BLOOD PLASMA UREA CONCENTRATION AND ITS RELATIONSHIP WITH MILK PRODUCTION PARAMETERS IN CZECH PIED COWS

OBSAH MOČOVINY V KREVNÍ PLAZMĚ A JEJÍ VZTAH K UKAZATELŮM MLÉČNÉ UŽITKOVOSTI DOJNIC ČESKÉHO STRAKATÉHO PLEMENE

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ABSTRACT

Experimental groups of 18 Czech Pied cows were observed in the course of 12 consecutive calendar months in order to describe the relationship between urea concentration in blood plasma and milk production. The cows were in early lactation, the mean number of lactation was 2.6, number of days after calving 55.6 and concentration of urea in blood plasma 5.42 mmol/l. During the first 100 days of lactation milk yield amounted to 2624 kg with 3.90 % fat, 3.47 % protein and 4.86 % lactose.

The calculated coefficients of the correlation between blood plasma urea concentration and milk production parameters greatly varied between test days and thus did not reveal any clear relationships. Graphic polynomials expressed the relationships better. They showed that urea concentration in blood plasma tended to have a significant positive relationship with milk fat content, and a significant negative relationship with milk protein content. The relationships between urea concentration and number of lactation, milk yield and lactose content were mainly positive while a mainly negative relationship was found with a number of days after calving.

KEY WORDS: Czech Pied cows, milk yield, milk protein, milk fat, lactose, blood plasma, urea

ABSTRAKT

V průběhu 12 po sobě jdoucích kalendářních měsících byly sledovány skupiny 18 kusů dojnic českého strakatého plemene tak, aby u nich mohl být popsán vztah mezi obsahem močoviny v krevní plazmě a mléčnou produkcí. Všechny dojnice se nacházely v první fázi laktace s průměrnými hodnotami 2,6 laktace, 55,6 dnů po otelení, 5,42 mmol/l močoviny v krevní plazmě. Během prvních 100 dnů laktace vyprodukovaly v průměru 2624 kg mléka s obsahem tuku 3,90 %, bílkovin 3,47 % a laktózy 4,86 %.

Koeficienty korelace vypočtené mezi obsahem močoviny v krevní plazmě a jednotlivými parametry mléčné užitkovosti kolísaly v jednotlivých dnech měření ve velmi širokém rozpětí, proto neposkytly jednoznačnou informaci o tomto vztahu. Jako vhodnější pro popis uvedených vztahů se jevilo jejich grafické vyjádření. To ukázalo, že obsah močoviny v krevní plazmě dojnic měl výrazný pozitivní vztah k obsahu tuku a výrazný negativní vztah k obsahu bílkovin v mléce. Její vztah k pořadí laktace, produkci mléka a obsahu laktózy byl převážně pozitivní, zatímco ke dnům po otelení byl naopak převážně negativní.

KLÍČOVÁ SLOVA: České strakaté, dojnice, mléko, bílkoviny, tuk, laktóza, krevní plazma, močovina

DETAILED ABSTRACT

České strakaté plemeno kombinované užitkovosti tvoří významnou část populace dojeného skotu v České republice. Jeho současná vysoká úroveň užitkovosti má za následek také vyšší požadavky dojnic na živiny. Významnou roli v tomto pohledu hrají dusíkaté látky. Za vhodné kriterium dusíkaté bilance organismu je považována hladina močoviny v krevní plazmě. Problematikou vztahu hladiny močoviny v krevní plazmě dojnic k jejich užitkovosti se zabývala řada autorů [3, 12, 11, 2, 1, 10 a 4], avšak s nejednoznačnými výsledky. Za fyziologické rozmezí pro hladinu močoviny v krevní plazmě dojnic považuje Jagoš et al. [6] hodnoty od 2.5 až 5.0 mmol/l. Poněkud vyšší hladiny 3.3 až 5.0 mmol/l, u vysokoprodukčních dojnic dokonce až 6.7 mmol/l, uvádějí Kraft and Dürr [8]. Cílem práce bylo vyhodnotit vztah obsahu močoviny v krevní plazmě k ukazatelům mléčné užitkovosti dojnic českého strakatého plemene

