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STUDY ON CHEMICAL AND BIOLOGICAL PARAMETERS OF COLOSTRUM IN ROMANIAN BLACK AND WHITE COWS

STUDIUL PARAMETRILOR CHIMICI ŞI BIOLOGICI AI COLOSTRULUI LA VACILE DE RASĂ BĂLȚATĂ CU NEGRU ROMÂNEASCĂ

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The aim of the paper was to evaluate the colostrum quality and changes in composition during the first seven days postpartum. Researches were carried out on five Romanian Black and White multiparous cows. Samples of colostrum and transition milk were collected at calving and at 6-hour interval for seven days. Samples were analyzed for chemical composition using an infrared spectrometer (fat, protein, lactose and solids non-fat), for somatic cell count using a viscosimeter, for density using a desimeter, for total bacteria count using the classic incubation on Petri dish, and for immunoglobulin concentration using a colostrometer. For study the evolution of the colostrum composition Wood incomplete gamma function was employed ($y=ab^x e^{(-cx)}$). Results showed a dramatic change in colostrum yield and composition from the first milking right after calving until the next milking occurred at 6-hour interval. Yield was very low in the first milking (0.9 kg) and increased rapidly with each milking, reaching 11.2 kg in the seventh day postpartum. In the first colostrum the concentrations of milk fat, protein and total solids were high (11.56%, 17.73% and 32.08%, respectively) and were almost half in the second milking, after 6 hours. Lactose concentration was low at the beginning (1.89%) and increased slowly until the seventh day postpartum to 4.39%. Density was as high as 1.74 kg/liter in the first colostrum and decreased rapidly at 1.49 kg/liter. In the seventh day the density was 1.029 kg/liter. Immunoglobulin content had an atypical evolution. It was low in the first colostrum (34.48 mg/ml) and the highest in the second milking (43.66 mg/ml). After that it was decreasing until the end of experiment. Somatic cell count and total bacteria count were high in the first milking (1,575,488 cells/ml and 46,834 cfu/ml, respectively) and decreased after that.

Key words: colostrum, transition milk, chemical composition, somatic cell count, total bacteria count, immunoglobulin, Romanian Black and White, cow

Introduction

Bovine colostrum contains higher amounts of fats, proteins and peptides, fat-soluble vitamins, and various enzymes, hormones, growth factors, cytokines,

minerals and nucleotides than mature milk, and except for lactose, the levels of these compounds rapidly decrease during the first three days of lactation to those typical to mature milk (Blum and Hammon 2000 a and b). Colostrum intake in neonatal calves is essential for passive immunity and influences metabolism, endocrine systems and nutritional state (Blattler et. al, 2001). Knowing the composition and physical properties of colostrum and postcolostrum secretions will help establish when such milk is suitable for processing and determine the best use of that (Tsioulpas et. al, 2007).

Breed, age, nutrition, and health status of the cow are well known to influence milk composition (Ontsouka et. al, 2003). Also, management practices could have an important influence on colostrum quality, and herd size influence the colostrum management and quality at the farm level (Kehoe et. al., 2007).

Colostrum differs greatly in composition from mature milk and meets the nutritional requirements of the newborn (Ontsouka et. al, 2003). Colostrum and milk components are secreted by different mechanisms (Ontsouka et. al, 2003). Secretion is regulated by both local and systemic factors (Cziszter, 2003).

Concentration of immunoglobulins in bovine colostrum and milk is well documented, especially for early lactation and in relationship with protection of calves (Caffin et. al, 1983)

Milk constituents change during milking of colostrum, which need to be considered if milk samples are taken for analysis and to evaluate the health of the udder (Ontsouka et. al, 2003).

The objectives of this study were to evaluate the colostrum quality and changes during the first 7 days of lactation in Romanian Black and White cows.

Materials and Methods

Researches were carried out on five Romanian Black and White multiparous cows from the university research farm, during the summer 2006. Samples of colostrum and transition milk were collected at calving and at each 6 hours up to the 7^{th} day of lactation. Samples were immediately analyzed for chemical composition, density, somatic cell count, total bacteria count, and immunoglobulin concentration. Also, for each milking the milk yield was measured.

