THE INFLUENCE OF TEMPERATURE, RELATIVE AIR HUMIDITY AND TEMPERATURE HUMID INDEX ON THE QUALITY OF COW MILK

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ABSTRACT
Centuries long experience has shown, and decades-long measurements have confirmed that there was no significant difference in the quality of milk on the farm during the year. These variations are correlated with a number of factors. Some of them are biological (are related to characteristics of breeds and individual cows), but a large number of groups are abiotic (Ambient conditions). With regard to biological factors difficult and slow to change, the aim of this study was to investigate the influence of environment conditions on the quality of milk on selected farms. The farm "Stari Tamis" near Belgrade was chosen. There are daily milked 200 cows to 220. About 95% of cows are the Holstein-Friesian and Simmental remained. Over 35% of cows in first lactation, and less than 5% had previously five lactations. Studies were performed using standard methods for determining the total amount of: fat, protein and dry matter. Analyzing the obtained results, it was found that with increasing temperature of the wet index values, there is a decrease in the quantity of dry matter in milk. Thus, at the lowest interval index of up to 74, the percentage of dry matter in milk was 12.26%, while the highest interval index of over 84, the percentage of dry matter was reduced to 11.81%. The increase of the index will result in declining of the amount of fat. In the days when it was the lowest interval when heat stress was hardly any, the amount of milk fat was 3.45%, while on days with extremely strong and heat stress the index value was over 84, fat dropped to 3,18%. The increase of the index humid temperature value, led to a decline in the amount of protein in milk. Thus, at the lowest interval index of up to 74, the amount of protein in milk was 3.30%, while the highest interval index of over 84, the amount of protein was reduced to 3.21%.

Key words: cows, temperature humidity index, stress, quality of cow's milk

INTRODUCTION

On the basis of several-century experience and several-decade measurements, it has been noticed that there is the difference in the quality of cow milk during lactation, and during the calendar year. The factors that lead to the change of milk ingredients are various, and they can be biological and environmental.
The main aim of this study is to notice the regularity of the change of milk ingredients at cows during the year on a farm and to realize the part of the influence of environmental conditions in the possible changes of the ingredients of the obtained milk. Temperature humid index (THI) has been established as the most significant index of environmental conditions.
Many different factors have influence on the ingredients of the obtained milk. As the significant biological factors the following have stood out: age, race, the number of previous lactations and the period of the following lactation, while as the most significant environmental factors we have the atmosphere parameters such as: air temperature, air humidity and temperature humid index.
The extremely high temperatures that can appear during the summer months present the sufficient factor for a very strong stress. Higher temperatures as the single environmental factor, relative air humidity, and their mutual relation presented as THI, can be so stressful for an animal that even its life can be endangered, while the ingredients of milk have changed, first by the falling of the

quantity of main ingredients of the milk quality (WELDY et al., 1964; JOHNSON, 1976; REMOND AND JOURNET, 1987; DRACKLEY, 1999; CINCOVIĆ, 2009; ZLATKOVIĆ, 2012).

MATERIAL AND METHODS

The research was done at the farm "Stari Tamis" near Pancevo in the period from July 1. 2009 to August 31. 2010. The farm has got the cows in the process of lactation and their number in the period of research was between 200 and 220. Over 95% of cows are Holstein - Frisian, while the others are Simmental breeds. The most number of the cows is in the first lactation (over 35%), while only less than 5% of the cows had more than 5 lactations. The cows have been raised in five separated buildings with at least forty heads. Animals are kept by the free systems, while each of the buildings has got the individual pastures. The buildings have excellent ventilation and illumination. Milking has been done two times a day in a separate building whose capacity is 2x8 cows. The building for milking satisfies all zoo-hygienic standards.The total quantity of milk and the total number of cows in the process of milking has been measured on the basis of the data which have been noted every day and have been electronically stored.
The data of the temperature and air humidity have been taken from the Weather bureau in Serbia. THI for each day has been established through the relation (FUKUAY, 1981).

$$THI = (0,8 \times Tmax) + (\varphi/100) \text{ x } (Tmax - 14,4) + 46,4$$

Tmax- maximal environment temperature (°C)
φ – relative air humidity (%).

The maximal value of the index for each day was counted during the research. The days were grouped according to the values when THI was below 74, between 75 and 78, between 79 and 83 and when it was above 84 (JOHNSON, VANJONACK, 1975). They compared the milk yield which was gained in each interval and between them. The milk ingredients have been tested in the laboratory for milk and milk products at the Agricultural faculty in Zemun (CARIĆ et al., 2000, ROMČEVIĆ et al., 2007). The laboratory has been completely equipped by the modern equipment for the examination of the quality, that is to say, milk ingredients. The quantity of milk fat has been established by the standard method according to Gerber, the protein quantity according to Kieldal, while the dry matter has been established by the gravimetrical method. Data processing has been done in SPSS Statistics, Statistics 8 and Windows (MALETIĆ, 2005).

