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QUALITY OF THE EWES' MILK AS A RAW MATERIAL IN THE DAIRY INDUSTRY IN THE REPUBLIC OF NORTH MACEDONIA

KVALITETA OVČJEG MLIJEKA KAO SIROVINE U MLIJEČNOJ INDUSTRIJI U REPUBLICI SEVERNOJ MAKEDONIJI

Gordana Dimitrovska, Aleksandra Grozdanovska, Vesna Karapetkovska - Hristova, B. Makarijoski, Katerina Bojkovska

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SUMMARY

This study is based on analyzing physico-chemical and microbiological characteristics of ewe milk from three different regions, which is used as a raw material in dairy industry of Republic of North Macedonia. All milk samples (n=123) were collected on dairy reception points of dairy industry in Pelagonia region, in a period of six (6) months. The average values for chemical composition of milk were in the range as follows: from 6.83±0.22% to 7.68±0.36% for milk fat, from 5.52±0.09% to 6.06±0.23% for proteins, from 4.62±0.08% to 4.79±0.05% for lactose, from 11.16±0.11% to 11.51±0.24% for non-fat dry matter (NFDM), from -0.561 to -0.543 °C for freezing point and 8.61±0.4 °SH to 8.88±0.47 °SH for titrable acidity. The microbiological and hygienic status of examined ewe milk samples was of poor hygienic quality. The average value of the examined samples for somatic cell count ranged from 753.333 cfu/mL to 1.125.000 cfu/mL and the average number of total bacteria count was from 532.444 cfu/mL to 1.986.222 cfu/mL.

Key words: ewe, physico-chemical characteristic, milk quality;

INTRODUCTION

Milk has always been an important attribute of the nutrition of many ancient civilizations throughout the centuries. Thanks to its nutritional value, numerous classic and scientific studies have confirmed the essential role of milk and dairy products in human and animal nutrition.

According to the world data presented by FAOSTAT (2018), ewe's milk production is 10.4 milion tones, and is mainly produced in Asia (45.6%), with remarkable amounts in China and Turkey, followed by Europe (29.0%) and Africa (24.5%). Additionally, there is a very small but growing production in the North and South America (0.9%) and Oceania (less than 0.1%).

According to the State Report on the production of ewe's milk in the country published by Food and Veterinary Agency (2012), significant oscillations for an extended period were reported.

The total production of ewe's milk, in addition to the genetic capacity of the ewe flocks and farming practices, it is also affected by the number of dairy animals.

Starting from the distribution of the animals in terms of ownership, the highest percentage (97 to 98%) of the total milk production in the past period belongs to individual agricultural producers.

While only 2 to 3% of the total milk production belongs to the large agricultural enterprises and cooperatives, (Food and Veterinary Agency, 2012).

Gordana Dimitrovska PhD, corresponding author: e-mail:gordana.dimitrovska@uklo.edu.mk, mobile:+389 72 230 373, Aleksandra Grozdanovska; Vesna Karapetkovska - Hristova, Assistant Professor; Borche Makarijoski, PhD; Katerina Bojkovska, Associate Professor; Faculty of biotechnical sciences, University St. Kliment Ohridski, Bitola, Macedonia.

The quality of the milk can be considered as basic and technological. The basic quality refers to fresh raw milk, milk for consumption and milk as raw material for processing, while technological quality refers to the processing of milk into dairy products.

Ewe's milk is a great raw material for dairy products, especially in cheese production. The genotype, the feeding technology, the botanical composition of the pastures, the health condition, the number of ewes lambing and live-born lambs, the milking technique and other factors have the biggest influence on the quality of ewe's milk, (Prpić et al., 2006).

Modern zoo technique and dairy farming, as well as good hygienic practices are the most important aspects of the production of good quality milk, because milk is an ideal medium for the growth and development of pathogenic microorganisms, and therefore a potential danger to human health.

In that sense, today in the world hygienic quality is actually the basis of the total market valorisation of milk. On the basis of the above criterion, national regulations were adopted which include bacteriological and cytological standards in raw milk and its classification into several classes so that it can be edequatily paid (Hadziosmanovic, 1995).

