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COWS MILK PROTEIN CONSTITUTE VARYING IN LACTATION DAYS

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Abstract

Cow's milk is a complex fluid consisting of a lot number of components. The objective of this study was to evaluate a relation between milk urea and milk yield as well as milk constituents in different lactation phase. Milk yield and content of total protein, casein, urea was collected from the herd control data from September 2009 to November 2010. Milk content parameters for total 2740 milk samples were analysed in accredited milk quality laboratory. The statistical analyses were performed with the SPSS program package. Based on General linear model data it was establish that an influence from lactation day on variability of urea, protein, casein yield and milk yield was statistical believable ($p<0.001$). The highest milk yield was 30.7 kg in 30-59 lactation days and 30.6 mg dL^{-1} of urea level per control day in 200-299 lactation days. Highest protein and casein contents were 3.91% and 2.99% in over 300 lactation days.

Key words: *dairy cow, milk yield, protein, casein and urea yield.*

INTRODUCTION

Milk is a complex biological fluid consisting of fats, proteins, minerals, vitamins, enzymes, and lactose. The composition of milk varies according to the breed, the genetic background of the animal, the stage of lactation, the nutritional quality of the animal's feed, the milking technology, and the incidence of disease such as mastitis and general environmental conditions (Coballero et al., 2003; Savickis et al., 2010).

It is essential to balance the energy and protein to bring indigestion, especially in the initial phase of lactation, resulting in reduced milk yield, fat and protein content of milk, difficulty in reproductive functions. At the end of the first week after calving begins period of negative energy balance when milk production are faster than the cows dry matter intake capacity, therefore, not guaranteed cows needs of energy (NG-KWAI-Hang et al, 1984).

Support of amino acids absorption in early lactation is an important factor in milk yield and protein outcome. The combination of low energy security and supply of high protein stimulates milk production and increase fat mobilization and increases the risk of ketosis and reduced milk yield (Schei et al., 2005). Changes in milk composition during lactation have been shown by many authors (NG-KWAI-Hang et al., 1985; Wilmink, 1987; Huth, 1995; Jonkus et al., 2004).

Normal bovine milk contains 30 to 35 g of protein kg^{-1}. Milk total proteins are composed of casein, whey proteins and non-protein nitrogen (Depeters and Cant, 1992). The two principal types of milk proteins are caseins and whey proteins. Caseins constitute 76 to 86% of the total milk protein. Whey proteins represent 14 to 24% of milk proteins and are in solution in the serum phase of the milk (Hui, 1993).

Urea is therefore a normal constituent of milk and comprises part of the nonprotein nitrogen fraction. Although opinions do vary to some extent, milk urea levels between 20 and 30 mg dL^{-1} are generally

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considered as normal for cow's milk. Urea accounts for roughly 50% of the non-protein nitrogen fraction in herd bulk milk of dairy cows, although this may vary from 35 to 65%. For milk from individual cows, this variation may be even larger (Bijgaart, 2003). The urea content may be used to monitor nutritional status of lactating dairy cows and improve dairy herd nutrition.

Urea in milk has proven to be an easily measurable indicator for protein metabolism efficiency in dairy cattle. The obtained figures can help to identify and correct imbalances in the protein/energy ratio in the diet, sub-optimal feed nitrogen utilization, the potential for reducing ammonia emissions from dairy farms, and fertility problems.

The variation in milk urea concentrations between herds and between cows indicates a wide variation in protein, energy and water intake within dairy cows and herds. If the milk urea content is outside of normal concentration it would suggest problems with the feeding program. Urea concentration in milk may provide an opportunity to look at problems with the feeding and system within farm.

In different countries measuring of milk urea content are used as a way to monitor the efficiency of protein utilization in dairy herds (Godden et al., 2001). The most important milk components for cheese and curd production are milk proteins. Now in Latvia the milk payment system is based on the content of total protein in milk, and on milk amount. Therefore task of the Latvia breeding programmes will be high milk yields with high protein content.

MATERIALS AND METHODS

In the study, individual cow milk samples (n=2740) were collected monthly from four dairy farms (Farm A, B, C, and D) from September 2009 to November 2010.

