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EFFECT OF SEASONS ON BULK MILK QUALITY IN FERIZAJ PROVINCE

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Abstract
In this study was evaluated the effect of season on bulk milk quality and compare the results between five principal regions in Ferizaj province, Kosovo. Fresh milk samples from the two years period between January 2018 and December 2019 were used as the research material. Samples were taken at five region farms in the municipality of Ferizaj for twelve months and analyzed in an accredited laboratory at Food and Veterinary Agency. One-way ANOVA was used to detect changes in the physicochemical composition and the total number of bacteria according to the impact of the season and farm location. Total bacteria count (TBC), somatic cells count (SCC) and physical-chemical parameters were affected by the period of seasons and varied significantly between regions ($P<0.05$). The levels of TBC bacterial count elevated from 4.90 to 7.03, 4.90 to 6.24, 5.88 to 6.43, 4.90 to 6.20 and 6.04 to 7.29 log cfu/ ml for A (Tern), B (Sojevë), C (Prelez), C (Softaj) and E (Pleshin) regions farm, respectively. The milk samples from the second season had higher bacterial counts inc comparison to another season. Finally, the current study shows that samples from the region of Sojevo, Prelez, Softaj and Pleshina included risks in terms of elevated levels in the somatic cell and total bacteria counts that imply more focus on milking hygiene and storage conditions.

Keywords: Milk quality, total bacteria count, somatic cell coun

1. Introduction

The influence of the seasons on animals may change milk characteristics over time. Among the main causes of these changes can involve dietary factors, especially the quality of feeds, as well as skills, housing circumstances, and the climatic seasons (microclimatic) of the region where the animals are breed (Bernabucci *et al*., 2015). Administration recommendation and milk-recording schedule are influenced by the sensibility of the variability in milk physical –chemical composition, hygienic parameters and the milk yield (Quist *et al.,* 2008). The nutrition aspect plays a great role as cows during winter are kept inside and feed with silage instead during spring-summer kept on pasture and fed with fresh grass. These significant variations in diets may impact physical and chemical properties of milk. Milk nutritional quality, processability, dairy product quality and safety are influenced by the milk composition and microbiological levels they are important factors to consider when evaluating quality (Malek dos Reis *et al*., 2013).

According to the country, region, livestock management practices and food safety standards, the parameters defining milk quality vary concerning the health aspects and hygiene conditions. Internationally accepted indicators of raw milk quality are such as: low total bacterial count, low somatic cell count, high fat and protein contents, absence of residues and contaminants, tuberculosis and brucellosis-free livestock. Changes in milk considerably affect the production, as well as the quality and safety of the final product (Picinin *et al.,* 2019).

Milk is one of the great nutritious foods which is rich in essential components for the development and maintenance of a good life. The importance is due to its abundance in protein, fat, lactose, vitamins, minerals, etc. which supply nutritional and immunological security. The physicochemical and biological properties of the milk can be easily altered by the activity of microorganisms thus, hygienic milking conditions and milk storage conditions are vital to ensure high quality (Paludetti *et al.,* 2018). The impact of the season on the variation of milk parameters is difficult to determine. Many factors affect milk quality such us: season, e.g. food, method of storage, lactation stage, temperature, humidity, etc. The most pronounced changes are presented to us in the seasonal extremes, that is the winter-summer period. The milk yield increases from spring and reaches its maximum in summer. The dry milk yield decreases in spring, while in summer there is a significant increase and the maximum reaches in the winter period. The lowest milk fat is in summer and more high at the beginning of the winter period. The decrease and increase are from 0.2% to 0.3% on average. General proteins and casein show the same difference (Vujičić, 1985).

According to the Ministry of Agriculture of the Republic of Kosovo (MAFRD), the average number of dairy cows in households is 1-5 heads, which makes up the majority of cows in milk production (94.2 %), while only 5.8 % are commercial farms that have over 5 heads of dairy cows. Farms with over 5 dairy cows are the main suppliers of the dairy processing industry. According to the data, there are 4.238 farms in the country with over 5 dairy cows that send about 62.2 million liters of milk per year to the dairy industry (MAFRD, 2015). The total local consumption of milk is estimated to be around 339.600 tons/year (with the change of calculations it varies), a value based on the number of inhabitants, about 2 million and the consumption of milk and dairy products, which is estimated to be around 170 l / per capita/year. The total production in Kosovo is estimated to be around 257.571 l tons/year and imports 82.024 tons/year complement the lack of supply. Domestic production is estimated to be about 76 % of total consumption, while imports cover 24 % (SOK, 2006).