With the implementation Council Directive 92/46 of the European Union, higher criteria for the quality of raw milk have been established. Thus, according to that directive, the quality of milk is established not only according to the chemical composition and physical properties, but also on the basis of hygienic quality and the presence of residues from some inhibitory substances.

In our country in 2018 the total number of milking ewes was 541 268, the average production of milk per ewe was 68 liters and the total production of ewe's milk was 36 599 000 liters, (State Statistical Office of R. N. Macedonia, 2018).

MATERIAL AND METHODS

This study on the quality of ewe's milk as a raw material in the dairy industry of the Republic of North Macedonia, was realized in the period from February to June 2018 in three different regions (I, II and III) in Pelagonia, Bitola. The first region was 10km away from the dairy, the second region was 10 to 30 km away and the third region was distance of over 30 km away. The samples were taken from collected milk that was separately brought from each region in a with transportation tanks to the dairy reception point. The physico-chemical analysis of the examined ewe milk samples includes contents of milk fat, proteins, lactose and non-fat dry matter (NFDM), that were analysed by using Lactoscope, Delta Instruments, acoording to ISO 9622:1999 (E). The freezing point of the milk was detected with a cryoscopy method using Cryo Star Funke Gerber (ISO 5764:2009). The titrable acidity was measured according to the method by Caric et al*.,* (2000). The total number of microorganisms as one of the most important factor for hygienic quality of the milk was detected by using Bentley Bactocount IBC (MKC EN ISO 21187:2011). The total number of somatic cells in the milk was detected by a Fluoro-optic electronic method (ISO 13366-2:2010) with Bentley Somacount CC150. Physico-chemical and microbiological parameters of ewe's milk were in different stage of lactation. The initial lactation stage was 42-70 days after birth, the middle lactation stages was between 71 and 120 days after birth and the late lactation was 121 days to the end of lactation. The obtained data were statistically processed by the use of the program package Microsoft Office (Microsoft Excel).

RESULTS AND DISCUSSION

Usually the chemical composition of ewe's milk contains 6-9% milk fat, 4-7% proteins, 4-6% lactose and 17-21% dry matter (Simos et al., 1996). The obtained results of the physico-chemical characteristics of the milk from three regions in North Macedonia are presented in Table 1.

According to our results presented in Table 1 it can be concluded that the percentage of milk fat in analysed ewe milk samples was constantly increasing during the examined period. During the first stage of lactation, the lowest milk fat content- 6.6±0.22% was observed in Region I, and the highest milk fat content with 7.16±0.72% was observed in Region II. In further lactation periods in all examined regions constant increased of milk fat content was observed. This phenomenon was due to changes in ewe's diet and the gradual reduction of water in the plants and also the increase of the percentage of dry matter in the flora of the pastures. According to many scientific papers, as lactation period comes to an end, ewe itself has a genetic potential that influences the constantly growing percentage of milk fat. At the end of lactation period the lowest percentage