Dairy farms were with different number of animals in herds, and with different milking and holding technologies. Farms A and C had a small (26 cows and 19 cows accordingly) number of animals and the traditional holding technology in the pasture-based seasonal dairying system. In these farms cows were managed in one feeding group. Whereas farms B and D were big farms (320 cows and 150 cows accordingly) with a balanced feeding and total mixed ration in all years without pasture period. Management in these farms was organized in feeding groups according to lactation stage. Milking frequency was two times per day. The herds were under official performance and pedigree recording.

The monthly control milk samples were analysed for protein, casein and urea content. Parameter was analysed in accredited milk quality laboratory SIA 'Piensaimnieku Laboratorija' with accredited instrumental infrared spectroscopy method.

Data regarding breed of cows and date of milk analysis were available from monthly records of the herds from state agency "Agricultural Data Centre" program.

Lactation stages were arranged in six groups: 1st – from 6 day to 29 (n=191), 2nd – from 30 day to 59 (n=239), 3rd – from 60 day to 99 (n=330), 4th – from 100 day to 199 (n=837), 5th – from 200 day to 299 (n=784), and 6th – from 300 to end of the lactation (n=359).

Dairy herds represent three breeds: Holstein Black and White (HB), Latvian Brown (LB), and cross breed XP (cross breed from HB and LB).

Control day was grouped into four seasons: winter (W) – (December, January, February, n= 601), spring (Sp) – (March, April, May, n=745), summer (S) – (June, July, August, n=693), and autumn (A) – (September, October, November, n=701).

Milk urea content unit (mg dL^{-1}) was transformed to % (FOSS, 2005).Afterwards the protein, casein and urea yield (g) in control day was calculated according to International Committee For Animal Recording (ICAR) guidelines (ICAR, 2011).

Somatic cells counts were transformed to SCS (Somatic Cell Score) with formula (Schutz, 1994):

$$SCS=\log2\ (Somatic\ cell\ count/100.000)+3 \qquad (1)$$

The statistical analyses were performed using SPSS program package and Microsoft Excel for Windows.

The obtained data were analyzed using descriptive statistics and Pearson correlation analysis. The significance of the differences between the samples was assessed using ANOVA.

RESULTS AND DISCUSSION

The study results were analysed to evaluate milk protein, casein and urea content and milk productivity traits in the lactation stage (Table 1).

Average cow milk yield in lactation stages were significantly different (from 30.7 to 17.0 kg per control day).

The urea content varied from 21.3 to 30.6 mL dL^{-1}. Researchers from Europe (Bijgaart, 2003) confirm that normal milk urea content in milk is from 15.0 to 30.0 mg dL^{-1}.

Table 1 Average milk productivity and quality traits during the research in different lactation stage (LS-Means±S.E.).

Lactation stage	1	2	3	4	5	6
	1-29	30-59	60-99	100-199	200-299	300 <
Protein content, %	3.37 ± 0.026^{a}	3.19 ± 0.023^{b}	3.28 ± 0.020^{c}	3.47 ± 0.012^{d}	3.66 ± 0.013^{e}	3.91 ± 0.019^{f}
Urea content, mL dL^{-1}	21.3 ± 0.63^{a}	$22.3\pm0.56^{a,b}$	23.4 ± 0.48^{b}	28.9 ± 0.30^{c}	30.6 ± 0.31^{d}	29.2 ± 0.46^{c}
Casein content, %	2.58 ± 0.019^{a}	2.47 ± 0.017^{b}	2.54 ± 0.015^{a}	2.67 ± 0.009^{c}	2.82 ± 0.009^{d}	2.99 ± 0.014^{e}
SCS thous. mL^{-1}	1.98 ± 0.114^{a}	1.62 ± 0.102^{b}	$1.79\pm0.086^{a,b}$	2.18 ± 0.054^{a}	2.70 ± 0.056^{c}	3.18 ± 0.083^{d}
Milk yield, kg	27.2 ± 0.48^{a}	30.7 ± 0.42^{b}	29.2 ± 0.36^{c}	26.9 ± 0.23^{a}	21.0 ± 0.23^{d}	17.0 ± 0.35^{e}