Taking into consideration the importance of raw milk quality as a precursor for the quality of milk products in Kosovo, as well as the diversity of microclimates in regions, it is important to gather information on the effects of seasonal conditions and dairy management practices on milk quality parameters. Despite the lack of studies on the determination of TBC and SCC in Kosovo, these investigations especially focused season variation. At this point, there is no detailed research pertaining the factors affecting TBC and SCC of bucket milk. This will also help to public health by revealing common risk factors for cow milk. The objective of this study was to investigate some factors effective on TBC and SCC of bovine milk in Ferizaj province, Kosovo.

2. Materials and methods

Milk samples were collected from bulk milk tanks of five dairy farms in the Ferizaj region, Kosovo during the four seasons within the one year. For each property selected, raw milk samples were collected once monthly over two years (January 2018 - December 2019), totalling 120 raw milk samples. The farms were labelled as A (Terrni), B (Sojeva), C (Prelez), D (Softaj) and E (Pleshina) are the location of 5 livestock farms selected in the study (Figure 1). All analyzes were performed in the accredited milk laboratory within the Food and Veterinary Agency, according to the protocols for the respective analyzes. This activity was developed in the framework of the cooperation of the Food and Veterinary Agency. Samples were taken by the approved method by ISO and IDF (ISO 13366-2:2006; IDF 141C:2000; IDF 148-2:2006; IDF 161A:1995). During the sampling, the following data are recorded: the name of the owner, the exact time of sampling, the type of

analysis required, the description of the products from which it was obtained the samples, the method of storage and storage of its products. Before sampling the milk is mixed well and with the help of a special spoon the test tube is filled, then treated with Azidol preservative, with two drops each test tube and stored in 4˚ C until it is sent for analysis for up to 5 days.

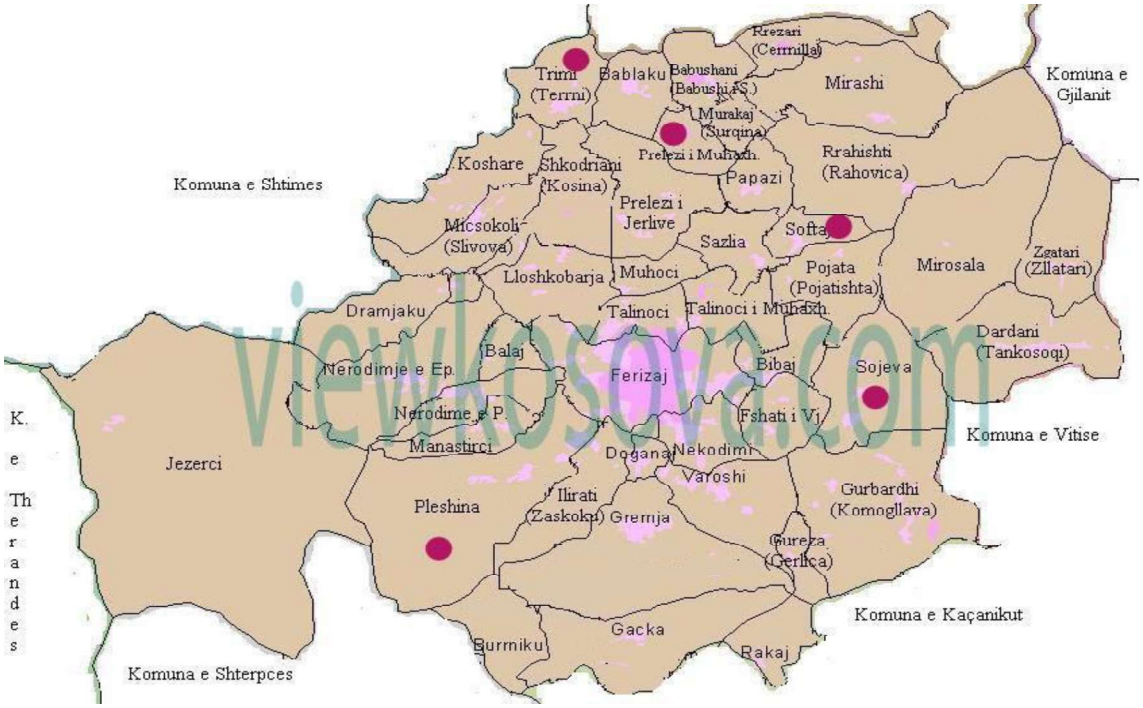

Figure 1. Geographical positions of regional farms marked with red dots

Fresh milk samples were analyzed by the Fourier Transform Infrared Spectroscopy (FT 120, Foss Electric, Hillerød, Denmark). Somatic cell count was determined by a fluorometric method on fresh samples (Fossomatic 180, Foss Electric). The determination of the number of bacterial colonies in milk was performed by BactoScan, based on the Flow cytometry technology.

