FIVE YEARS STUDY OF SEASONAL VARIATIONS OF MILK COMPOSITION

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ABSTRACT

Serbia has the largest dairy sector in the Balkan region, producing about 1.55 million tons of milk per year. However, farms are still very small and fragmented, with 600,000 cows on 220,000 farms, giving an average herd size of 2.7 animals.
The composition of cows' milk is of the greatest importance for the dairy industry. Compositional parameters were of interest from a nutritive and a technological point of view. In this study, 5945 milk samples were collected in Srem district in Vojvodina and analysed during 5 years (2010 – 2014) for milk fat, protein and non fat dry matter contents. Statistical analysis and estimates of the significance of the variation due to month and season was performed with the Kruscal–Wallis test.
The mean milk fat content was 3.85%, the protein content 3.23% and non fat dry matter 8.46%. All investigated parameters showed significant seasonal variation ($p < 0.01$). As expected, all three parameters were the lowest during summer months while the highest values were found during winter. Factors influencing the composition of milk are numerous including cows breed, feeding systems, milking frequency and milking systems.
Compared with a previous investigation (1976) of milk composition in same part of country, milk fat and non fat dry matter contents increased, while protein content stayed constant. Data from developed countries indicated a higher fat and protein contents meaning that there is space for improvement of milk quality in our country.

***Keywords**: raw milk, milk fat, proteins,non fat dry matter, season*

INTRODUCTION

Serbia has the largest dairy sector in the Balkan region. According to the Serbian Chamber of Commerce, food production participates with 6.4% in the Gross Domestic Product (GDP) of the Republic of Serbia. The dairy sector is among the leading food sectors.

According to official statistical data, total milk production in Serbia is around 1.55 million tons per annum. Cow milk production accounts for about 96% in total milk production in Serbia, while in north part of country - Vojvodina is app. 24%. It is estimated that about 220,000 farms are included in milk production from which 97% has 1 – 5 cows (Perisic *et al.,* 2011). The estimated average number of cows (2.7 animals) is considerably lower than in the EU 25 (about 16.6 cows). The actual composition of the national cattle herd in Serbia is as follows: 35% of pure Simmental, 50% of Domestic spotted cattle of the Simmental type or the domestic Simmental breed, 5% of black-white cattle with various percentages of HF genes, as well as pure Holstein-Friesians, and 10% of primitive breeds and crosses (Petrovic *et al*., 2002). Average milk yield of registered cows of Simmental breed in Serbia is around 4500 kg, and Holstein Friesian breed about 8700 kg, while milk yield in total population of cows in Serbia (controlled heads and estimated milk yield of cows) ranges from 3000 and 3500 kg. In EU 25 average milk yield in overall population of cows is about 6357 kg (Perisic *et al.,* 2011).

Approximately near 50% of milk is delivered and processed in 200 dairy plants of different capacities (Analysis, 2012).

The composition of cow milk is of the greatest importance for the dairy industry. Compositional parameters are of interest from a nutritive and a technological point of view. Factors influencing the composition of milk are internal factors, e.g. the breed of cow, and external factors such as feeding systems, seasonal changes, milking frequency and milking systems.

Over the years many studies have been performed on the composition of milk regard to seasonal variation (Auldist *et al.,* 1998; Lindmark-Månsson *et al.,* 2003; Heck *et al.,* 2009), but but to the best of our knowledge no data was reported ever since about the seasonal variations of the cow milk composition produced in Serbia. The aim of this paper was to analyze the composition of cow milk during five years (2010 – 2014) and to evaluate the impact of seasons on compositional variations.

MATERIAL AND METHODS

Milk samples were collected in Srem district in Vojvodina, north part of Serbia, during five years (2010 – 2014). Total of 5945 samples were analyzed for fat (MF), protein (TP) and non-fat dry matter (NFDM) on Lactoscope C-4 2.0 (Delta Instruments). Analysis were done in triplicate. Seasons were divided as follows: winter (December, January, February), spring (March, April, May), summer (June, July, August) and autumn (September, October, November). Statistical analysis and estimates of the significance of the variation due to month and season was performed with the Kruscal–Wallis test in Statistica 7.1 software (Stat-Soft, USA).

