Bulgarian Journal of Veterinary Medicine (2005), 8, No 1, 35–39

ALTERATIONS IN CHEMICAL COMPOSITION OF COLOSTRUM IN RELATIONSHIP TO POST-PARTUM TIME

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Summary

Georgiev I. Penchev, 2005. Alterations in chemical composition of colostrum in relationship to post-partum time. *Bulg. J. Vet. Med.*, **8**, No 1, 35–39.

Experiments were designed to study the alterations in colostrum composition in relationship to *post-partum* time in dairy cows differing in milk yield. Two groups of 5 cows each, with high or low milk yield, respectively were used. Colostrum samples were collected on day 1 and day 3 after birth. Concentration of the major colostrum constituents (milk protein, lactose, dry matter and solid non-fat extract) changed significantly after birth, the levels on day 3 being similar to those of mature milk. The most significant changes were those in the concentration of milk protein, that on day 3 was more than twice lower as compared to the first portion of colostrum. There was no effect of milk secretion intensity on chemical composition of colostrum.

Key words: colostrum composition, dairy cows, milk yield

INTRODUCTION

Early postnatal colostrum feeding has important effects on immunological, metabolic, hormonal and hematological traits and on growth performance in neonates (Egli & Blum, 1998; Rauprich *et al.*, 2000; Blättler *et al.*, 2001; Georgiev *et al.*, 2003). Colostrum intake seems to have longer-lasting effect, notably with respect to immunoprotection and nutritional status of calves (Blum & Hammon, 2000). Bovine colostrum contains various nutrients (proteins, essential and non-essential amino acids and fatty acids, lipids, lactose, vitamins, minerals, oligoelements) as well as non-nutrient substances such as immunoglobulins, enzymes, nucleotides, peptides, polyamines, growth factors, hormones and cytokines, which are important for nutrient supply, specific and non-specific host defense, growth and development, i.e. for overall adaptation of neonatal calves to the new environmental factors after birth related to drastic change from primarily parenteral nutrition during fetal period to exlusively enteral provision of nutrients at birth (Levieux, 1999; Blum & Hammon, 2000; Blum & Baumrucker, 2002; Blum *et al.*, 2002).

Age, breed, nutrition, regimen of rearing, stage of lactation, energy balance and health status of udder are well known to affect milk composition (Iliev, 1988; Reist, 2001; Tomov, 2002; Ountsouka *et al.*, 2003; Reist *et al.*, 2002). Milk constituents change markedly during the course of milking (Ountsouka *et al.*,

2003). Furthermore, colostrum, especially the first portions, differ greatly in composition from mature milk (Levieux, 1999; Ountsouka *et al.*, 2003; Blum & Baumrucker, 2002).

Colostral period lasts about one week (Blum *et al.*, 2002). However, in neonatal calves "gut closure" with respect to protein macromolecules such as γ-globulins, β-lactoglobulin, α-lactoalbumin occurs within 24–36 hours after birth (Tomov, 2002; Georgiev *et al.*, 2002; Blum *et al.*, 2002).

Therefore, the objective of this study was to clarify the changes in colostrum composition in dairy cows closer to parturition and whether these changes depended on milk secretion intensity. We have tested the hypothesis that on day 3 of lactation the concentration of the main colostrum constituents was similar to that of milk.

MATERIALS AND METHODS

Animals, husbandry and experimental design

Ten dairy cows (Black and White) in their third lactation and their offsprings all originating from the University Experimental Station, Stara Zagora were studied. The cows were assigned to two groups according to the preceding average milk yield for a 305 - day period: high yielding group (Gr_{HY}; 5468.7 ± 188.68 kg of milk) and low yielding group (Gr_{LY}; 3086.3 ± 321.85 kg of milk). To avoid stress reactions they were fed and milked according to the normal regimen of the herd. During the dry period and early lactation the diet, consisting of alfalfa, maize silage, brewers grain and concentrates, was balanced for body maintenance and milk production requirements. The cows were milked twice daily at approximately equal intervals at 5.00 AM and 4.00 PM.

After birth, the offsprings were also divided into two groups according to the milk yield of their mothers: Gr_{CHY}, neonatal calves from Gr_{HY} and $Gr_{CLY,}$ neonatal calves from Gr_{LY}. Calves were fed colostrum from their mothers by bottle and received the first meal about 1.30 h after birth. They received mother's colostrum until day 5 and later milk pooled from all early lactating cows.

Blood samples for total protein determination were taken from all cows between 8.00 and 9.00 AM, 11-5 days before and on day 1, 3 and 12 after calving. Colostrum samples were collected on day 1 and day 3 after birth. Because milk components differed markedly in different milk fractions (Ontsouka *et al.*, 2003), we used average colostrum samples of cisternal and alveolar fractions. The daily milk yield was recorded by Milkoscope MKII (Foss Electric, Denmark). Blood samples from calves for total protein determination were taken on day 1 (before colostrum intake), 3 and 12 after birth.

Laboratory procedure and statistical analysis

Concentrations of fat, total protein, lactose, dry matter (DM) and solid non-fat extract (SNFE) in colostrum were determined by infra-red spectroscopy (Milko-Scan, Foss Electric, Hillerod, Denmark). Total protein concentrations in blood serum of cows and their offspring was determined by the biuret method, described by Kolb & Kamishnikov (1982).

Values of milk traits and serum total protein concentrations were expressed as means ± SEM. The data were evaluated using the general ANOVA/MANOVA procedure of the statistical program

STATISTICA. Group and time *post-partum* were used as fixed effects within animals and colostrum constituents (milk fat, milk protein, lactose, DM and SNFE) and serum protein values as variable. Differences ($P<0.05$) were evaluated by least significant difference (LSD) test (t-test). In addition, milk and serum parameters were subjected to simple correlation analysis.