Chemical composition was performed using the instrument MilkoScan® S54B, which works in infrared spectrometry. The following components were determined: fat percentage, total protein percentage, lactose percentage, and solids non-fat percentage. By adding milk fat to the solids non-fat, the total solids percentage in the milk was calculated. Density was performed using the desimeter. Somatic cell count was determined using the instrument MT-02®. This instrument is using viscosity to determine the number of somatic cells, after adding to 10 ml milk 5 ml coagulation reagent. Total bacteria count was determined by incubation on classic nutritive agar medium. Immunoglobulin concentration was assessed using a colostrometer™ from Biogenics.

In order to better observe the evolution of the colostrum and transition milk components during the first 156 hours after calving, the results were modeled using Wood, 1967 equation, as follows $y=ab^{x}e^{(-cx)}$, where y is the yield or component at time x; a, b, and c are parameters of the function and; and e is the base of natural logarithm. Graphs were plotted using the results of modeling in order to describe the evolution of components and milk yield after calving.

Results and Discussions

Table 1 presents the equation parameters of the Wood function, for each colostrum component, together with the determination coefficient and residual mean squares.

We could state that, generally, the colostrum chemical components and density evolutions were described in a large extent by the Wood function, the determination coefficient varying from 0.45 for fat percentage to as high as 0.84 for lactose percentage.

Table 1

Estimated equation parameters for colostrum traits

Trait	a	b	c	R^2	RMS
Milk yield	0.090624	1.199251	0.00795926	0.61	506.19
Fat percentage	8.461663	-0.135672	0.00062808	0.45	247.30
Protein percentage	13.430573	-0.120776	0.00555789	0.83	204.87
Lactose percentage	1.190902	0.257819	-0.00001463	0.84	12.98
Solids non-fat percentage	16.618469	-0.090881	0.00124781	0.83	139.17
Total solids percentage	25.099362	-0.106556	0.00103510	0.73	578.20
Density	1.059712	-0.005788	0.00000109	0.70	0.0048
Total immunoglobulins	44.262043	0.107001	0.03425331	0.48	13348.5
Somatic cell count (log)	13.585114	-0.019531	0.00008339	0.09	62.50
Total bacterial count (log)	10.422188	-0.014347	0.00026849	0.18	21.08

R^2 – determination coefficient, RMS – residual mean squares

The biological indicators of the colostrum had a lower determination, the determination coefficient being as low as 0.09 for the somatic cell count to 0.18 for the total bacteria count. The evolution of the total immunoglobulins concentration in colostrum was described with a very good precision by the Wood function (R^2=0.48).

The goodness of fit for total solids percentage is shown in Figure 1, as an example as how the Wood equation is adjusted to the actual data. It could be observed that at time zero, immediately after calving, the concentration of the total solids in colostrum was as high as 34%, which rapidly decreased to about 18% during the first 12 hours.

The colostrum/milk yield increased from milking to milking (Figure 2). It was below 1 kg for the first two milkings, and then increased up to 11.18 kg at 156 hours after calving that is the 27th milking. Milk yield at first milking was very low and was rapidly increasing, with a rate of 1.199 (parameter b in Table 1).