Table 1 Physico-chemical characteristics of ewe milk samples

Tablica 1. Fizikalno-kemijske karakteristike uzoraka ovčjeg mlijeka

Parameters Parametri	Stage of lactation	Region I - Područje I n 42			Region II - Područje II n 41			Region III - Područje III n 40		
		$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
Milk fat (%) Mliječna mast (%)	Initial	6.6	0.22	3.33	7.16	0.72	10.05	7.14	0.44	6.16
	Middle	6.69	0.17	2.54	7.34	0.21	2.86	7.58	0.4	5.27
	End	7.21	0.27	3.74	7.91	0.22	2.78	8.33	0.27	3.24
	Average	6.83	0.22	3.2	7.47	0.38	5.23	7.68	0.36	4.89
Protein (%) Bjelančevine (%)	Initial	5.41	0.15	2.77	5.87	0.26	4.42	5.91	0.2	3.38
	Middle	5.55	0.06	1.08	5.94	0.09	1.51	6.11	0.29	4.74
	End	5.63	0.07	1.24	5.96	0.07	1.17	6.17	0.22	3.56
	Average	5.52	0.09	1.69	5.92	0.14	2.36	6.06	0.23	3.89
Lactose (%) Laktoza (%)	Initial	4.88	0.03	0.61	4.76	0.09	1.89	4.67	0.1	2.14
	Middle	4.82	0.06	1.24	4.82	0.05	1.03	4.7	0.06	1.27
	End	4.68	0.07	1.49	4.57	0.08	1.75	4.5	0.11	2.44
	Average	4.79	0.05	1.11	4.71	0.07	1.55	4.62	0.08	1.95
NFDM (%) STBM (%)	Initial	11.09	0.1	0.9	11.12	0.95	8.54	11.43	0.25	2.18
	Middle	11.13	0.16	1.43	11.49	0.28	2.43	11.5	0.24	2.08
	End	11.27	0.08	0.7	11.55	0.12	1.03	11.61	0.23	1.98
	Average	11.16	0.11	1.01	11.38	0.44	4	11.51	0.24	2.08
Freezing point Točka ledišta	Initial	-0.566	0.003	0.54	-0.546	0.01	1.24	-0.554	0.007	1.19
	Middle	-0.561	0.005	0.81	-0.544	0.01	2.07	-0.552	0.012	2.08
	End	-0.557	0.004	0.75	-0.539	0.05	0.87	-0.567	0.008	1.48
	Average	-0.561	0.004	0.69	-0.543	0.01	1.39	-0.557	0.009	1.57
Acidity (°SH) Kiselost (°SH)	Initial	8.59	0.4	4.69	8.62	0.27	3.07	8.72	0.39	4.44
	Middle	8.62	0.45	5.21	8.76	0.41	4.72	8.93	0.58	6.53
	End	8.63	0.35	4.1	8.93	0.53	5.94	8.98	0.43	4.8
	Average	8.61	0.4	4.67	8.77	0.4	4.58	8.88	0.47	5.26

of milk fat was observed in Region I – 7.21±0.27%, and the highest percentage of milk fat was observed in Region III – 7.68±0.36%. The average percentage of milk fat in examined milk samples was as follows: Region I – 6.83±0.22%, Region II – 7.47±0.38% and Region III – 7.68±0.36%. Although milk fat is the most variable milk component, in our study no great variability was found that could be determined from the coefficient of variation, which was in the average range from 3.20% to 5.23%.

Our results are similar to those presented by Mahmood and Usman (2010), who found out that ewe milk analized from different regions of Pakistan contained 6.49±0.23% milk fat. The analysis of ewe milk for fat content, from three different Greek local breeds, that was done by Skoufos et al. (2017), was within of our results. The milk fat percentage was from 6.12% to 8.57%. A constantly increase of milk fat content during lactation period has been noticed, which has been confirmed by our results.

According to our Regulation for Raw Milk Quality, (2012), ewe milk needs to contain minimum of 4% milk fat, and the milk samples from all examined regions in this study have met this criterion.

The protein content in ewe milk samples in all examined regions was constantly increasing during the lactation period. At the first stage of lactation the highest protein content – 5.91±0.20% was observed in Region III, and the lowest in Region I – 5.41±0.15%. At the end of lactation, the highest percentage of protein content was also found in milk samples in Region III – 6.17±0.22%, and the lowest in Region I – 5.63±0.07%. The average percentage of protein in examined milk samples was as following: Region I – 5.52±0.09%, Region II – 5.92±0.14% and Region III – 6.06±0.23%. No great variability was found in protein content, which could be determined from the coefficient of variation, which was in the average range from 1.69% to 3.89%.

Our results are similar to results presented by Gregurek (2015), who has determined that ewe milk has an average of 5.74% proteins. According to Antunac et al. (2008) ewe milk contains 6.04% proteins, which is also in the range of our results. According to Talevski et al. (2009), who have examined 270 ewe milk samples from different regions in Macedonia, have determined an average value for milk proteins of 5.89%, which is in accordance with our results.

According to our Regulation for raw milk, ewe milk needs to contain a minimum of 3.8% milk protein, and the milk samples from all examined regions in this study have met this criterion.