RESULTS AND DISCUSSION

The milk composition determines its nutritive quality and value as a raw material for making different dairy products and many of their properties (Walstra and Jenness, 1984). Simmental is the predominant dairy breed in Serbia (80%) (Petrovic *et al.,* 2002), therefore the analyzed milk samples mainly reflect the composition of this breed. Table 1 shows the mean monthly values of fat, protein and non fat dry matter contents during five years. The mean milk fat content was 3.85%, the protein content 3.23% and non fat dry matter content 8.46%. In developed countries the average content of main milk components are usually higher. Lindmark-Månsson *et al.* (2003) showed that the mean protein and fat content in Swedish milk is 3.37% and 4.34%, respectively, while study about Dutch raw milk composition (Heck *et al.,* 2009) shows even higher protein and fat contents (3.48% and 4.38%). Nevertheless, there are large differences in milk composition in different EU countries (Eurostat, 2016). Ozrenk and Inci (2009) presented much lower fat and protein contents of milk from Van province in Turkey. Even more, large changes in milk composition in the past decades have occurred in EU.

Table 1. Composition of cow milk during months

Month	Number of sample	Milk fat (%)				Total protein (%)				Non fat dry matter (%)			
		Xsr	Min	Max	Sd	Xsr	Min	Max	Sd	Xsr	Min	Max	Sd
January	532	3.93	2.23	5.61	0.38	3.32	2.63	4.72	0.31	8.60	6.61	9.47	0.33
February	530	3.97	2.30	5.65	0.39	3.33	2.51	4.52	0.32	8.60	6.67	9.40	0.33
March	583	3.91	2.07	5.42	0.41	3.26	2.51	4.14	0.30	8.53	7.01	9.49	0.34
April	530	3.84	2.75	6.03	0.38	3.24	2.47	4.28	0.30	8.50	7.41	9.66	0.32
May	564	3.76	2.72	4.67	0.38	3.22	2.52	4.22	0.29	8.47	7.20	9.52	0.31
June	535	3.74	2.26	5.31	0.40	3.13	2.20	4.33	0.29	8.36	6.82	9.54	0.34
July	449	3.69	2.00	4.87	0.40	3.06	2.30	4.04	0.26	8.28	6.74	9.47	0.29
August	460	3.77	1.80	5.04	0.41	3.10	2.30	4.09	0.28	8.29	7.21	9.16	0.29
September	461	3.81	1.88	5.17	0.44	3.19	2.51	4.00	0.27	8.33	6.82	9.13	0.31
October	463	3.91	2.23	4.90	0.40	3.29	2.57	4.32	0.28	8.44	6.99	9.34	0.30
November	422	3.92	2.51	5.27	0.38	3.30	2.47	4.17	0.31	8.50	6.39	9.48	0.37
December	416	**3.97**	2.31	5.39	0.39	3.31	2.64	4.32	0.28	8.55	7.56	9.54	0.31
TOTAL	5945	3.85	1.80	6.03	0.41	3.23	2.20	4.72	0.30	8.46	6.39	9.66	0.34

Comparison of our results with previous investigation of milk composition in the same part of country in 1972-1975 (Vujicic *et al.,* 1976), milk fat and non fat dry matter contents slightly increased, while protein content stayed constant. In Sweden, milk fat content from 1970s increase significantly from 4.03% to 4.34%. Reasons for difference between milk compositions among countries as well as during years are different breeds, feeding regimens and different calving patterns and cattle management (e.g. milking frequency).

Seasonal variations and regional differences in milk composition are of great importance to the manufacturer of dairy products. The variation in the milk nitrogen fraction affects the consistency, yield and quality of a number of dairy products (Mehra *et al.,* 1999). Also, the quality and composition of the milk fat contents are of the utmost importance to the dairy industry.

Seasonal variations of milk fat and protein contents are shown in Figure 1-2. All investigated parameters (milk fat, proteins and non fat dry matter content) showed significant seasonal variations ($p < 0.01$). As expected, all three parameters were the lowest during summer months while the highest values were found during winter. During winter months average milk fat and protein contents were 3.96% and 3.32%, while in summer were 3.73% and 3.10%, respectively. Although the level of the main components can differ, similar seasonal patterns have been found in other studies (Auldist *et al.,* 1998; Lindmark-Månsson *et al.,* 2003; Ozrenk and Inci, 2008; Heck *et al.,* 2009). Heck *et al.* (2009) reported much higher value of both components in Dutch milk and found minimum content of fat and protein in June (4.10% and 3.21%) and maximum in January and December (4.57% and 3.38%).