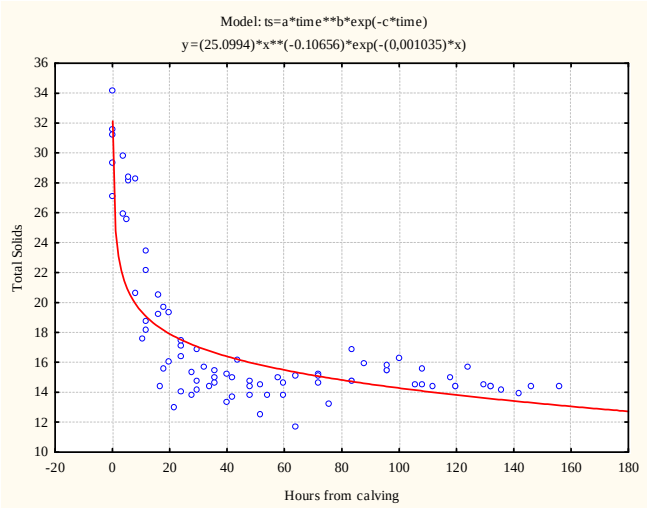

Figure 1. Goodness of fit for the total solids percentage to the Wood equation

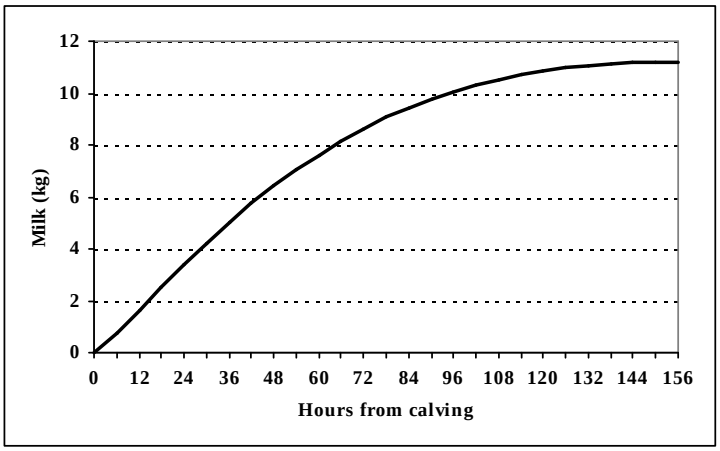

Figure 2. Colostrum/milk yield evolution during the first week after calving

Evolution of the milk fat, protein and lactose content of colostrum during the first 7 days is presented in Figure 3.

Milk fat was as high as 11.56% in the first milking and rapidly decreased to 6.61% in the second milking, after 6 hours. Then, there was a slight but steady decrease in milk fat percentage as cows passed to the transition period. At 7 days postpartum, the milk fat percentage was similar to that of the mature milk 3.87%.

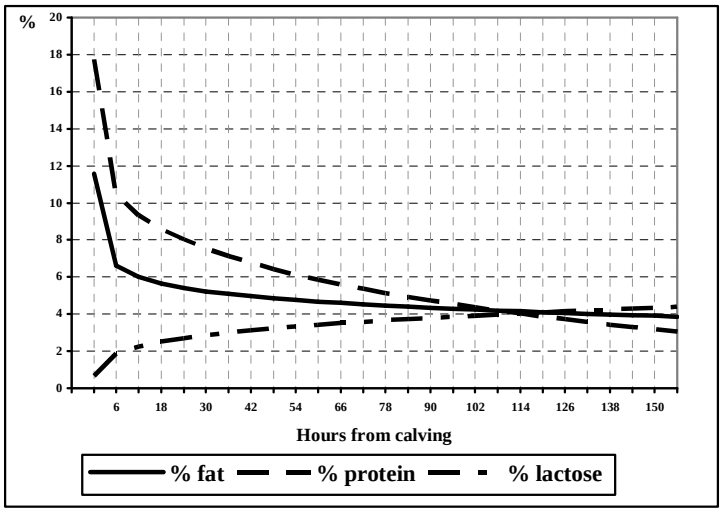

Figure 3. Fat, protein and lactose content evolution during the first week after calving

Protein percentage was 17.73% in the first colostrum, and decreased to 10.46% in the second milking (Figure 3). After that, the milk protein percentage had a higher decreasing rate compared to milk fat percentage. The c parameter of the equation was 0.00555789, meaning that each day in milk the protein percentage was that value lower. During the 7th day the protein percentage reached the normal value of the mature milk of 3.07%.

Lactose percentage of milk (Figure 3) was low in the first colostrum (1.89%) and increased to a value of 4.39% at the end of the experimental period (7 days post partum).

Total solids and solids non-fat percentage evolutions are presented in Figure 4. Both chemical indices had similar evolution during the experimental period. Total solids was 32.08% in the first colostrum milked right after calving and decreased rapidly to 20.61% in the second milking. After that, the total solids percentage decreased with a lower rate until de seventh day postpartum. At the end of the experimental period the content of milk in total solids was 12.47%, characterizing the mature milk.

The evolution of the density and immunoglobulin content of the colostrum is presented in Figure 5. The first colostrum had a density of 1.74 kg/liter and decreased to 1.49 kg/liter during the first six hours post partum. Then, the decrease

of the milk density was slow until reached the lower value of 1.029 kg/liter at the end of the experimental period (7 days postpartum).

