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Influence of Summer Temperatures on Milk Content and Technological Properties of Three Cow Breeds Kept Under Identical Conditions

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Abstract

The aim of this study was to assess the influence of summer temperatures on the milk content and technological properties for three different cow breeds. The experiment took place between June and August 2015. We observed 18 dairy cows, kept in identical conditions. We used cows of 3 breeds: Czech Fleckvieh (C), Holstein (H) and Ayrshire (A). Samples were taken weekly. The analyzed parameters were: total yield per observed period, milk content, density, active and titrable acidity, rennet coagulation time (RCT) and curd class quality. Average daily yield was 22.8 (A), 28.1 (H) and 24.4 (C) liters. All cows were at the same lactation (2nd). All breeds showed an increase (from 12.74% to 12.24%) in dry matter. Titrable acidity was significantly ($P < 0.05$) increasing and active acidity was decreasing for all three breeds. When it comes to technological properties Czech Fleckvieh and Holstein showed a decrease in RCT and curd quality, and Ayrshire showed an increase in both RCT and curd quality. This can point to the fact that, though these three breeds are different, some characteristics (dry matter, titrable and active acidity) of their production are affected by the high summer temperatures. RCT values indicate that Czech Fleckvieh is more adaptable to high temperatures.

Key words: stress, heat, breed, technological properties, milk content

Introduction

Milk content is one of the most important factors in milk trade for the farmers. This content is not static, but variable throughout the time. Contents of fat, protein and lactose are the main parts of breeders' interest besides the yield, and they are also pointers of milk quality. Each breed has a different milk content and can be used for a different field of milk production (cheese making, consumption of liquid milk, yogurts etc.). All the nutrients come to milk from feed through blood vessels. For one liter of milk approximately 500 liters of blood have to flow through udder. Also, milk synthesis does not have the same intensity throughout the whole day. The most intensive synthesis occurs 3 hours after milking (Jelínek et al. 2003).

A series of factors have impact on milk content. Mainly, the ability to produce milk and its processing qualities are already determined by genotype of the cow (Bayram et al., 2009; Matějíček et al., 2008). Other factors, which are important for the characteristics mentioned above, are stage of lactation and parity (Summer et al., 2003) and feed (Davies and White, 1958). Another factor that is not of a less importance is environment and seasonal influence (Cimen et al., 2010). West et al. (2003) claims that hot weather has large effect on yield.

Technological properties like RCT (Rennet Coagulation Time) are also influenced by both external (environment) and internal (genotype) factors. In work of Falta et al., (2014) they report differences in titrable acidity depending on the milk temperature. The aim of this study was to assess the influence of summer temperatures on the milk content and technological properties for three different breeds kept under the identical conditions.

Material and Methods

The experiment, which we made for the purpose of our study, took place in ZD Okrouhlička, Czech Republic. The period of observation was three months long, specifically from June till August 2015. Three breeds that we used were Holstein (H), Ayrshire (A) and Czech Fleckvieh (C). All three breeds had genotype 100. In each group there were 6 cows. All cows were on the same stage of lactation (2nd)

The cows were housed in a stable 90 meters long and 25 wide. Housing was a free box with straw softener. Excrements were removed every day by a tractor. Feeding was provided by a feeding wagon. TMR was fed to the cows. TMR was composed of corn silage, lucern-grass mixed silage and wheat, barley grind and extracted rapeseed grind.

Six milk samples of each breed were analyzed. The samples were obtained by the aperture for the yield control and on a day of monthly milk recording scheme. After this, the samples were frozen and analyzed after two weeks of sampling. The analyses took place in the laboratory of applied lactology at the Department of Animal Breeding of Mendel University in Brno.

Analysis started with the defrosting of sample in water base. The temperature of defrosting was set for 20 °C. After the sample defrosting was complete, the following parameters were analyzed: titrable (SH) and active (pH) acidity, rennet coagulation time (RCT), milk composition (fat and protein content, solids non-fat in %), density (cm^3) and curd quality (on 1-5 scale).

Total milk yield was analyzed from results of routine milk recording. We must mention that the total mean yield in the experimental period was 2050.19 (A), 2530.31 (H) and 2195.96 (C) liters. The daily average yield was 22.8 (A), 28.1 (H) and 24.4 (C) liters. All cows were on the second lactation.

Titrable and active acidity were analyzed by device HI902C1–02 by Hanna Instruments Company. With use of ion selective electrodes, this device is capable to determine the acidities of milk.

Composition of milk was analyzed by MilkoScope Julie C5 device. This particular device can analyze content of milk (fat, protein density and solids non-fat). Dry matter was calculated from the content of fat and solids non-fat.

Turbidimetric detector for determining the RCT was used. This instrument can detect the coagulation of milk by permeability of light through the sample (Přibyla and Čejna, 2006 and Chládek et al. 2011).

For evaluation of curd quality method of Gajdušek (1997) was used. This method uses the 5-point scale of evaluation (1 = best, 5 = worst) for the determination of curd quality. This evaluation takes place when curd and whey fully appear after the rennet is added.

The average daily temperature during our observation was as follows: 19.72 °C for June, 21.85 °C for July and 19.86 °C for August. These temperatures were taken into consideration when interpreting the results. These temperatures were obtained from the Weather station Brno-Židenice (2016).

Results and Discussion

Table 1 shows the influence of genotype on the milk content and technological properties of milk. There was a significant difference between titrable acidity, fat content, solids non-fat, dry matter, density and protein content due to cattle breed ($P<0.05$).