In this study we have observed a minimal and continuously decreasing of lactose content in all examined ewe milk samples during lactation period. The lactose decrease was also observed by Antunac et al. (2008). The average percentage of lactose in examined milk samples was as follows: Region I – 4.79±0.05%, Region II – 4.71±0.07% and Region III – 4.62±0.08%.

Similar results to ours were also presented by Antunac et al. (2008), who determined the average percentage of lactose - 4.45%. Talevski et al. (2009), presented results which match ours -3.58 to 4.94%, with an average of 4.37% lactose in milk.

A constant increase NFDM in ewe milk samples was observed during the lactation period in all examined regions. At the first stage of lactation the percentage of NFDM was at the highest level in Region III – 11.43±0.25%, and the lowest level in Region I – 11.09±0.10%. In the middle stage of lactation, the highest level of NFDM was also found in Region III. At the end of lactation period NFDM was in the range of 11.27±0.08% to 11.61±0.23%. The average values for NFDM during the whole lactation in all regions were in the range of 11.16±0.11% to 11.51±0.24%. No great variability was found in NFDM in all examined milk samples, which could be determined from the coefficient of variation, which was in the average range from 1.01% to 2.08%.

Hanuš et al. (2015) determined that NFDM in ewe milk in Slovakia, was between 9.05% and 12.98%, which also matched our results.

According to our Regulation for raw milk, ewe milk needs to contain a minimum of 9.50% NFDM, and the milk samples from all examined regions in this study have met this criterion.

According to the results of examined ewe's milk samples from all regions it can be concluded that milk producers did not make milk falsification. The average value for freezing point was ranged between -0.561 and -0.543 °C. These values are very small and it can be concluded that the water in milk was probably left behind after got washing the dairy equipment.

Ewe milk has higher milk acidity and it ranges from 8.0 to 9.6 °SH in the first half of the lactation and 10-12 °SH in the second half of the lactation (Antunac and Havranek, 1999). From our results it can be established that the titratable acidity of ewe's milk from all examined regions showed a constant increase during lactation. In the initial period of the study, titratable acidity was in the range from 8.59 °SH to 8.72 °SH. In the middle stage of lactation, titratable acidity increased and it was in the range between 8.62 °SH to 8.93 °SH.

The acidity at the end of the analysis was 8.63 °SH to 8.99 °SH. The average value of all samples from the purchasing regions ranged from 8.61 °SH to 8.88 °SH. Our results are similar to those of Kuchtik et al. (2008) in milk obtained from the East Frisian ewe where titrable acidity increased from 7.24 °SH (33 days) to 8.93 °SH (191 days). According to our Regulation for raw milk, titrable acidity of ewe milk should be 8-12 °SH, and the milk samples from all examined regions in this study have met these criteria.

According to the current Regulation for Raw Milk Quality (2012), ewe milk should contain less than 1 500 000 of colonies at 30 °C in 1 ml.

From our results it can be established that ewe milk from examined regions did not meet the requirements of the Regulation for milk safety and hygiene. Namely, the best microbiological results were found in milk samples from Region I with

an average number of 532 444 / mL, while the worst microbiological picture had ewe milk from Region III with 1 986 222/mL, (Table 2).

Antunac et al. (2008) found variations in the total number of bacteria in milk samples analized from the ewes of Krk breed, (83 000 / mL morning milking - 552 000 / mL evening milking). Our results have shown higher values for this examined parameter. Furthermore, our results are in accordance with the previously established results presented by Talevski et al. (2009), who examined ewe's milk quality from three different regions in the Republic of Macedonia. In their research, the microbiological quality of ewe milk at the state level was very poor with TBC level between minimum of 378 000/mL, and maximum of 29 638 000/mL in all samples. In this study a constant increase of the number of somatic cells in the beginning until the end of our research was observed. The average number of somatic cells from all examined samples was from 753 333/mL (Region II) to 1 125 000/mL (Region I).