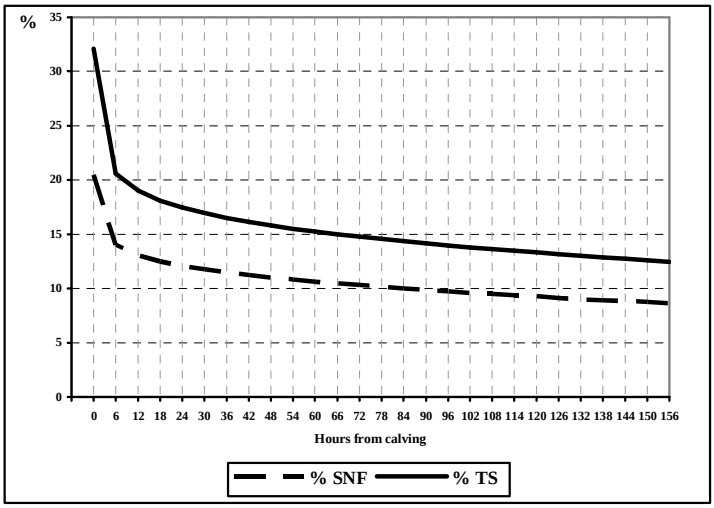

Figure 4. Solids non-fat and total solids content evolution during the first week after calving

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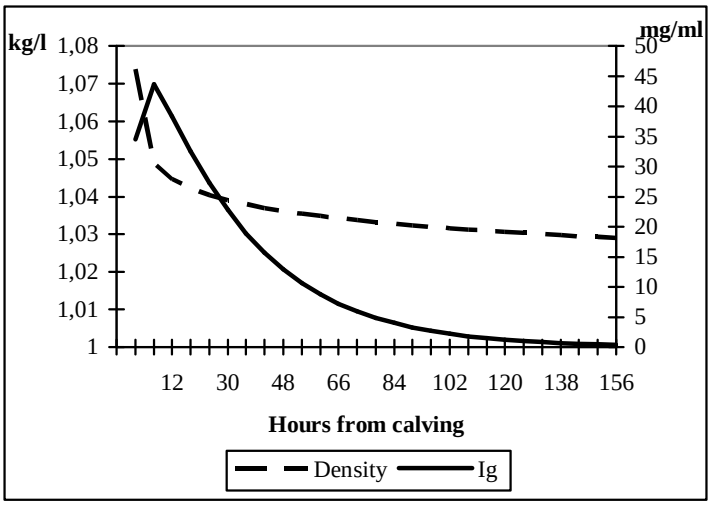

Figure 5. Density and immunoglobulin content evolution during the first week after calving

The immunoglobulin content of the colostrum (Figure 5) had an evolution different from what do we know from the literature. The first colostrum had an Ig concentration of 34.48 mg/ml. This concentration increased in the second milking after 6 hours to 43.66 mg/ml. After that, the Ig content of the transitional milk was decreasing with a high rate until 42 hours post partum (8^{th} milking). The Ig content of milk continued to decrease after that, but with a lower rate, reaching a value of 0.36 mg/ml, specific to the mature milk.

The evolution of the somatic cell count and total bacteria count in colostrum during the first week post partum is presented in Figure 6.

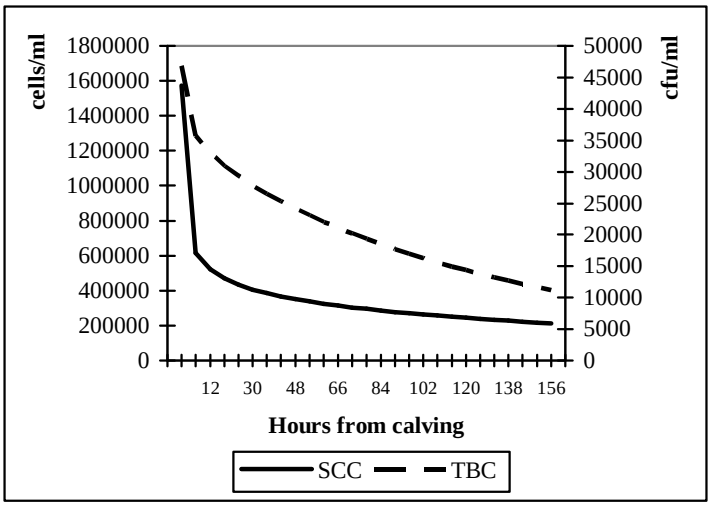

Figure 6. Somatic cell count and total bacteria count evolution in milk during the first week after calving

Somatic cell count was very high in the first colostrum milked, over 1.5 million (1,575,488 cells/ml). In the next milking, that took place 6 hours postpartum, SCC dropped to 616,575 cells/ml. During the following milkings the SCC decreased, reaching the value of 212,506 cells/ml in the last studied milking, on the seventh day of the experiment. High value of the SCC in the first colostrum is the way cows try to cope with the high potential for mammary gland infection threat at the beginning of lactation.