V průběhu 12 po sobě jdoucích kalendářních měsících byly sledovány skupiny 18 kusů dojnic českého strakatého plemene, které se nacházely v první fázi laktace (20 až 100 dnů po otelení). Dojnice byly ustájeny ve stejné stáji a krmeny podle doporučení Sommera et al. [13]. Krmná dávka nebyla krmena formou TMR a koncentrovaná krmiva byla krmena podle užitkovosti. Každý měsíc byla vybrána skupina 18 krav a od každé z nich byla odebrána krev (z vena subcutanea abdominis), týž den byla v krevní plazmě stanovena močovina kolorimetricky. Údaje o mléčné užitkovosti za prvních 100 dnů laktace byly převzaty z plemenářské dokumentace. Vzájemný vztah mezi hladinou močoviny v krevním plazmě a ukazateli mléčné užitkovosti byly hodnoceny na základě koeficientů korelace a grafického vyjádření průběhu hodnot.

Průměrné hodnoty hladiny močoviny v krevní plazmě a vybraných parametrů mléčné užitkovosti během prvních 100 dnů laktace jsou uvedeny v tabulce I. Polynomické vyjádření průběhu sledovaných ukazatelů je pak obsaženo v grafech 1 až 6. Naše výsledky naznačují, že pro posouzení vztahu hladiny močoviny v krevní plazmě k vybraným ukazatelům mléčné užitkovosti dojnic je vhodnější použít grafického vyjádření než koeficientů korelace, protože ty kolísaly v jednotlivých měsíčních měřeních ve velmi širokém rozmezí. Grafické vyjádření průběhu sledovaných hodnot ukázalo, že hladina glukózy v krevní plazmě dojnic měla výrazný pozitivní vztah k obsahu tuku v mléce a výrazný negativní vztah k obsahu bílkovin v mléce. Její vztah k pořadí laktace, produkci mléka a obsahu laktózy byl převážně pozitivní, zatímco ke dnům po otelení byl naopak převážně negativní.

INTRODUCTION

The original dual-purpose Czech Pied cattle breed (Simmental) plays an important role in milk production in the Czech Republic. Its milk and meat productions are regularly analysed, e.g. by [9, 7 or 5]. The situation in the neighbouring countries is comparable; they keep cattle of the same origin and similar production type [14].

Increased milk and meat production of Czech Pied cows leads to higher nutritional requirements. Apart from other nutrients, nitrogen and energy content play the key role in cow's diet; their quantity, quality and mutual ratio are essential for meeting specific demands. One of the main indicators of a nitrogen supply in a cow's organism is urea concentration in milk or blood plasma. For practical reasons, urea concentration is more often measured in milk rather than in blood as it is much easier. However, urea concentration in blood plasma is a primal reflection of nutritional state of an organism and it is closely related to urea concentration in other body fluids. A higher intake of nitrogen or increased catabolism of protein causes an increase of urea concentration in blood plasma. On the contrary, feeding of a diet low in nitrogen leads to a lower content of urea in plasma [1].

Orozco-Hernandez and Brisson [10] studied relationships between plasma urea and milk production. They found out that a higher milk production was associated with a lower plasma urea concentration and a lower milk production was accompanied by a higher concentration of urea in plasma. Roseler et al. [11] observed five groups of Holstein cows fed diets with different content and ratio of degradable and undegradable protein. The lowest serum urea concentration was found in a group with the lowest milk production but this tendency was not confirmed in the other four groups. The group with the highest milk protein and fat content also had the highest plasma urea but this trend was not found in the other groups.

Broderick et al. [2] found no clear relationships between plasma urea content and milk yield, milk protein and fat content. Ruegg et al. [12] came to similar conclusions; they found no significant relationships between plasma urea content and milk production parameters. Older cows had lower plasma urea content compare to first-calvers; also, plasma urea content was lower at the beginning of lactation and it increased in the course of lactation with increasing dry matter intake [3].

The relationship between blood plasma urea concentration and milk production in Holstein cows was studied by [4]. He found out that urea concentration in plasma was rather positively correlated to milk yield and negatively correlated to protein content. His results suggested that the relationships were clearer when expressed graphically

rather than described by coefficients of correlation which varied greatly between test-days.

According to [6], physiological values of blood plasma urea concentration in cows range from 2.5 to 5.0 mmol/l. Kraft and Dürr [8] presented slightly higher values, from 3.3 to 5.0 mmol/l, or even 6.7 mmol/l in high-producing cows.