Tab. 1. Influence of genotype on the technological properties and milk content
Утицај генотипа на технолошке особине и садржај млијека

Breed *Paca*	Active acid. (SH) *активна киселост*	Titrable acid. (pH) *титрир. киселост*	Fat (%) *масти*	SNF (%) *безм. материје*	Dry Matter (%) *сува материја*	Density (gcm^{-3}) *густина*	Protein (%) *садржај протеина*	RCT (s) *вријеме коагулације*	Curd Class (class) *класа сурутке*
A	7.460	6.430[a]	3.721[a]	8.450[a]	12.171[a]	1.028[a]	3.106[a]	240.722	2.000
C	7.414	7.270[b]	4.153[b]	8.779[b]	12.932[b]	1.030[b]	3.230[b]	211.435	1.696
H	7.346	6.639	3.864[b]	8.676[b]	12.540	1.029[b]	3.189[b]	249.611	1.611

Note: values in the same line marked with different symbols are statistically different (P < 0.05)

At almost all displayed parameters, there was a difference between Ayrshire and Holstein or/and Czech Fleckvieh. This could be caused by the fact that Czech Fleckvieh is bred as a combined breed. Same results were shown in the work of Navrátil et al., (2016). Important parameters like RCT were not significantly different, yet there were certain differences. The milk of Czech Fleckvieh had shortest RCT, while the longest on the other hand was shown by the milk of Holstein cows.

Tab. 2. Influence of the research date on technological properties and milk content
Утицај датума анализе на технолошке карактеристике и садржај млијека

Month *Mjesec*	Active acid. (SH) *активна киселост*	Titrable acid. (pH) *титрир. киселост*	Fat (%) *масти*	SNF (%) *безм. материје*	Dry Matter (%) *сува материја*	Density (gcm^{-3}) *густина*	Protein (%) *садржај протеина*	RCT (s) *вријеме коагулације*	Curd Class (class) *класа сурутке*
VI	7.30[a]	6.93	4.15	8.59	12.74	1.03	3.16	254.05	1.89
VII	7.70[b]	6.26[a]	3.68	8.56	12.24	1.03	3.15	234.40	1.45
VIII	7.22[a]	7.32[b]	3.94	8.83	12.77	1.03	3.24	210.11	1.89

Note: values in the same line marked with different symbols are statistically different (P < 0.05)

Table 2 shows the influence of month on milk content and the technological properties of milk. Active acidity and titrable acidity are the only two parameters that showed statistically significant difference due to the month of research ($P < 0.05$), but we can see differences in all parameters.

Content of fat and protein showed different trends. The content of fat was on the highest level in June, while the content of protein was highest in August.

When we compare temperatures of all three months (19.72 °C for June, 21.85 °C for July and 19.86 °C for August) we can claim that the two cooler months of our experimental period were better for the synthesis of milk protein and fat. This is supported by the findings of Čejna et al. (2006) and Kuczaj (2001). In their studies, both protein and fat decreased with the increase of outside temperatures. Chladek et al. (2011) also claim that with decreasing temperature, the content of fat increases.

Conclusion

This work was targeted on the influence of summer period and genotype on milk content and its technological properties. Our results showed, that the titrable acidity, fat content, solids non-fat, dry matter, density and protein content showed statistically significant differences ($P<0.05$) when it comes to different genotypes of animals.

When it comes to effect of the temperature, only active and titrable acidities showed the statistically significant differences ($P<0.05$). The values that were recorded for the fat and protein correspond with work of other authors. It can therefore be claimed that when the temperature is higher, the fat and protein content is lower.

Our conclusion supports statements of other authors, that the temperature and season has influence on not only yield, but also the technological properties of milk. To manage these changes properly, more research is necessary.

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Утицај љетњих температура на садржај млијека и технолошке карактеристике код три различите расе крава у идентичним условима производње

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Сажетак

Циљ овог истраживања је процјена утицаја љетњих температура на на садржај млијека и технолошке карактеристике код три различите расе крава. Оглед је трајао од јуна до августа 2015 године. Укупно је анализирано 18 млијечних раса крава, у идентичним условима производње. Кориштене су краве сљедећих раса: чешки сименталац (C), холштајн (H) и ејршир (A). Узорци су узимани на једном седмично. Анализирани су сљедећи параметри: укупан мљечност у посматраном периоду, садржај млијека, густина, активна и титрацијска киселост, вријеме коаулације (RCT) и квалитет сурутке. Просјечна дневна млијечност је била 22.8 (A), 28.1 (H) и 24.4 (C) литра. Све краве су биле у друој фази лактације. Све расе крава су имале повећање у сувој материји током овог периода (од 12.74% до 12.24%). Титрирајућа киселост се значајно повећавала ($P < 0.05$) а активна киселост се смањивала код све три расе крава. Када су у питању технолошке особине, расе чешки сименталац и холштајн су имале смањење у погледу вријемена коагулације и квалитета сурутке а ејршир раса је имала раст код дата два параметра. Ово указује на чињеницу да, иако су ове три расе различите, неки параметри квалитета млијека (сува материја, титрирајућа и активна киселост) су условљени високим љетњим температурама. Вриједности RCT указују на то да раса чешки сименталац има бољу адаптацију на високе температуре.

Кључне ријечи: стрес, топлота, раса, технолошке особине, садржај млијека

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