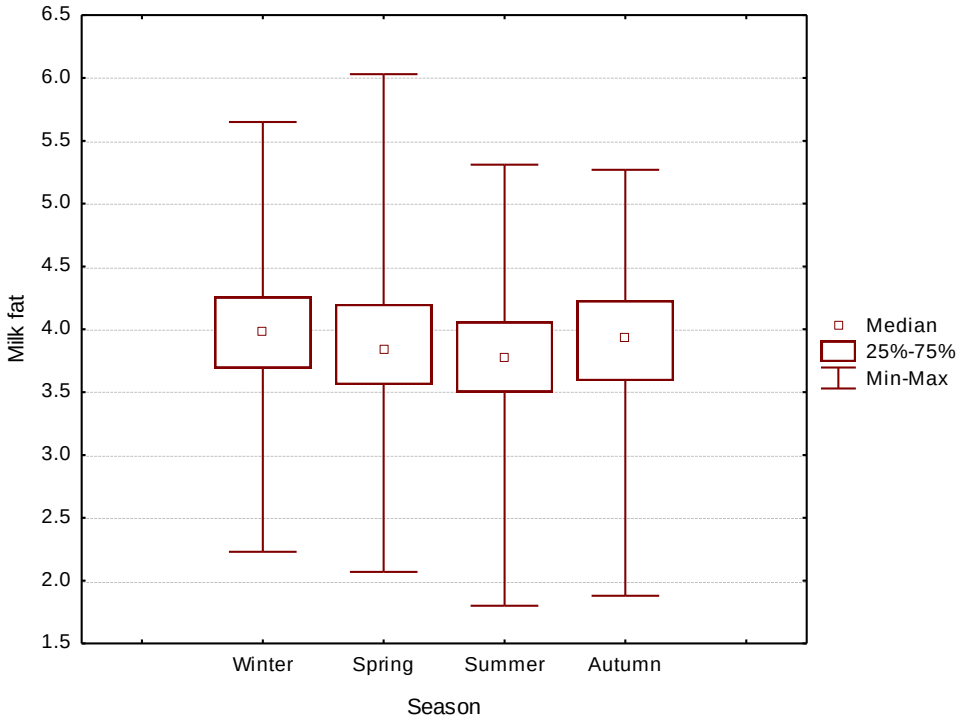

Figure 1. Box-plot of milk fat content seasonal variations

Seasonal variations in milk composition could conceivably be caused by differences in temperature, nutrition, and stage of lactation and the interactions among them (Jennes, 1984). Especially, there is a negative correlation between environmental temperature and the amount of milk fat and protein. Increase of temperature contributes to decrease of non fat dry matter (Ozrenk and Inci, 2008).

However, seasonal variations in the main milk components are mostly the consequence of a feeding regime. Kelly *et al.* (1998) and Elgersma *et al.* (2004) showed that milk composition changes when cows switch from a silage-based diet to a fresh grass based diet and back.