The aim if the present study was to examine relationships between blood plasma urea concentration and milk production parameters in Czech Pied cows.

MATERIALS AND METHODS

The experimental groups of 18 Czech Pied cows were observed once a month for one year. The cows came from one dairy herd with an average milk yield of 6 000 kg per cow, per lactation. All the cows were housed in the same cowshed with a tethered system and straw bedding. The diet consisted of feeds typical for that region (maize and grass silage, grain meal, extracted meal, minerals and vitamins) and the ration was calculated according to recommendations of [13]. The diet was not served as TMR and the concentrated feed was fed according to the milk yield.

Each month a group of cows (n=18) in early lactation (20 to 100 days after calving) was chosen for observation. Each cow was blood sampled (from vena subcutanea abdominis) in the morning. On the same day blood samples were centrifuged to separate blood and urea concentration was assessed colorimetrically using Bio-La-tests. Other milk production parameters (for the first 100 days of lactation) were adopted from the database of milk recording - A_4) were adopted from the database of milk recording (A_4), where the samples were analysed for milk fat, protein and lactose content using Milkoscan 255 AB.

Trends in the relationships between blood plasma urea concentration and milk production parameters were described by coefficients of correlation and by graphical expression of their values.

RESULTS

Mean values of blood plasma urea concentration and some milk production parameters during the first 100 days of lactation are presented in Table I. There were 18 cows in the experimental group each month. Blood plasma urea concentration was, on average, 5.42 mmol/l with maximum and minimum values of 8.81 mmol/l and 3.52 mmol/l, respectively. The mean number of days after calving was 55.6 with a minimum of 47.1 days and a maximum of 69.5 days. The milk yield ranged from 2495 kg to 2849 kg, with a mean of 2624 kg. Milk fat content was on average 3.90% while the highest fat content was 4.27% and the lowest was 3.60%. The mean milk protein content was 3.47% with a maximum of 3.88% and a minimum of 3.14%. Milk lactose content ranged from a minimum of 4.720% to a maximum of 5.031% with a mean value of 4.86 %.

Table I also shows coefficients of correlation. The mean coefficient of correlation between blood plasma urea concentration and number of lactation was -0.119 and the values ranged from –0.557 to 0.195; the coefficients of correlation between urea and number of days after calving ranged from –0.529 to 0.568 with a mean -0.065; the coefficients of correlation between urea and milk production ranged from -0.585 to 0.343 with a mean -0.016. The coefficients of correlation between blood plasma urea and milk components were as follows: mean 0.237 (minimum –0.313 and maximum 0.252) for milk fat, mean -0.397 (minimum –0.349 and maximum 0.5229) for milk protein and mean -0.130 (minimum –0.494 and maximum 0.477) for lactose content.

Graphical expressions of changes in blood plasma urea concentration and the observed milk production parameters, including their polynomial trend, are presented in Fig. 1 (for number of lactation), in Fig. 2 (for number of days after calving), in Fig. 3 (for milk yield per 100 days), in Fig. 4 (for milk fat content) in Fig. 5 (for milk protein content) and in Fig. 6 (for lactose content).

DISCUSSION

The mean milk yield of the experimental animals was 2624 kg per 100 days, which meant that daily milk yield was approximately 26 kg and a predicted milk yield per lactation 6000 kg. These values were slightly lower than those presented by Chládek [4] or Ruegg et al. [12], but the difference was not unexpected because they observed dairy Holstein cattle while we studied dual-purpose Czech Pied cows.

Our mean value of urea concentration in blood plasma corresponded with results of [4] but it was higher than the mean value presented by [6] and it neared the maximum physiological value for high-producing cows presented by [8]. Two of our values even exceeded that maximum value (8.81 a 8.39 mmol/l).