According to the Regulation for Raw Milk Quality (2012), the values of SCC of ewe milk could be a maximum of 1 500 000 somatic cells in 1 ml. A lot of researchers have presented different values of SCC in the milk samples as follow: Talevski et al. (2009), 378 000 -1 300 000/ mL, Antunac et al. (2008), 816 000/mL, Bogdanovičová et al. (2016), 50 000/mL to 1 900 000/mL, and all of these presented values for SCC were in accordance with our results.

CONCLUSIONS

According to the analyses which have been made and the presented results on the ewe's milk quality from three different regions, it can be concluded that all physico-chemical parameters met the needed criteria, but the microbiological quality of the examined milk samples was poor. The average values for chemical composition of milk were as follows: milk fat from 6.83±0.22% (Region I) to 7.68±0.36% (Region III), proteins from 5.52±0.09% (Region I) to 6.06±0.23% (Region III), lactose from 4.62±0.08% (Region III) to 4.79±0.05% (Region I), NFDM from 11.16±0.11% (Region I) to 11.51±0.24% (Region III), added water from 0 to 0.05%, titrable acidity from 8.61±0.4°SH (Region I) to 8.88±0.47°SH (Region III). The average somatic cell count ranged from 753.333/mL (Region II) to 1.125.000/mL (Region I) and average number of total bacteria was from 595.791 cfu/mL (Region I) to 1.986.222 cfu/mL (Region III). In our research, was identified poor hygienic quality of ewe's milk from all examined regions therefore we highly recommend that measures should be taken as soon as possible by the State authorities and Scientific institutions to improve the milk quality hygiene and. With a better understanding of the importance of milk hygiene and quality parameters, milk producers will be educated and trained on implementation of modern production practices, which will result in producing milk of better quality that meets the Standards of industry and consumers acceptance.

Table 2 Microbiological and hygienic characterstics of ewe milk samples

Tablica 2. Mikrobiološke i higijenske karakteristike uzoraka ovčjeg mlijeka

Parameters Parametri	Stage of lactation	Region I - Područje I n 11			Region II - Područje II n 12			Region III - Područje III n 9		
		X	SD	CV	X	SD	CV	X	SD	CV
TBC (CFU/ml)	Initial	309 375	178 563.26	57.71	444 333	298 171.51	67.1	2.058.666	1 812 010.34	88.01
	Middle	387 000	311 126.98	80.39	389 000	120 208.15	30.9	3 024 000	3 292 289.17	108.87
	End	1 091 000	1 251 579	114.71	764 000	472 347.33	61.82	876 000	106 066.02	12.1
	Average	595 791	580 423.08	84.28	532 444	296 909.00	53.28	1 986.222	1 736 788.51	69.67
SCC/ml	Initial	1 155 000	68 526	5.93	608 000	74 566	12.26	880 000	98 699	11.21
	Middle	980 000	74 998	7.65	748 000	89 743	11.99	743 000	128 741	17.32
	End	1 240 000	65 447	5.27	904 000	80 222	8.87	920 000	130 054	14.13
	Average	1 125 000	69 657	6.19	753 333	8 1510	10.81	847 666	119 164	14.05