$^{a;\,b;\,c;\,d;\,e;\,f}$ milk productivity and quality traits by different superscripts are significantly different lactation stage ($p<0.05$)

The lactation stage significantly influenced average protein, casein and urea content and SCS in milk. The lowest average protein and casein content in milk were in second lactation stage (3.19 and 2.47%), but the highest (3.91 and 2.99%) in sixth lactation stage. The influence of the lactation stage on the milk

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composition is observed by many approved researchers (Ng-Kwai-Hang et al., 1984; Jonkus et al., 2004). In this study the average urea content differ between lactation stages. The lowest levels of protein and casein content in milk were observed together with the highest milk yield in second lactation stage. At the fourth, fifth lactation month these parameters in milk started to increase and the highest content was found in the end of the lactation. In the lactation time unacceptable exceed fat content percents difference 0.5% of units (example, form 3.90 to 4.40%), but for total protein 0.8% of units (Rossow and Richardt, 2003).

The average milk productivity and quality traits were significantly different among breeds between lactation stages (Figure 1).

The milk protein and casein yield was highest of the HM breed and lowest of the LB breed. Researchers (Joudu et al., 2008) clarify that different breed's cow milk proteins and caseins content are various. Observe that Estonian Red breeds cow milk content higher protein and casein than Estonian Holstein breeds cow milk. The average urea content was highest of the XP breed cow milk and lowest of the LB breed cow milk.

The average protein and casein yield was higher and significantly different in first, second and third lactation stage for all breeds. Observed decrease after 200 lactation day of the average protein, casein and urea content and milk yield per control day.

The milk urea yield was significantly different in begin stage of lactation till 200 lactation day between breeds.

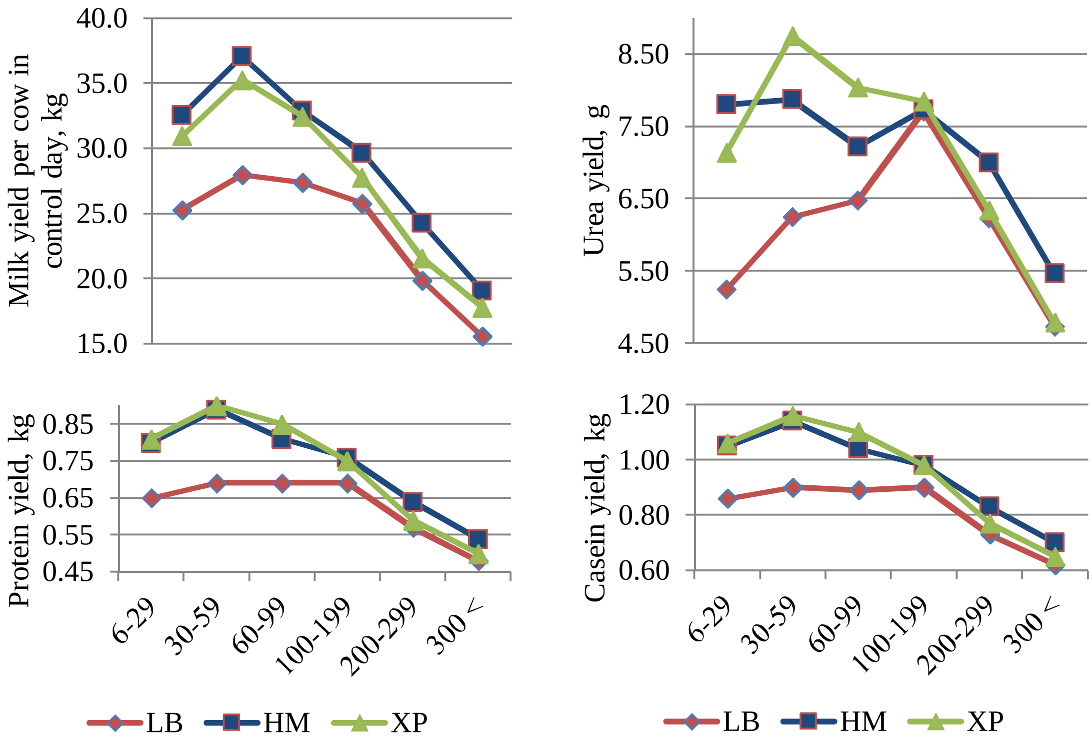

Figure 1. Milk yield and protein, casein and urea yield depending on the breeds and lactation stage

The next in study were established that from seasons and lactation stage had influence protein, casein and urea yield (Table 2).