Our coefficients of correlation between blood plasma urea concentration and milk production traits, calculated for each test day, did not show a clear relationship because they varied greatly. Graphic polynomials expressed the relationships better. This finding was consistent with

Table 1: Mean values of blood plasma urea concentration and some milk production parameters during the first 100 days of lactation

Observed	Units	Month of observation												Average
parameters		XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	I - XII
Number of cows		18	18	18	18	18	18	18	18	18	18	18	18	216
Lactation	number	2.5	2.5	2.4	2.5	2.9	2.5	2.6	2.3	2.4	2.7	2.8	2.9	2.6
Days after calving	days	50.9	56.8	47.6	47.1	51.3	64.0	52.3	56.9	54.5	69.5	56.8	58.9	55.6
Urea	mmol/l	8.81	6.13	8.39	4.90	4.69	4.67	4.34	3.52	4.70	4.11	5.07	5.68	5.42
Milk production														
Milk yield	kg	2495	2608	2680	2583	2586	2518	2662	2626	2602	2646	2634	2849	2624
Fat content	%	4.27	4.16	4.06	3.86	3.81	3.61	3.60	3.80	3.68	3.85	3.91	4.17	3.90
Protein content	%	3.24	3.18	3.14	3.27	3,45	3.52	3.82	3.88	3.73	3.60	3.37	3.44	3.47
Lactose content	%	4.92	4.88	4.88	4.87	4.90	4.84	4.72	4.72	4.83	4.77	4.98	5.03	4.86
Coefficients of correlation*														
Urea and lactation		-0.303	0.195	-0.281	-0.490	-0.264	0.117	-0.379	-0.116	0.028	-0.557	0.001	-0.253	-0.119
Urea and days after calving		0.306	-0.431	-0.313	0.568	-0.072	-0.298	0.451	0.328	-0.529	0.150	0.326	0.198	-0.065
Urea and milk yield		-0.389	-0.048	-0.122	-0.123	-0.585	0.294	0.293	0.182	0.182	-0.210	0.254	0.343	-0.016
Urea and fat content		0.081	-0.091	0.052	-0.152	0.155	0.252	-0.100	0.098	-0.198	-0.178	-0.313	-0.138	0.237
Urea and protein content		0.522	0.407	0.146	-0.170	-0.349	-0.083	-0.286	0.086	-0.322	-0.288	-0.233	0.101	-0.397
Urea and lactose content		0.219	-0.346	0.156	-0.494	-0.054	0.106	0.058	-0.089	0.084	0.477	-0.390	-0.422	0.130