RESULTS AND DISCUSSION

The quantity of proteins in milk, depending on the examined parameter

During the processing of results, maximum daily temperatures have been classified in four temperature intervals.

Table 1. Average quantity of proteins in milk, depending on the maximum daily temperature, during the whole calendar year.

Temperature (^{0}C)	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 7	3.35±0.015	3.34	3.40-3.26	0.047**	1.40
7-21	3.29±0.018	3.30	3.39-3.16	0.083	2.51
21-28	3.26±0.029	3.26	3.39-3.00	0.109	3.34
> 28	3.20±0.012	3.21	3.30-3.07	0.051	1.59

Legend: ** < 0,005 (99%)

The average quantity of milk has failed with the decrease of daily temperatures. Thus, the maximum quantity of proteins has been 3.35% in the lowest temperature interval, while the lowest values of quantities of proteins 3.20% have been during the days when the maximum daily temperatures passed 28 °C *(Table 1)*.

The average quantity of proteins in milk, depending on relative air humidity

During the processing of results, the values of relative air humidity have been classified in three intervals.

Table 2. Average quantity of proteins in milk, depending on relative air humidity during the whole calendar year

Air humidity (%)	Proteins				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 50	3.23±0.016	3.22	3.39-3.00	0.091	2.80
50 – 75	3.29±0.018	3.29	3.40-3.16	0.077	2.34
> 75	3.34±0.015	3.35	3.40-3.22	0.055	1.66

The average quantity of proteins in milk has increased with the increase of the values of relative air humidity. Thus, the minimum protein quantity has been 3.23% in the lowest interval, while the highest values of protein quantity 3.34% have been during the days when relative air humidity was above 75% *(Table 2)*.

The average quantity of proteins in milk, depending on temperature humid index

During the processing of results, temperature humid index have been classified in four temperature intervals.

Table 3. Average quantity of proteins in milk, depending on temperature humid index during the whole calendar year.

temperature humid index (%)	Proteins				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 74	3.30±0.014	3.45	3.39-3.00	0.047 **	1.40
75-78	3.21±0.014	3.39	3.30-3.16	0.083	2.51
78-83	3.19±0.009	3.32	3.26-3.12	0.109	3.34
> 84	3.00±0.025	3.12	3.18-2.87	0.051	1.59

Legend: ** < 0,005 (99%)

The average quantity of milk has failed with the decrease of index. Thus, the maximum quantity of proteins has been 3.30% in the lowest index, while the lowest values of quantities of proteins 3.00% have been during the days when the maximum daily index passed 84 *(Table 3)*.

The quantity of dry matter in milk, depending on the examined parameter

During the processing of results, maximum daily temperatures have been classified in four temperature intervals.

Table 4. Average quantity of dry matters in milk, depending on the maximum daily temperature, during the whole calendar year.

tmax (^{0}C)	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 7	12.38±0.062	12.325	12.72-12.18	0.194	1.57
7-21	12.32±0.071	12.285	12.82-11.68	0.318	2.58
21-28	11.99±0.080	12.135	12.32-11.38	0.298	2.49
> 28	11.66±0.089	11.760	12.12-10.95	0.366	3.14

The average quantity of milk has failed with the decrease of daily temperatures. Thus, the maximum quantity of dry matter has been 12,38% in the lowest temperature interval, while the lowest values of quantities of dry matters 11,66% have been during the days when the maximum daily temperatures passed 28 °C *(Table 4)*.

The average quantity of dry matter, depending on relative air humidity

During the processing of results, the values of relative air humidity have been classified in three intervals.

Table 5. Average quantity of dry matter in milk, depending on relative air humidity during the whole calendar year.

air humidity (%)	Dry matter				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 50	11.86±0.074	11.99	12.72-10.95	0.407	3.43
50 – 75	12.15±0.065	12.18	12.62-11.52	0.275	2.67
> 75	12.46±0.090	12.50	12.82-11.55	0.325	2.61

The average quantity of dry matters in milk has increased with the increase of the values of relative air humidity. Thus, the minimum dry matters quantity has been 11,86% in the lowest interval, while the highest values of dry matter quantity 12,46% have been during the days when relative air humidity was above 75% *(Table 5)*.

The average quantity of dry matter, depending on temperature humid index

During the processing of results, temperature humid index have been classified in four temperature intervals.