RESULTS AND DISCUSSION

The milk yield in Gr_{HY} on day 1 (14.2 ± 0.7 kg), 3 (16.9 ± 1.1 kg) and 12 (22.5 ± 1.0 kg) was significantly ($P < 0.05$) higher than in Gr_{LY} (8.1± 0.5 kg, 10.8 ± 0.6 kg and 13.2 ± 0.8 kg, respectively).

In both groups milk protein concentrations (Table 1) declined significantly ($P < 0.05$) on day 3, the values being more than twice lower than those of the first day colostrum, taken immediately after birth. This could be attributed to the sharp fall of the concentration of immunoglobulin fractions, especially IgG. The immunoglobulin levels are nighest in the first portions of colostrum and represent about 50% of total protein concentrations (Iliev, 1988; Levieux, 1999; Rauprich *et al.*, 2000; Blum & Hammon, 2000; Tomov, 2002; Blum & Baumrucker, 2002). Large amounts of IgG is delivered to the neonate in the initial colostral milking, and after absorption appears in the neonate blood stream, promoting neonatal host defense during the first days of life (Tomov *et al.*, 1989; Blum & Baumrucker, 2002).

Our results (Table 2) showed a marked decrease in serum total protein concentrations in high and low yielding cows from pre- to day 1 post-partum. In contrast, colostrum intake caused a significant ($P < 0.05$) increase of serum total protein concentration in neonatal calves (Table 3). Milk protein was correlated negatively ($P < 0.05$) with total protein concentration in blood serum of cows ($r = – 0.68$ and $r = – 0.57$ in Gr_{HY} and Gr_{LY}, respectively) and calves ($r = – 0.83$ and $r = – 0.75$, in Gr_{CHY} and Gr_{CLY} respectively). On the other hand, serum total protein concentration in neonatal calves was correlated positively with serum total protein concentration of their mothers ($r = 0.46$ and $r = 0.21$). Taken together these results confirm the transfer of several protein fractions from

Table 1. Concentrations (mean ± SEM) of milk fat, milk protein, dry matter and solid non-fat extract (SNFE) in colostrum[1] in high- (n=5) and low-yielding cows (n=5)

Days after calving	Milk fat, %	Milk protein, %	Lactose, %	Dry matter, %	SNFE, %
High-yielding cows					
Day 1	4.8±0.7	11.9±1.7[a]	1.7±0.2[a]	19.3±1.3	14.5±1.6[a]
Day 3	5.3±1.4	5.4±0.7[b]	3.5±0.3[c]	15.1±1.7	9.9±0.4[b]
Low-yielding cows					
Day 1	4.6±0.7	11.1±2.0[a]	2.1±0.5	18.7±1.8	14.1±1.9
Day 3	5.9±1.0	5.0±0.8[b]	3.5±0.3	15.3±0.7	9.5±0.7

[1]Colostrum samples were obtained on day 1, immediately after calving and on day 3 of lactation. Significance of differences within groups: [a-b]$P<0.05$; [a-c]$P<0.01$.

Table 2. Pre- and postnatal serum total protein concentrations (g/L) (mean ± SEM) in high- (n=5) and low-yielding cows (n=5)

Days	High-yielding cows	Low-yielding cows
Pre-calving		
Days 11–5	78.3±1.6[a]	79.2±2.4[a]
After calving		
Day 1	71.9±2.7[b]	69.9±2.7[b]
Day 3	73.9±2.8	71.9±2.5
Day 12	75.2±2.3	73.3±2.2

Significance of differences within groups: [a-b] P<0.05.

Table 3. Serum total protein concentrations (g/L) (mean ± SEM) in neonatal calves born by high (Gr_{CHY}; n=5) and low-yielding cows (Gr_{CLY}; n=5)

Days after calving	Gr_{CHY}	Gr_{CLY}
Day 1	50.5±2.2[b]	51.1±2.3[a]
Day 3	53.0±2.3	54.1±2.9
Day 12	60.6±1.19[c]	59.8±1.3[b]

Significance of differences within groups: [a-b] P<0.05; [a-c] P<0.01.

mother's to neonate blood stream via colostrum.

DM and SNFE (Table 1) in colostrum were numerically or significantly (P < 0.05) lower on day 3 than on day 1 for SNFE in GrHy due to greater amounts of milk solids in colostrum. On the contrary, lactose concentrations on day 3 were higher (P < 0.05) than on day 1 which is in line with other studies (Rauprich *et al.*, 2000; Blattler *et al.*, 2001; Georgiev *et al.*, 2003). Among the various measured traits, milk fat concentrations, did not differ significantly between day 3 and 1 as described previously (Ontsouka *et al.*, 2003).

The results of the present study showed no effect of milk secretion intensity on the concentration of major colostrum constituents. There were no significant group differences in the concentration of milk fat, protein, lactose, DM and SNF (Table 1). It has been also demonstrated that lysosyme activity in colostrum was not closely related to the milk yield (Gueorguiev *et al.*, 1996). Other factors like age, breed, nutrition, season, regimen of rearing and energy balance during the dry period and the early lactation seem to have greater effect on colostrum composition than milk secretion intensity (Iliev, 1988; Levieux, 1999; Reist 2001; Tomov, 2002; Reist *et al.*, 2002).

In conclusion, concentration of the major colostrum constituents (milk protein, lactose, dry matter and solid non-fat extract) changed markedly after birth, the levels on day 3 being similar to that of mature milk. There was no effect of milk secretion intensity on chemical composition of colostrum.

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Paper received 15.05.2003; accepted for publication 23.11.2004

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