varied 6.57 and 6.66.

Urea content of milk allows us to monitor the rumen utilization efficiency of the feed protein and to reduce the losses of protein through urine [8]. Studies proved that there is an optimal value for milk urea that is relevant for the rightness of protein content of the ration, and especially for the efficiency of utilization of the ration protein in milk synthesis [2].

Table 3 shows the averages, dispersion indices and statistical significance for milk urea content in the three farm size groups.

Table 2. Average, standard error of the mean and statistical significance for milk pH according to the farm size

Control	Farm size			Significance		
	Small	Middle	Large	Small vs. Middle	Small vs. Large	Middle vs. Large
1	6.79±0.01	6.80±0.01	6.83±0.02	***	***	***
2	6.80±0.01	6.80±0.01	6.81±0.01	ns	ns	ns
3	6.70±0.01	6.68±0.01	6.65±0.01	***	***	***
4	6.68±0.01	6.67±0.01	6.62±0.01	***	***	***
5	6.64±0.01	6.61±0.01	6.58±0.01	***	***	***
6	6.65±0.01	6.64±0.01	6.63±0.01	***	***	***
7	6.62±0.01	6.62±0.01	6.62±0.01	ns	ns	ns
8	6.65±0.01	6.61±0.01	6.63±0.01	***	***	***
9	6.63±0.01	6.60±0.01	6.55±0.01	***	***	***
10	6.62±0.01	6.64±0.01	6.52±0.01	***	***	***
11	6.62±0.01	6.64±0.01	6.61±0.01	***	***	***
12	6.83±0.01	6.80±0.02	6.77±0.02	***	***	***
13	6.82±0.01	6.81±0.01	6.83±0.01	**	**	**

ns = $p>0.05$, $p\leq0.05$*, $p<0.01$**, $p<0.001$***

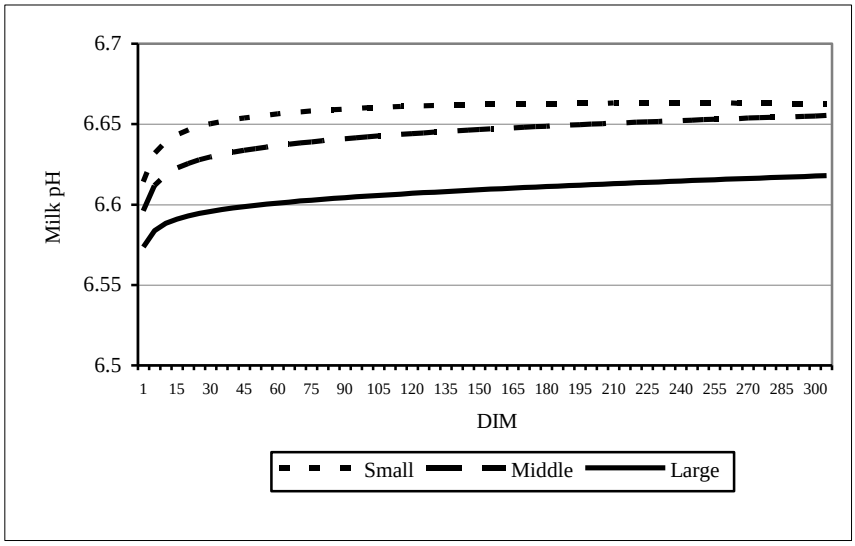

Figure 2. Lactation curve for milk pH in Romanian Spotted cows, by farm size, after applying the incomplete gamma function

Farm size had a significant effect ($p<0.01$) on urea content of milk (Table 3), except for controls 1 and 3, where there was no effect seen ($p>0.05$). Also, the difference between small and large farms in control 13 was small and statistically non-significant ($p>0.05$).

Lactation curves for urea content of milk in the three farm sizes are shown in Figure 3. The shape of the lactation curve was similar for all farm size categories, but the level was different. Thus, the highest urea content was found in the milk of cows from middle farms, followed by those from small farms, while cows reared in large farms had the lowest values for urea content throughout the whole lactation, and did not exceed the value of 30 mg/100g milk. This was probably because of a more balanced feeding in large farms compared to small and middle farms.

Table 4 shows the averages dispersion indices and statistical significance for milk somatic cell count by controls and farm size.

There was a significant effect of farm size on the somatic cell count in milk ($p<0.05$), in most of controls. Exception was observed in controls 3, 4 and 7, where differences for somatic cell count were not detected ($p>0.05$) among the farm size categories.

Unfortunately, in all controls, in all farm size categories, the somatic cell count took values higher than the maximum limit admitted (400x1000 SCC/ml milk), even 2-3 times higher at the beginning and end of lactation.