Table 6. Average quantity of dry matters in milk, depending on temperature humid index during the whole calendar year.

THI	Dry matters				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 74	12.26±0.045	12.20	12.82-11.38	0.294	2.40
75-78	11.63±0.090	11.54	12.05-11.29	0.284	2.44
79-83	11.51±0.229	11.76	12.10-10.95	0.512	4.44
> 84	11.31±0.038	11.50	11.88-11.15	0.066	0.56

The average quantity of milk has failed with the decrease of index. Thus, the maximum quantity of dry matters has been 12,26% in the lowest index, while the lowest values of quantities of dry matters 11,31% have been during the days when the maximum daily index passed 84 *(Table 6)*.

The quantity of milk fat, depending on the examined parameter

During the processing of results, maximum daily temperatures have been classified in four temperature intervals.

Table 7. Average quantity of milk fat, depending on the maximum daily temperature, during the whole calendar year.

Temp. max (^{0}C)	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 7	3.56±0.036	3.60	3.75-3.35	0.116	3.24
7-21	3.53±0.042	3.52	3.80-3.15	0.189	5.35
21-28	3.30±0.026	3.32	3.40-3.05	0.099	3.00
> 28	3.19±0.029	3.20	3.50-3.00	0.120	3.78

The average quantity of milk has failed with the decrease of daily temperatures. Thus, the maximum quantity of milk fat has been 3,56% in the lowest temperature interval, while the lowest values of quantities of milk fat 3,19% have been during the days when the maximum daily temperatures passed 28 °C *(Table 7)*.

The average quantity of milk fat, depending on relative air humidity

During the processing of results, the values of relative air humidity have been classified in three intervals.

Table 8. Average quantity of milk fat, depending on relative air humidity during the whole calendar year.

air humidity (%)	Milk fat				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 50	3.26±0.031	3.25	3.75-3.00	0.165	5.07
50 – 75	3.44±0.040	3.45	3.80-3.15	0.167	4.84
> 75	3.61±0.034	3.60	3.80-3.40	0.124	3.45

The average quantity of milk fat has increased with the increase of the values of relative air humidity. Thus, the minimum milk fat quantity has been 3,26% in the lowest interval, while the

highest values of milk fat quantity 3.61% have been during the days when relative air humidity was above 75% *(Table 8)*.

The average quantity of milk fat, depending on temperature humid index

During the processing of results, temperature humid index have been classified in four temperature intervals.

Table 9. Average quantity of milk fat, depending on temperature humid index during the whole calendar year.

THI	Milk fat				
	$\bar{x} \pm S_{\bar{x}}$	Mediana	IV	SD	CV (%)
< 74	3.47±0.028	3.45	3.80-3.05	0.185	5.32
75-78	3.22±0.032	3.22	3.40-3.10	0.101	3.15
79-83	3.10±0.041	3.15	3.20-3.00	0.094	3.02
> 84	3.02±0.017	3.05	3.20-2.95	0.029 **	0.91

Legend: ** < 0,005 (99%)

The average quantity of milk has failed with the decrease of index. Thus, the maximum quantity of milk fat has been 3,47% in the lowest index, while the lowest values of quantities of milk fat 3,02% have been during the days when the maximum daily index passed 84 *(Table 9)*.

Different atmosphere parameters have different influence on the function of milk glands, and cow milk ingredients. After processing of the obtained results it has been determined that the increase of temperature has negative influence on each of three tested nutritive matters in milk. Thus, the average part of proteins in milk has failed for 0.15%, of dry matter for 0.72% while the average part of milk fat has failed for 0.37% during the days when maximum daily temperature passed 28˚C compared to the days when it was below 7˚C. This parameter has negative influence on the milk gland, but its influence is rather small.

On the other hand, relative air humidity has positive influence on the function of the milk gland and the total quantity of nutritive matters. However, even this atmosphere factor do not have great significance, because the average quantity of proteins has increased for 0.11%, of dry matter for 0.6%, while the part of milk fat has increased for 0.35%, during the days when relative air humidity passed 75% compared to the days when it was below 50%.

The atmosphere parameter which has negative influence, but the greatest significance, is temperature humid index. Its influence on the function of milk gland and milk ingredients is statistically very big. When its value was extremely high, and the degree of stress that an animal undergoes in such conditions very dangerous not only for its health but also its life, the part of proteins has failed for 0.30%, of dry matters for 0.95%, while the part of milk fat has failed for 0.45%. The results obtained in this study in great degree have matched to various studies published on this topic (JOHNSON, 1987; MCARTHUR AND CLARK, 1988; KADZERE ET AL., 2002).

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