2.1.Statistical analyses

For statistical analysis, TBC values were transformed to log10 base due to obtain homogenity of variance among data. All statistical analyses were performed using SPSS 16.0 (2007) at 0.05 level. While effect of season and region on TBC were tested by one-way Anova, group means were compared with Duncan test.

3. Results and discussions

The composition of fresh milk or some of its parameters can be generally influenced by the season or by the regions due to many factors. In the event of serious and professional attention to animal health, we may not have any significant effects on milk parameters.

Table 2. Milk characteristics observed in winter, spring, summer and autumn season

Parameters	Season	A	B	C	D	E
Fat. %	I	3.57	3.37	3.6	4.27	4.03
	II	3.53	3.74	3.89	3.84	3.45
	III	3.09	3.44	4.14	4.01	4.09
	IV	4.17	3.52	4.14	3.65	3.77
	P-value	**0.39**	**0.49**	**0.75**	**0.52**	**0.39**
Protein. %	I	3.62	3.04	3.16	3.09	3.34
	II	2.86	3.17	3.12	2.69	3.28
	III	2.57	3.08	2.98	3.02	3.27
	IV	3.34	3.34	3.20	3.28	3.35
	P-value	**0.01**	**0.54**	**0.6**	**0.24**	**0.75**
Lactose. %	I	4.33	3.33	4.00	3.67	4.00
	II	4.00	4.00	4.00	3.67	4.00
	III	4.00	4.00	4.00	3.67	4.00
	IV	4	4.00	4.00	3.67	4.00
	P-value	**0.45**	**0.45**	**1**	**1**	**1**
*SNF. %	I	9.53	7.99	8.39	8.21	8.73
	II	8.53	8.79	8.51	7.74	8.77
	III	8.2	8.54	8.35	8.09	8.58
	IV	8.59	8.79	8.47	8.26	8.44
	P-value	**0.05**	**0.63**	**0.87**	**0.66**	**0.63**
Total solids. %	I	13.07	11.5	12.06	15.88	12.81
	II	12.08	12.54	12.43	14.94	12.26
	III	11.33	12.02	12.52	13.67	12.78
	IV	12.8	12.34	12.65	13.05	12.56
	P-value	**0.07**	**0.62**	**0.76**	**0.38**	**0.41**
Density gr/cm³	I	1.034	1.029	1.028	1.025	1.031
	II	1.030	1.031	1.029	1.023	1.031
	III	1.029	1.03	1.029	1.027	1.029
	IV	1.029	1.031	1.029	1.027	1.031
	P-value	**0.07**	**0.44**	**1**	**0.8**	**0.9**

	I	9.95	5.93	7.71	7.06	7.45
	II	6.48	7.56	6.64	5.60	8.12
pH	III	6.13	6.65	6.33	7.41	8.12
	IV	8	7.26	6.17	7.42	7.54
	P-value	**0.15**	**0.36**	**0.14**	**0.36**	**0.41**

**Solids non fat, Regions: A (Tern), B(Sojevë), C (Prelez), D (Softaj), E (Pleshin)*

The minimum fat content results in the summer season (3.09 %) in the region of Ternj and the maximum in the winter season (4.27 %) in the region of Softaj (Table 1) however variations in fat content was not significantly important(P>0.05). The minimum protein value (2.57%) was in the spring season, in the Terrn region and (2.69 %) in the spring season in the Softaj region. In the region of the Trnj there are significant differences in the level P>0.05.

In the current study, the lower concentration of fat and protein in milk were observed in summer and the greater concentration were observed in winter; intermediate values were observed in spring (Figure 2). Reduction of fat and protein concentration and milk yield as temperature increases has been reported (Bertochi *et al*., 2014, Bernabucci *et al*., 2010; Calamari *et al*., 2013). The milk and the safety of its products can be increased by applying good hygienic standards at the animal level, in stable conditions and milking sites, and through the uniform application of milking practices that reduce milk pollution (Zucali *et al.,* 2011).