The average protein, casein and urea yield was significantly different between lactation stages in different seasons. A significant difference was established between all lactation stages and between all seasons. In the second and third lactation stage protein and casein yield was highest in spring season and lowest in summer. Whereas urea yield was highest in summer season in same lactation stages and lowest in winter season. The results of this study confirm results of previous researchers (Meijier et al., 1996; Savickis et al., 2010) that milk urea content differ between the periods of sampling and individual cows.

Table 2 Average urea content and yield in milk per cow in control day at different seasons

Lactation stage		1 1-29	2 30-59	3 60-99	4 100-199	5 200-299	6 300 <
Protein yield, kg	W	0.93±0.027[a,d]	0.98±0.023[a]	0.93±0.020[a,d]	0.91±0.017[a,b,f]	0.81±0.050 [b,f]	0.59±0.087 [c]
	Sp	0.91±0.051 [a,c]	1.01±0.030 [a]	0.99±0.021 [a]	0.95±0.011 [a,c]	0.81±0.016 [a,b]	0.80±0.057[a,b]
	S		0.87±0.188 [a]	0.90±.0.052 [a,b]	0.91±0.014 [a,b]	0.76±0.010 [a,c]	0.57±0.016 [a,d]
	A	0.90±0.021 [a]	0.96±0.025 [b]	0.97±0.025[b]	0.89±0.030 [a,b,c]	0.69±0.014 [d]	0.63±0.014 [e]
Urea yield, g	W	5.59±0.293 [a]	5.88±0.245[a]	5.94±0.219[a]	6.07±0.180 [a]	5.89±0.545[a]	3.20±0.943 [b]
	Sp	8.37±0.658 [a,c]	9.55±0.384 [a]	8.34±0.271 [ac]	8.81.4±0.138 [a,c]	6.55±0.203 [b]	5.42±0.725 [b]
	S		12.30±2.510 [a]	9.02±0.700 [a]	8.88±0.184 [a]	6.81±.0.129 [b]	5.53±0.235 [c]
	A	5.68±0.252 [a]	6.66±0.290 [b]	6.30±0.290 [a,b]	7.30±0.355 [cb]	5.53±0.169 [a]	4.71±0.161 [d]
Casein yield, kg	W	0.71±0.021[ac]	0.75±0.017 [a]	0.72±0.016 [ac]	0.69±0.013 [b]	0.62±0.039[c,b]	0.45±0.067 [d]
	Sp	0.70±0.040[a]	0.78±0.023[ac]	0.77±0.016[ac]	0.73±0.008 [a,c]	0.63±0.012 [a,b]	0.62±0.044 [a,b]
	S		0.67±0.146 [a]	0.70±0.041 [a]	0.71±0.011 [a]	0.59±0.008 [a,b]	0.52±0.014 [a,c]
	A	0.68±0.017 [a]	0.74±0.019 [b]	0.75±0.019 [c,b]	0.69±0.023 [a,b]	0.53±0.011 [d]	0.49±0.011 [e]
Milk yield, kg	W	27.4±0.81 [ae]	30.4±0.68 [b]	28.0±0.61 [a]	26.1±0.50 [ae]	21.8±1.51 [c]	14.7±2.62 [d]
	Sp	28.5±1.58 [a]	32.4±0.92 [b]	31.1±0.65 [a,b]	27.4±0.33 [a]	23.1±0.49 [c]	22.1±1.73 [d,c]
	S		27.1±5.79[a]	29.5±1.61 [a,b]	26.9±0.42 [a,b]	21.5±0.30 [a,c]	18.8±0.54 [a,d]
	A	26.7±0.64 [a]	30.0±0.74 [b]	29.0±0.74[b]	25.3±0.90 [a]	18.0±0.43 [c]	15.8±0.41 [d]

[a; b; c; d; e; f] milk productivity traits by different superscripts are significantly different between lactation stages ($p<0.05$)

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The average milk productivity and quality traits were significantly different among lactation between lactation stages (Figure 2).