REFERENCES

1. Antunac N., Mikulec N., Bendelja D., Prpić Z., Barać Z. (2008): Karakterizacija i istraživanje kvalitete mlijeka u proizvodnji krčkog sira. Mljekarstvo 58 (3), 203-222.
2. Antunac N., Lukac-Havranek J. (1999): Proizvodnja, sastav i osobine ovčjeg mlijeka. Mljekarstvo 49 (4), 241-254.
3. Bogdanovičová K., Vyletělová-Klimešová M., Babák V., Kalhotka L., Koláčková I., Karpíšková R. (2016): Microbiological quality of raw milk in the Czech Republic. Czech J. Food Sci., 34: 00–00.
4. Carić, M, Milanović, S., Vucelja, D. (2000): Standardne metode analize mleka i mlečnih proizvoda, Prometej, Novi Sad.
5. Council Directive 92/46/EEC of 16 June 1992 laying down the health rules for the production and placing on the market of raw milk, heat-treated milk and milk-based products
6. Gregurek Lj. (2015): Proizvodnja sireva - teorija i praksa. Probiotik d.o.o Zagreb.
7. Hadziosmanovic M. (1995): Mlijeko medicinski i prehrambeni problemi. Hrvatska akademija medicinskih znanosti. Zagreb.
8. Hanuš O., Tomaška M., Hofericova M., Vyletelova-Klimešova M., Klapačova L., Jedelska R., Kološta M. (2015): Relationship between freezing point and raw ewes' milk components as a possible tool for estimations of milk adulteration with added water. Journal of Food and Nutrition Research. Vol. 54, No. 4, pp. 281-288.
9. Kuchtik J., Šustova K., Urban T., Zapletal D. (2008): Effect of the stage of lactation on milk composition, its properties and the quality of rennet curdling in East Friesian ewes. Czech J. Anim. Sci. 53(2), 55-63.
10. Mahmood A., Usman S. (2010): A Comparative study on the Physicochemical Parameters of Milk Samples Collected from Buffalo, Cow, Goat and Ewe of Gujrat, Pakistan. Pakistan Journal of Nutrition 9 (12), 1192-1197.
11. Official Gazette of the Republic of Macedonia no. 26 (2012): Rulebook on the special requirements for safety and hygiene and the manner and procedures for performing official controls of milk and dairy products. Food and Veterinary Agency.
12. Prpić Z., Pavić V., Mioč B., Antunac N., Samaržija D., Barać Z., Vnučec I. (2006): Stadij laktacije kao čimbenik proizvodnosti i kakvoće ovčjeg mlijeka. 41 hrvatski i 1 međunarodni znanstveni simpozij agronoma, Opatija, 13 -17. veljače. Zbornik radova.
13. Simos E.N., Nikolaou E.M., Zoiopoulos P.E. (1996): Yield, composition and certain physicochemical characteristics of milk of the Epirus mountain ewe breed. Small Rumin. Res., 20, 67-74.
14. Skoufos I., Giannenas I., Karamoutsios A., Tsinas A., Papadopoulos G.K., Tzora A. (2017): Milk quality characteristics of indigenous ewe breeds Boutsko, Frizarta and Karagouniko. J. Hellenic Vet. Med. Soc. 68 (1), 059-066
15. Statistical Yearbook of the Republic of Macedonia, State statistical office, 2013-2016
16. State Statistical Office of R. N. Macedonia, Yearbook, 2018.
17. Talevski G., Čobanova-Vasilevska R., Srbinovska S., Sireta Z. (2009): Quality of the ewe milk as a raw material in dairy industry of Macedonia. Biotechnology in Animal Husbandry 25 (5-6), p. 971-977

SAŽETAK

Ovaj se rad temelji na analizi fizikalno kemijskih i mikrobioloških značajki ovčjeg mlijeka iz triju različitih dijelova Republike Sjeverne Makedonije koje se upotrebljava kao sirovina u mliječnoj industriji. Svi uzorci mlijeka (n=123) sakupljani su na sabiralištima mljekarske industrije na području Pelagonije u razdoblju od šest (6) mjeseci. Prosječne vrijednosti kemijskog sastava mlijeka kretale su se u sljedećem rasponu: 6,83±0,22% do 7,68±0,36% za mliječnu mast, od 5,52±0,09% do 6,06±0,23% za bjelančevine, od 4,62±0,08% do 4,79±0,05% za laktozu, od 11,16±0,11 do 11,51±0,24% za suhu tvar bez masti (STBM), od -0,561 do -0,543 °C za točku ledišta i od 8,61±0,4 °SH do 8.88±0.47°SH za titracijsku kiselost. Mikrobiološko i higijensko stanje pregledanih uzoraka ovčjeg mlijeka bilo je slabe higijenske kakvoće. Prosječna vrijednost pregledanih uzoraka za broj somatskih stanica kretala se od 753,333 cfu/ml do 1.125,000 cfu/ml, a prosječni broj ukupnih bakterija bio je od 532,444 cfu/ml do 1.986,222 cfu/ml .

Ključne riječi: ovca, fizikalno kemijska značajka, kakvoća mlijeka