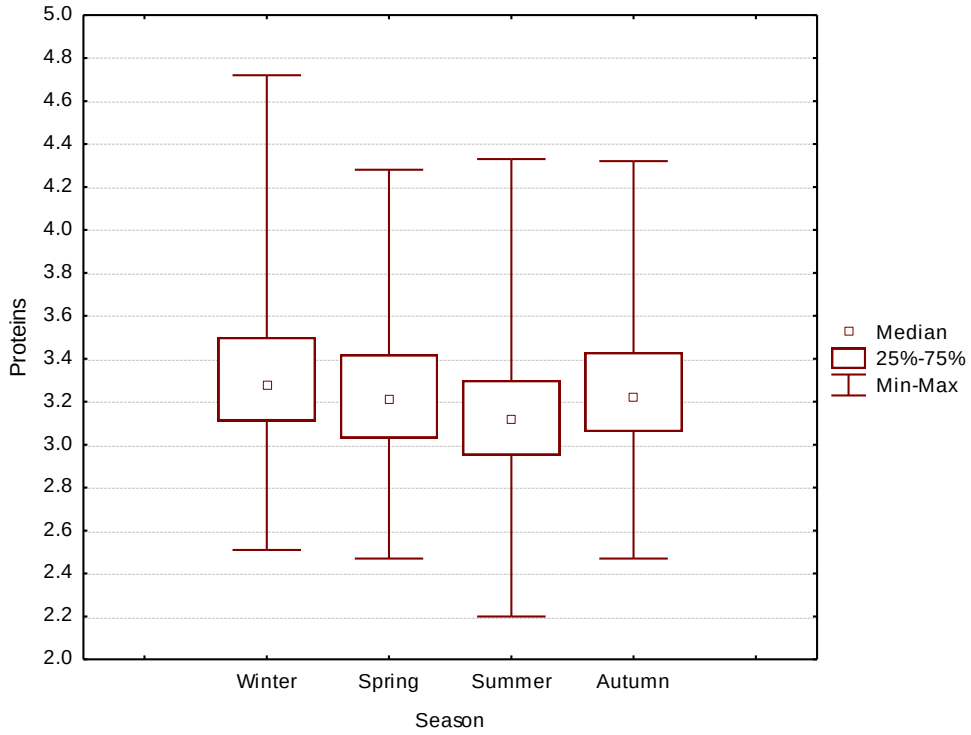

Figure 2. Box-plot of milk protein content seasonal variations

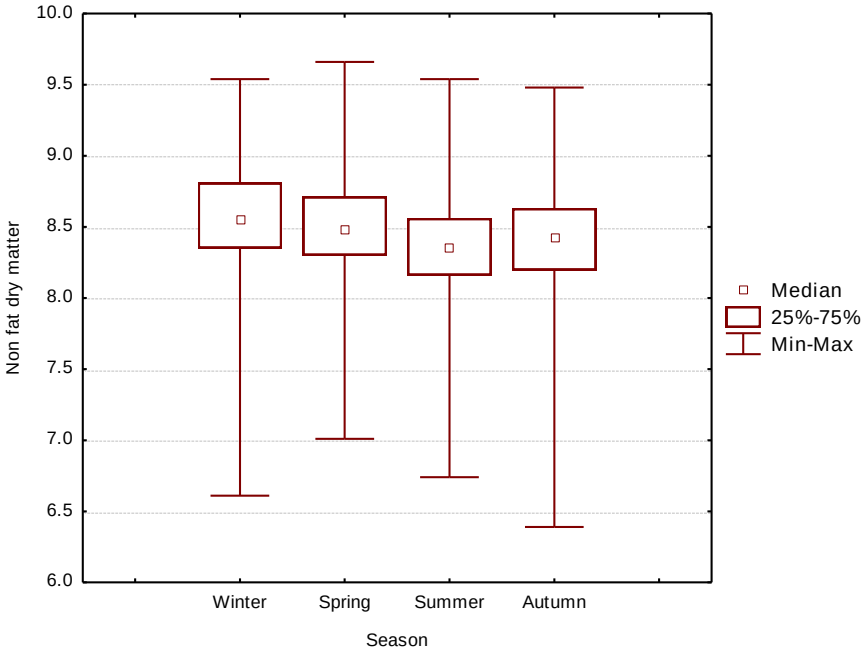

Figure 3. Box-plot of milk non fat dry matter content seasonal variations

Because such changes in the diet of cows occur very rapidly (e.g., with changes of weather conditions), milk composition can change markedly, even on a week-to-week basis. The change of feeding regime is probably the most significant factor influencing the changes in milk composition obtained in our study. Also, availability and quality of pasture through year

influence significantly the milk composition, especially in countries as Ireland, New Zealand where pasture based dairying system are dominant (Auldist *et al.,* 1998). Fat content had the highest variation indicating that fat is the most sensitive component of milk to dietary seasonal changes (Heck *et al.,* 2009). Variation of protein content was less pronounced.

CONCLUSIONS

This work provides data for the composition of cow raw milk in Srem district of Vojvodina, obtained by analysis during five years. Also, this study provides insight into the seasonal changes in milk composition.

Large seasonal variation exists in concentrations of the main milk components. The minimum values for milk fat, proteins and non fat dry matters were found during summer, while the highest were during winter months.

Compared to literature data from developed countries a lower fat and protein contents were found in cow milk in our country, meaning that there is a space for improvement of milk quality.

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