Table 3. Average (mg/100g), standard error of the mean and statistical significance for milk urea content according to the farm size

Control	Farm size			Significance		
	Small	Middle	Large	Small vs. Middle	Small vs. Large	Middle vs. Large
1	22.30±0.40	22.20±0.36	21.33±0.31	ns	ns	ns
2	19.32±0.38	21.99±0.40	21.45±0.43	***	***	***
3	28.74±0.57	28.13±0.46	28.10±0.60	ns	ns	ns
4	27.67±0.44	30.45±0.46	32.21±0.46	***	***	***
5	31.94±0.56	35.81±0.61	32.33±0.58	***	***	***
6	27.16±0.48	31.56±0.36	28.43±0.56	***	***	***
7	36.33±0.61	37.73±0.52	43.24±0.85	***	***	***
8	35.87±0.43	38.78±0.55	40.15±0.64	***	***	***
9	33.95±0.46	39.84±0.49	44.15±0.91	***	***	***
10	38.45±0.55	39.83±0.42	44.80±0.52	***	***	***
11	46.01±0.71	47.37±0.59	40.19±0.88	***	***	***
12	20.55±1.86	29.69±1.28	28.27±0.36	***	***	***
13	22.50±0.44	24.34±0.43	22.57±0.47	**	ns	**

ns = p>0.05, p≤0.05*, p<0.01**, p<0.001***

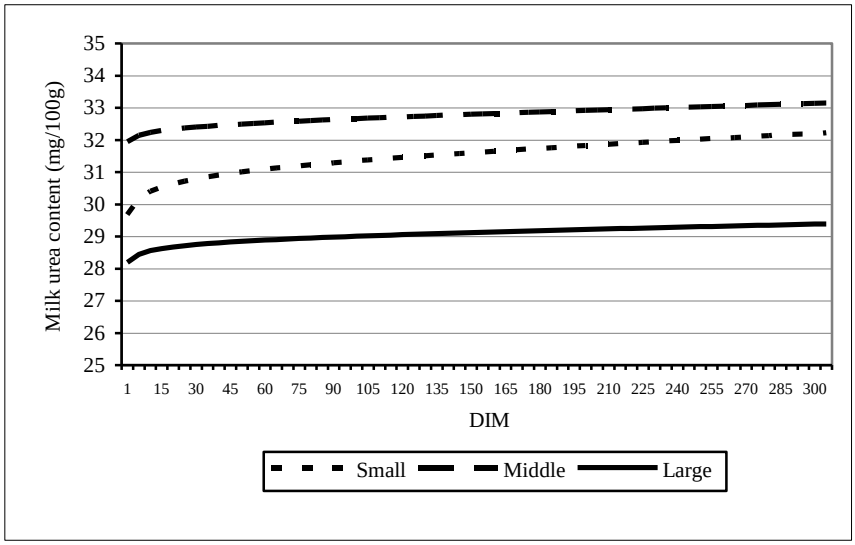

Figure 3. Lactation curve for milk urea content in Romanian Spotted cows, by farm size, after applying the incomplete gamma function

After applying the incomplete gamma function to the raw data, lactation curves were obtained for somatic cell count (Figure 4). In this case, there was obtained a clear difference among the farm size categories. The highest values for somatic cell count in milk were observed in middle farms, at the beginning of lactation a value of 653,000 cells/ml were obtained. This value decreased abruptly to 611,000 cell/ml during the first month of lactation. After this nadir, somatic cell count increased slowly towards the end of lactation to a value of 668,500 cells/ml.

Cows reared in large farms had average values for somatic cell count in milk throughout the lactation. The shape of the lactation curve was flat, almost a steady increase of the somatic cell count from the beginning to the end of the normal lactation. Thus, the initial value was 440,973 cells/ml, and at the end of lactation the value reached 583,957 cells/ml.

Cows from small farms had the lowest values for somatic cell count in milk. The shape of the lactation curve was somehow atypical, showing a high value at the beginning (483,241 cells/ml) abruptly decreasing to 291,412 cells/ml at 90 days after calving, and continuing to decrease slowly until the end of lactation to reach 260,599 cells/ml.

Table 4. Average (x1000/ml), standard error of the mean and statistical significance for milk somatic cell count according to the farm size

Control	Farm size			Significance		
	Small	Middle	Large	Small vs. Middle	Small vs. Large	Middle vs. Large
1	1315.31±83.10	997.83±63.86	1122.79±67.11	**	**	**
2	847.98±59.55	973.03±60.13	1169.63±73.36	**	**	**
3	627.07±31.39	595.47±26.88	689.51±42.14	ns	ns	ns
4	672.28±35.36	602.78±26.22	602.35±35.71	ns	ns	ns
5	597.19±32.87	464.26±22.08	717.45±44.62	***	***	***
6	721.42±32.57	716.56±30.19	572.24±34.12	***	***	***
7	594.85±29.16	618.96±26.61	552.81±29.48	ns	ns	ns
8	829.76±35.28	774.37±29.07	682.06±43.49	*	*	*
9	600.16±25.48	489.89±20.75	475.33±29.32	**	**	**
10	551.83±35.40	636.18±31.14	448.25±24.84	**	**	**
11	656.01±41.36	502.51±28.33	555.41±36.96	*	*	*
12	1297.88±89.54	957.00±42.87	438.67±43.53	***	***	***
13	1365.28±96.87	1464.76±82.15	1230.41±95.59	*	*	*