*Significant levels:
0,470 for P ≤ 0,05
0,590 for P ≤ 0,01

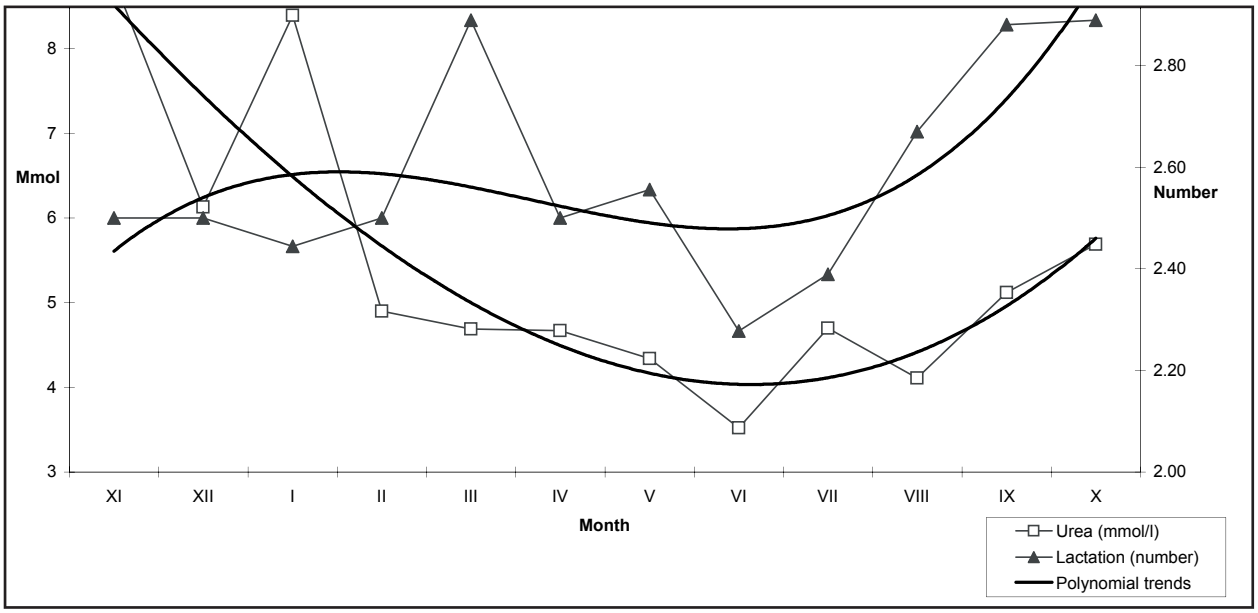

Figure 1: Blood plasma urea concentration and number of lactation

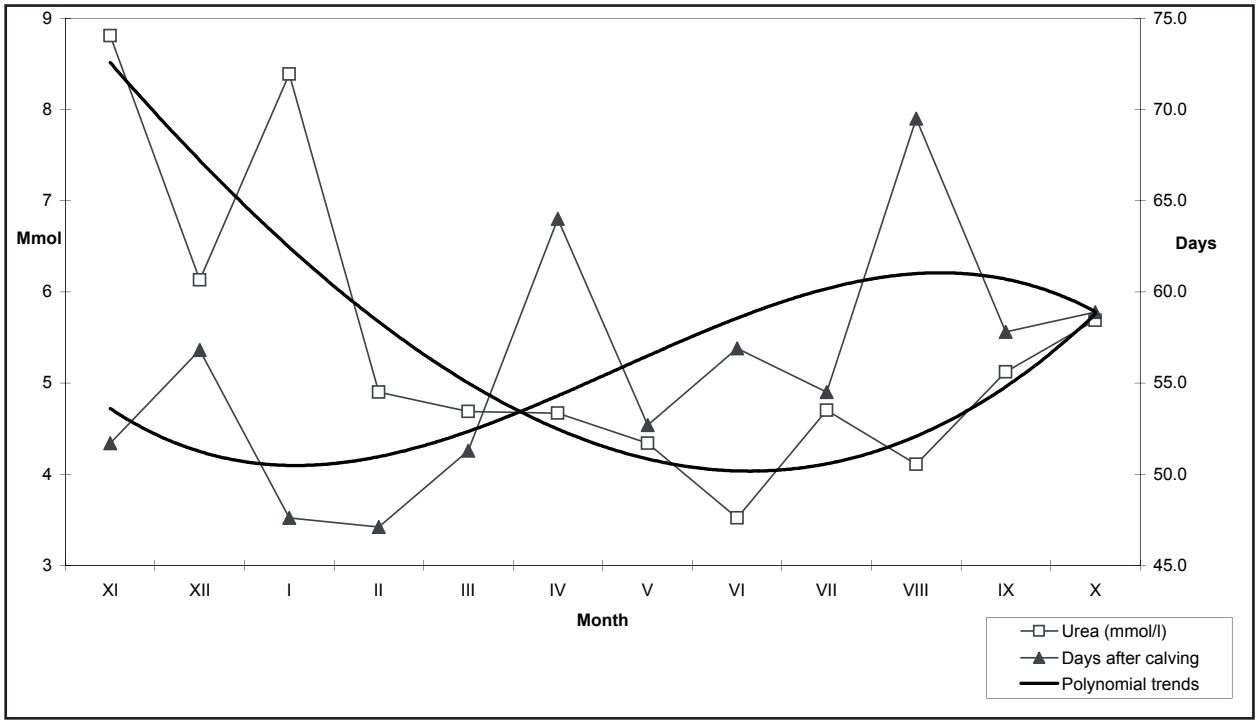