Total bacteria count in colostrum and transition milk was relatively low, and followed the same trend as SCC. The highest value was observed in the first colostrum (46,834 cfu/ml). This value abruptly decreased until the third milking at 12 hours postpartum to 32,966 cfu/ml. During the next 6 days of the trial TBC continued to decrease to the value of 11,209 cfu/ml at the last milking of the experiment, during the seventh day.

Conclusions

Results showed a dramatic change in colostrum yield and composition from the first milking right after calving until the next milking occurred at 6-hour interval.

Wood's gamma incomplete function described well the evolution of the colostrum chemical composition, density and total immunoglobulin concentration, but les the biological indicators such as somatic cell count and total bacteria count.

Yield was very low in the first milking (0.9 kg) and increased rapidly with each milking, reaching 11.2 kg in the seventh day postpartum.

In the first colostrum the concentrations of milk fat, protein and total solids were high (11.56%, 17.73% and 32.08%, respectively) and were almost half in the second milking, after 6 hours. Lactose concentration was low at the beginning (1.89%) and increased slowly until the seventh day postpartum to 4.39%.

Density was as high as 1.74 kg/liter in the first colostrum and decreased rapidly at 1.49 kg/liter. In the seventh day the density was 1.029 kg/liter.

Immunoglobulin content had an atypical evolution. It was low in the first colostrum (34.48 mg/ml) and the highest in the second milking (43.66 mg/ml). After that it was decreasing until the end of experiment.

Somatic cell count and total bacteria count were high in the first milking (1,575,488 cells/ml and 46,834 cfu/ml, respectively) and decreased after that.

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~~**STUDIUL PARAMETRILOR CHIMICI ŞI BIOLOGICI AI COLOSTRULUI LA VACILE DE RASĂ BĂLȚATĂ CU NEGRU ROMÂNEASCĂ**~~

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Scopul acestei lucrări a fost acela de a evalua calitatea şi modificările de compoziţie ale colostrului în primele şapte zile postpartum. Cercetările s-au efectuat pe un număr de cinci vaci multipare din rasa Bălţată cu negru românească. Probele de colostru şi lapte de tranziţie au fost recoltate la fătare şi apoi la intervale de 6 ore timp de şapte zile. Probele au fost analizate pentru determinarea compoziţiei chimice (grăsime, proteină, lactoză şi substanţă uscată degresată) folosind un spectrometru în infraroşu, pentru determinarea numărului de celule somatice folosind un viscozimetru, pentru densitate cu nun densimetru, pentru numărul total de bacterii folosind metoda clasică de incubare în plăci Petri şi pentru determinarea concentraţiei de imunoglobuline folosind un colostrometru. Pentru a studia evoluţia compoziţeii colostrului s-au modelat datele obţinute cu ajutorul funcţiei gamma incomplete a lui Wood ($y=ab^{x}e^{(-cx)}$). Rezultatele au arătat că producţia şi compoziţia colostrului s-au modificat brusc între prima mulsoare şi cea de-a doua care s-a efectuat la 6 ore după fătare. Producţia a fost foarte mică la prima mulsoare, de numai 0,9 kg şi a crescut rapid cu fiecare mulsoare atingând valoarea de 11,2 kg în a şaptea zi de lactaţie. Concentraţiile de grăsime, proteină şi substanţă uscată au fost ridicate la prima mulsoare (11,56%, 17,73% şi respectiv 32,08%), şi aproape că s-au înjumătăţit la a doua mulsoare după 6 ore. Concentraţia de lactoză a fost mică la început (1,89%) şi a crescut treptat până în a şaptea zi de lactaţie la 4,39%. Densitatea a fost de 1,74 kg/litru la primul colostru, apoi a scăzut la 1,49 kg/litru la a doua mulsoare. În a şaptea zi a experimentului densitatea a fost de 1,029 kg/litru. Concentraţia imunoglobulinelor a avut o evoluţie atipică. A fost mai mică în primul colostru muls (34,48 mg/ml) şi cel mai mare nivel l-a atins la a doua mulsoare (43,66 mg/ml), după care a scăzut până la sfârşitul experimentului. Numărul de celule somatice şi numărul total de bacterii din lapte au fost foarte ridicate la prima mulsoare (1.575.488 celule/ml şi respectiv 46,834 UFC/ml), după care au scăzut.

11.10. **Cuvinte cheie:** colostru, lapte de tranziţie, compoziţie chimică, număr de celule somatice, număr de bacterii, imunoglobuline, Bălţată cu negru românească, vacă