ns = p>0.05, p≤0.05*, p<0.01**, p<0.001***

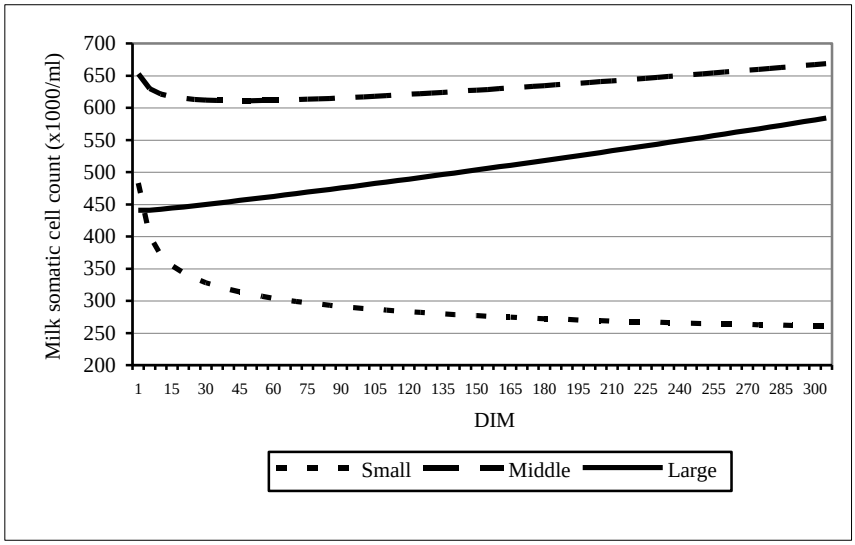

Figure 4. Lactation curve for milk somatic cell count in Romanian Spotted cows, by farm size, after applying the incomplete gamma function

4. Conclusions

Farm size had a significant influence on the milk dry matter percentage, milk pH, milk urea content and milk somatic cell count.

In some controls, the difference among different farm size groups were not statistically assured.

Using gamma incomplete function to obtain the lactation curve for these milk indices, was a useful tool to depict the differences among farm size groups. Thus, for dry matter percentage and somatic cell count, there were clear different shapes of the lactation curves by farm size.

Milk pH varied between 6.5 and 6.7, and the shape of the lactation curves were similar among farm size categories.

Urea content of milk varied from 28 to 33 mg/100g, being lower in large farms and higher in middle and small farms.

References

1. Cziszter L.T., (2003) – Dirijarea funcţiei glandei mamare, Ed. Eurostampa, Timişoara

2. Huntington, G.B., Archibeque, S.L. (1999) - Practical aspects of urea and ammonia metabolism in ruminants. J. Anim. Sci., 77), pp. 1-11.

3. Frank, B., Swensson, C. - Relationship between content of crude protein in rations for dairy cows and milk yield, concentration of urea in milk and ammonia emissions. J. Dairy Sci., 85 (2002), pp. 1829-1838.
4. Campeneere S. D, De Brabander D.L, Vanacker J.M - Milk urea concentration as affected by the roughage type offered to dairy cattle. Livest. Sci., 103 (2006), pp. 30-39
5. Erina Silvia, Acatincăi, Baul. Dronca D., Nicula Marioara, Bucur A., Simona, Cziszter, L.T., (2019) – Study on Some Factors Influencing the Milk Production Indices in Romanian Black and White and Romanian Spotted Cows from Hunedoara County, Proceeding of the Multidisciplinary Conference on Sustainable Development, Filodiritto Editore-Proceedings, pg.440-450.
6. Kohn, R.A, Kalscheur, K.F., Russek-Cohen, E. (2002) - Evaluation of models to estimate urinary nitrogen and expected milk urea nitrogen. J. Dairy Sci., 85, pp. 227-233
7. Cziszter L.T., Milovan Gh., Sala Claudia, Morar Adriana, Acatincăi S., Baul Simona, Erina Silvia, Tripon I., Petreuș C. (2007) - Cercetări asupra compoziţiei chimice şi a numărului de celule somatice din laptele crud de vacă, Lucrări șt Zootehnie şi Biotehnologii, vol. 40(2), Timişoara, pag. 521-529.
8. https://www.revista-ferma.ro/articole/alimentatie/importanta-cunoasterii-nivelului-ureei-din-lapte
9. StatSoft, Inc. (2011). Electronic Statistics Textbook. Tulsa, OK: StatSoft. WEB: http://www.statsoft.com/textbook/
10. Wood, P. D. P. 1967. Algebraic model of the lactation curve in cattle. Nature 216:164-165.