Figure 2: Blood plasma urea concentration and number of days after calving

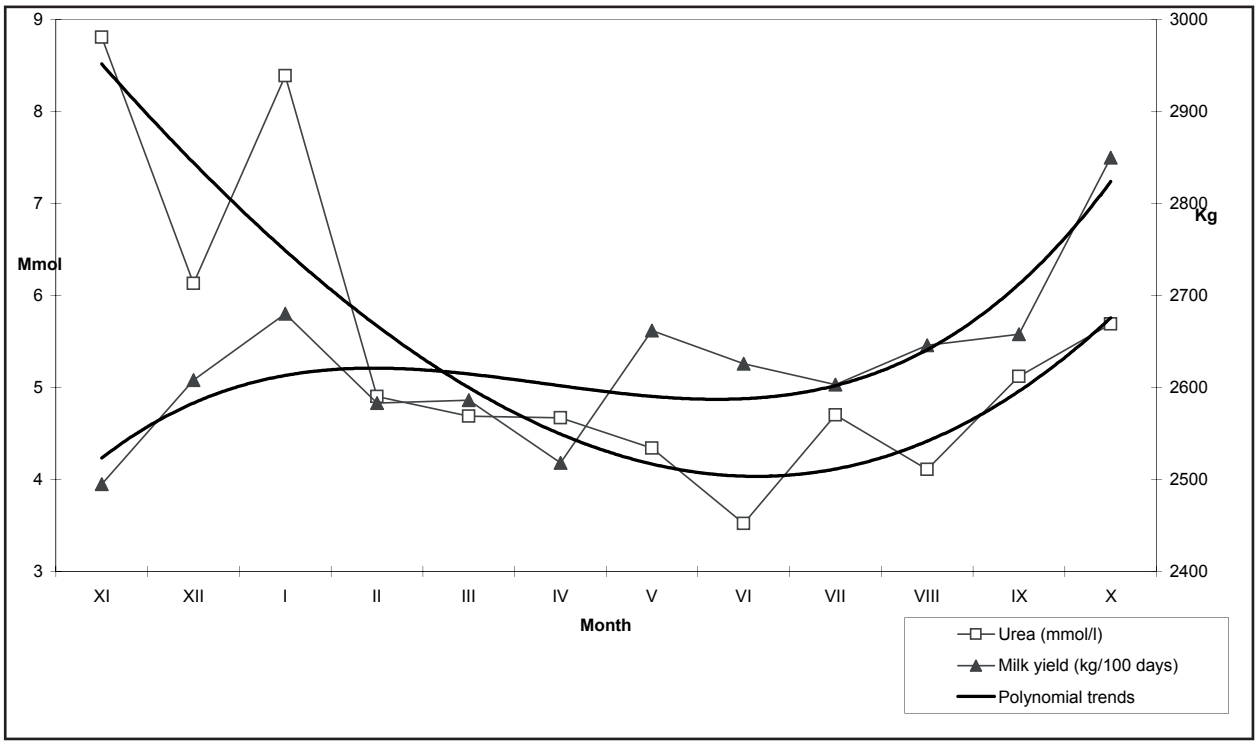

Figure 3: Blood plasma urea concentration and milk yield per100 days

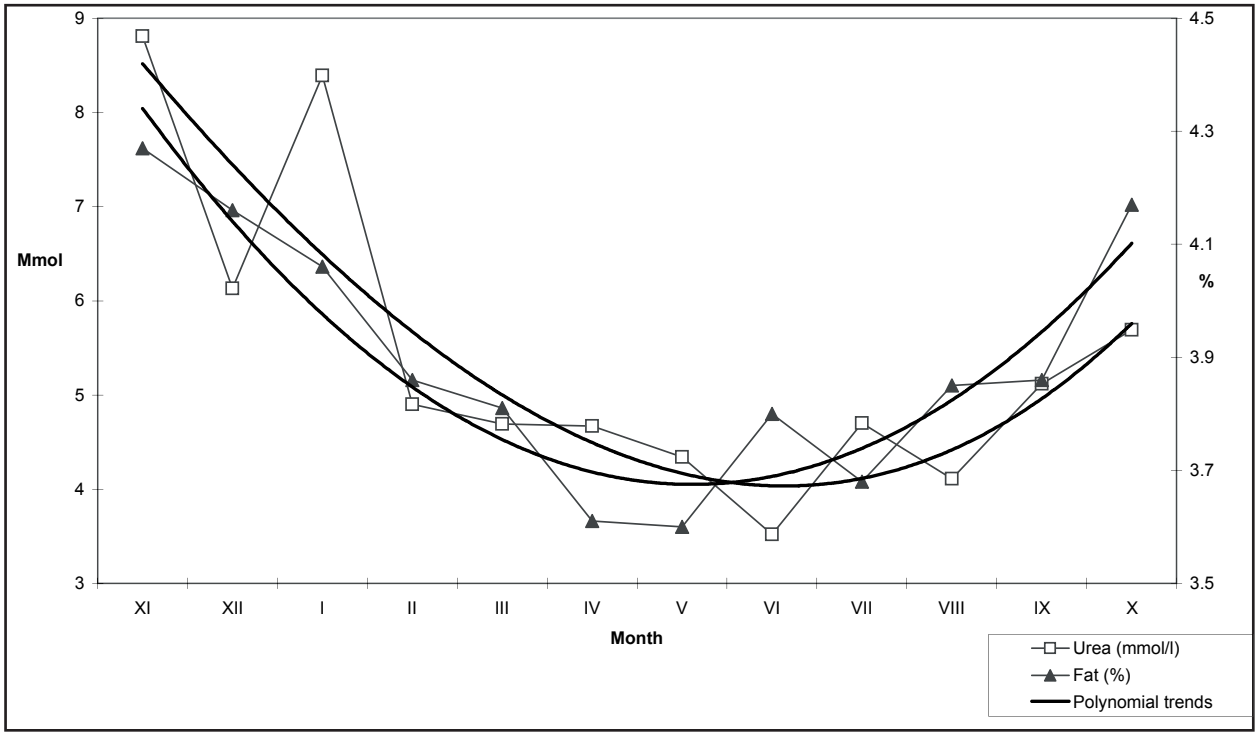