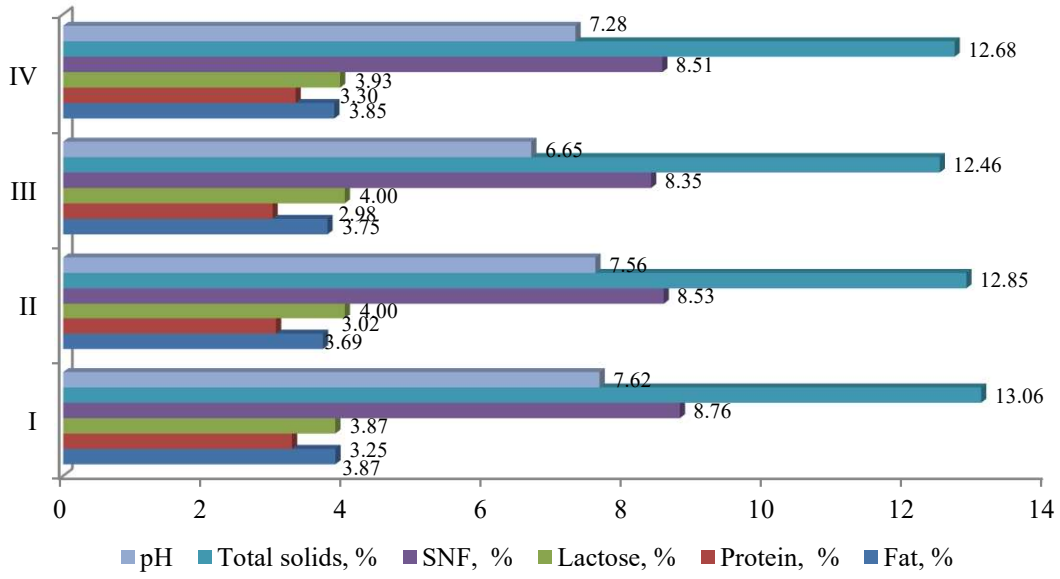

Figure 2. Physical-chemical composition of the bulk milk during four seasons

Generally for the main milk components (total solids, SNF, fat, and proteins), the lowest values were observed in summer season and the greatest in winter; intermediate values were observed in spring. Among the main milk components, only lactose did not change throughout the seasons (Table 1). Similar results were determined by Bernabucci *et al.* (2015) for the fresh milk from Italian Holstein lactating cows located near Brescia, Italy. A mild effect of season was observed for milk TBC (Table 2), with greater values in spring (6.24 log $^{-1}$). The minimum lactose content was (3.33 %) in the winter season in the Sojevo region and the

maximum was (4.33 %) in the winter season in the Terrn region.The minimum value of lactose resulted (3.33 %) in the winter season in the Sojevo region. Also, the region in Softaj resulted in 3.67 % in all seasons that according to the administrative instruction (UA-NR.20 / 2006) should contain at least 4.5-4.6 % lactose. The non fat solid in the Tërn region (8.20 %) in the summer season, Sojeva region (7.99 %) in the winter season, Prelez Muhaxheri region in the winter season, autumn(8.39 %, 8.35 %, 8.47 %), Softaj in all seasons (8.21 %, 7.74 %, 8.09 %, 8.26 %) and the Pleshina region in the autumn season do not meet the criteria of fresh milk according to the instruction.

The total solids in all regions meet the criteria of fresh milk except in the summer season (11.33 %) in the region of Trnni as according to the instruction the milk must contain at least 11.5 %. According to the MA-NR.20 / 2006 administrative instruction, the minimum density value should not be less than 1.028gr / cm³ and not higher than 1.032gr / cm³. The table presents that the density in the Tern region in the winter season (1.034gr / cm³) and in the Softaj region in winter (1.023 gr / cm³) spring (1.025 gr / cm³) summer (1.027 gr / cm³) and autumn (1.027 gr / cm³) seasons does not meet the milk quality standards. The acidity value should be 6.5 - 7.8 as instructed. Based on the results, we see that in the region of Tërrn it does not meet the criteria, in the region of Sojeva in the winter season (5.93 %), in the region of Prelez of Muhaxherve in the summer and autumn season (6.33 %, 6.17 %) does not meet criteria, in the region in Softaj in the spring season (5.60 %) does not meet the standards and in the Pleshina region in the spring and summer season (8.12 %, 8.12 %) does not meet the criteria and standards of milk quality standards.