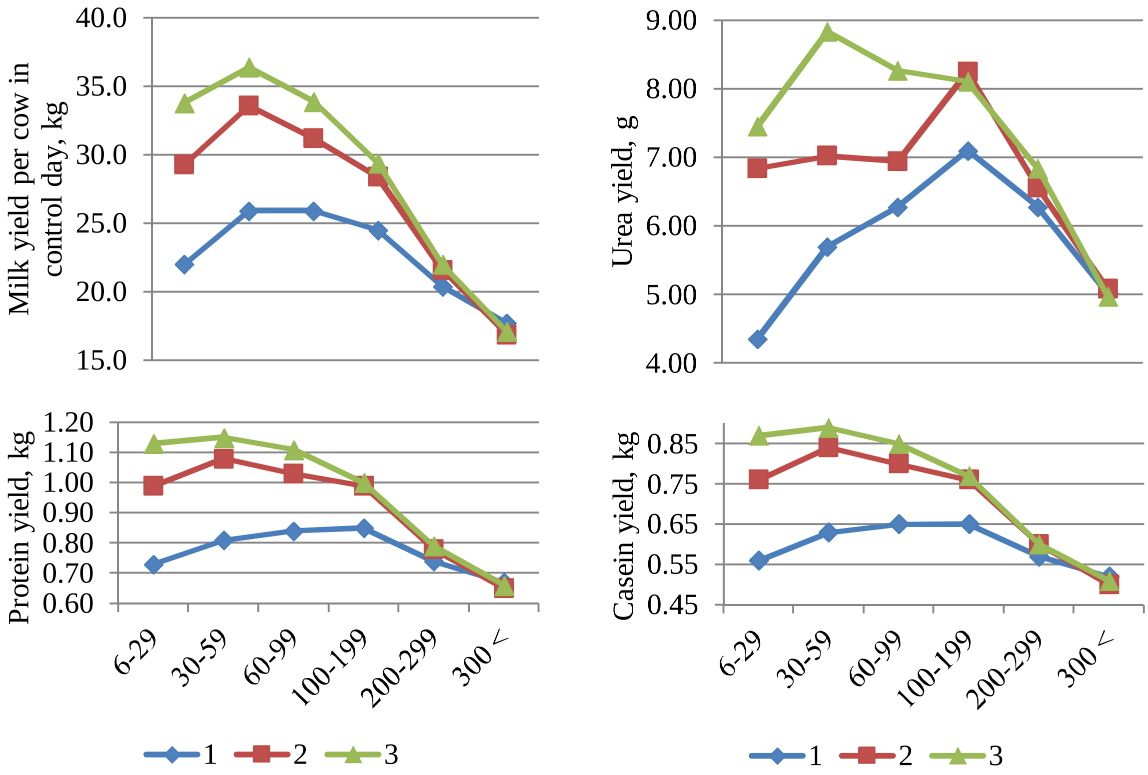

Figure 2. Milk yield and protein, casein and urea yield depending on the lactation and lactation stage

The average milk yield, protein, casein and urea yield of cow milk were significantly lower in first lactation and first till fourth lactation stage. In the fifth and sixth lactation stages was not difference between lactation. Observed not significant different between second and third lactation in milk yield and protein and casein yield after 200 lactation day. Has been reported that milk urea to be lower in first-lactation cows than second- or later-lactation animals in several studies (Ng-Kwai-Hang et al., 1985; Oltner et al., 1985).

CONCLUSIONS

The study results approve that milk protein, urea, casein, content and yield statistically believable varies between different lactation stages. The protein, casein and urea yield in milk were significantly ($p<0.05$) influenced by the dairy cows breed, seasons and lactation number. The highest milk yield was HM breed cows and highest urea yield was XP breed cows. The influence of the lactation stage on the milk content was significantly to all productivity traits.

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