Figure 4: Blood plasma urea concentration and fat content in milk yield per100 days

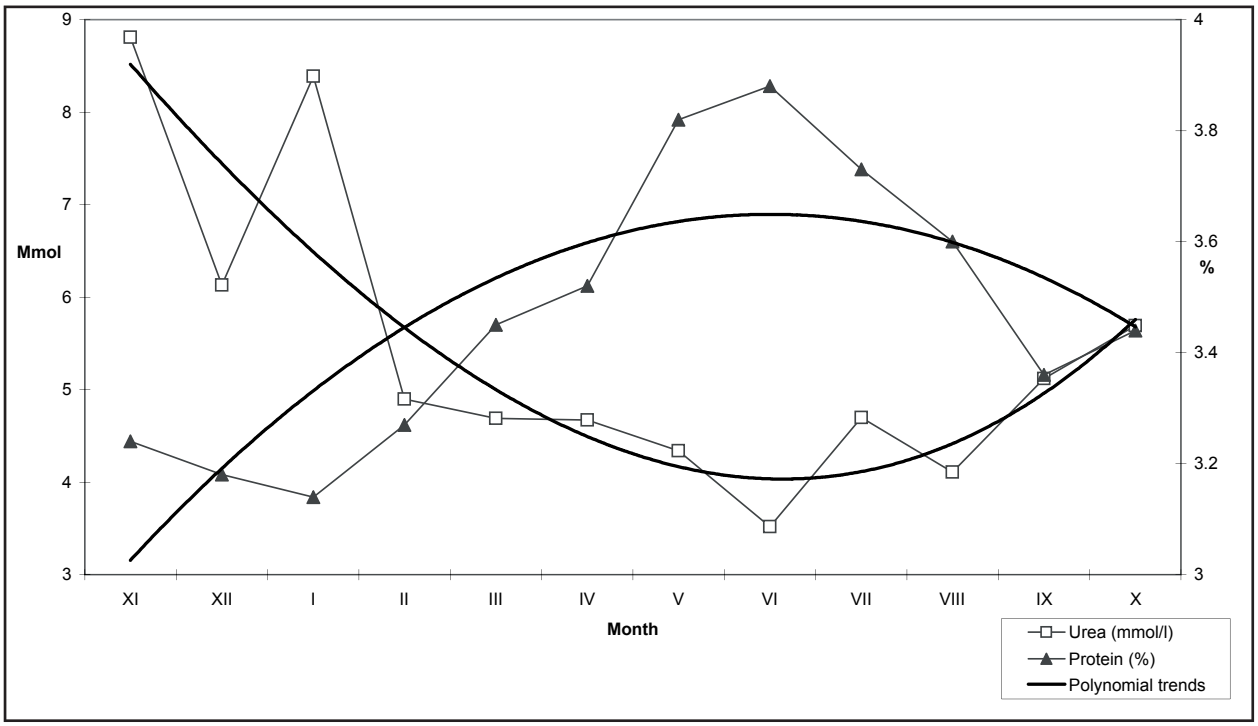

Figure 5: Blood plasma urea concentration and protein content in milk yield per100 days