Table 2. Total bacteria count during seasons in Ferizaj province

Parameters	Season	A	B	C	D	E
TBC, log ($n \cdot mL^{-1}$)	I	4,90	6,24	6,42	6,18	7,28
	II	7,03	5,97	6,30	4,90	7,00
	III	5,46	4,90	6,17	4,83	6,04
	IV	5,62	6,19	5,88	6,20	6,07
	P (value)	**0,24**	**0,60**	**0,07**	**0,34**	**0,36**

Regions:A (Tern), B(Sojevë), C (Prelez), D (Softaj), E (Pleshin)

Table 2 presents the results for the number of bacterial cells in the 5 research regions. Referring to the results, it is noted that milk, in general, has not been good in microbiological terms. The dairy industry should be concerned about the safety of milk and its derivatives (Doyle & Roman, 1982) because of outbreaks of disease in people. In the Tërn region in the winter seasons, meets the standards based on the administrative instruction. Milk in the Sojevo region meets the standards only in the summer season, in the Softaj region the milk meets the criteria in the spring and summer season and in the Pleshina region milk does not meet the hygienic requirements in any of the seasons.

Tabel 3. Physical-chemical characteristics of milk from five regions at Ferizaj province

Item	*A*	*B*	*C*	*D*	*E*
Fat,%	3.59[a]	3.52[a]	3.94[a]	3.94[a]	3.85[a]
Protein,%	3.10[ab]	3.16[ab]	3.12[ab]	3.02[a]	3.31[b]
Lactose,%	4.08[b]	3.83[ab]	4.00[b]	3.67[a]	4.00[b]
SNF,* %	8.72[a]	8.53[ab]	8.43[ab]	8.07[a]	8.63[a]
TS %	12.32[a]	12.10[a]	12.42[a]	14.39[b]	12.60[a]
Density gr/cm³	1.030[b]	1.030[b]	1.029[b]	1.025[a]	1.031[b]
pH	7.64[a]	6.85[a]	6.71[a]	6.87[a]	7.78[a]
TBClog (n·mL)**	6.46[ab]	6.04[a]	6.24[a]	5.91[a]	6.90[b]

[a-b] Means of values with different letters in the same order differ significantly P <0.05. Solid non fat. **Total bacteria count.*

Regions: A (Tern), B(Sojevë), C (Prelez), C (Softaj), E (Pleshin)

Table 3 presents no significant differences between the regions in terms of fat content (P>0.05). The content of protein in Softaj and Pleshin region presents differences. Lactose in terms of content distinguishes the region in Softaj from other regions. Non-fat total solids displays content differences in the region of Tërrn, Softaj and Pleshinë More with the region of Sojeva and Prelez. Total solids content showing differences in Softaj region more with other regions. The density in Softaj differs from other regions but acidity shows no difference. The number of bacteria displays differences in Pleshina region more with other regions.

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Conclusion

Season of the collection had a significant influence on the milk chemical composition, the highest milk yield with the lowest concentration being obtained during the summer season, while the lowest milk yield with the highest chemical composition was obtained in winter. Physical properties of the raw milk were less affected by the season of collection, with the lowest freezing point in the winter and the highest density in the autumn. The highest somatic cell count and coliform bacteria count was obtained during the spring and the lowest total bacteria count was obtained in the winter season. There was a significant interaction between year and season of production for all raw milk traits. The milk samples showed changes in the composition of the milk. There was a decrease in the% of proteins below the standards allowed in the Tërn region in season II and III (2.86; 2.57), Prelez in season III (2.98), Softaj season II (2.69). The non-fat dry matter showed a decrease of % below quality standards in Tërrn season III (8.20); Prelez season I, III, IV (8.39,8.35,8.47), Softaj season I (8.21), Pleshinë season IV (8.44). The high bacterial loads found in this study prove that the microbiological quality of the milk produced in the four researched farms, was poor. The high level of pollution indicates that no measures are being taken to prevent bacterial growth in raw milk (insufficient cleaning and disinfection of

breastfeeding, inadequate hygiene in the production system, including the disposal of waste on the surfaces of manual/mechanical milking equipment, act as nutrients that support the growth of contaminating microorganisms). These results indicate the need for immediate implementation of training programs for manufacturers, to encourage improvements in the microbiological quality of milk and dairy products offered to consumers.

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