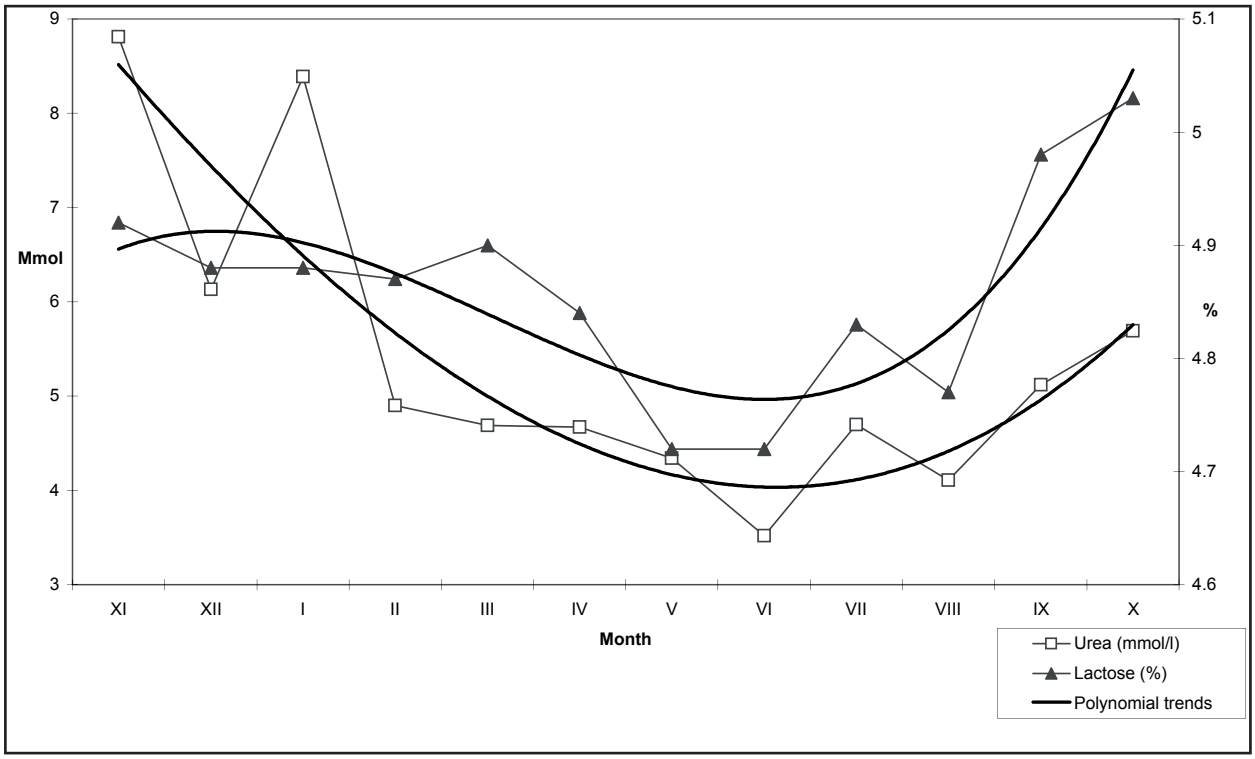

Figure 6: Blood plasma urea concentration and lactose content in milk yield per100 days

results of [4] despite the fact that he monitored daily milk yield in Holstein cows while we examined milk yield per 100 days in dual-purpose Czech Pied cows.

Blood plasma urea concentration was strongly positively related to milk fat content and strongly negatively related to milk protein content. Similar relationships between plasma urea and fat content were found by [11]; however, we did not agree with them on the relationship between plasma urea concentration and milk protein. But Chládek [4] also found a negative correlation between blood plasma urea concentration and protein content in milk. In general, the elimination of excess nitrogen from cow's organism requires extra energy which is then missing in the process of protein synthesis. This mechanism can explain the negative relationship between blood plasma urea and protein content.

The relationships between blood plasma urea concentration and number of lactation, milk yield and lactose content were not explicit. The relationships were negative in all cases in the first three months and they were positive in all the cases in the rest of the months. This discrepancy was probably caused by very high values of blood plasma urea concentration, which exceeded even the maximum physiological value [8] in the first months of the experiment. The relationships between plasma urea and number of lactation, milk yield and lactose content switched from negative to positive when urea concentration reached 6.0 to 6.5 mmol/l. The relationship between plasma urea and the number of days after calving also changed when urea concentration reached 6.5 mmol/l but in this case it switched from positive to negative.

In conclusion: urea concentration in blood plasma had a significant positive relationship with milk fat content, and a significant negative relationship with milk protein content. The relationships between urea concentration and number of lactation, milk yield and lactose content were mainly positive while a mainly negative relationship was found with a number of days after calving.

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