Biochemical and Haematological Blood Parameters at Different Stages of Lactation in Cows

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Bulletin UASVM Animal Science and Biotechnologies 74(1)/ 2017

Print ISSN 1843-5262; Electronic ISSN 1843-536X

DOI:10.15835/buasvmcn-asb: 12283

Abstract

The health status of cows is evaluated and depending on haematological and biochemical profile of blood. Nutrition is the main technological factor that can produce profound changes in the metabolic profile in animals (Dhiman *et al.*, 1991; Khaled *et al.*, 1999; Ingvarsten, 2006). Blood parameters analyze can lead to identify if there are errors in nutrition of lactating cows (Payne *et al.*, 1970). The aim of this study was the evaluation of metabolic and biochemical changes that occur during colostrum period and in terms of number of lactations in cows. The biological material was represented by a total of 60 heads of dairy cows from a family farm from Sălaj County, Romania. The cows are all from Holstein breed and presented no clinical signs of any specific pathology. Blood samples were collected from the jugular vein of each cow and analyzed. 10 individuals from each of the six lactations have been randomly selected. Haematological and biochemical parameters showed variations depending on factors analyzed here. In lactation 1 Hb was 7.55 ± 3.05 (g/dl), while in lactation 6 the value was 12.5 ± 2.10 (g/dl). RBC ranged as follows: in lactation 1 - 28.50 ± 2.05 and in lactation 6 - 30.02 ± 2.05 . Lymphocytes varied within very wide limits under the influence of lactation: in lactation 1 - 2.8 ± 1.56 and in lactation 6 - 7.55 ± 1.80 . The number of lactations and lactation rank have influenced blood biochemical and hematological parameters in dairy cows. Biochemical parameters are influenced by post-partum day, showing the lowest values in the early days of colostrum period and the highest in the last few days of the same period.

Keywords: *albumin, cholesterol, cow, milk, MCH, MCHC, RBC*

INTRODUCTION

The health of the cows can be evaluated and depends on haematologic and biochemical profile of blood. Hematology is highly informative as a diagnostic tool in bovine medicine, not solely, but in combination with clinical examination or other diagnostic procedures (Roland *et al.*, 2014). Nutrition is the main technological factor that can produce profound changes in the metabolic profile in animals (Dhiman *et al.*, 1991; Khaled *et al.*, 1999; Ingvarsten, 2006). The deficiency of minerals, proteins and vitamins in the diet

of lactating cows causes profound changes in metabolism (Pârvu, 1992). Haematological parameters reflect the adaptability of cows to adverse environmental conditions, as well as other stressors. Haematological and biochemical profile within normal physiological limits reflects a good health status and is highly correlated with milk production (Coroian *et al.*, 2011). Blood parameters analysis can identify if there are errors in nutrition in lactating cows (Payne *et al.*, 1970).

Biochemical and hematological parameters of cattle blood were analyzed based on several

factors and by many authors over time: the influence of blood biochemical profile in cows with reproductive disorders and clinically healthy cows (Ruginosu *et al.*, 2011); influence of lactation on biochemical profile in cows (Filipejová and Kovacik, 2009); biochemical variation within the transition period in dairy cows (Seifi *et al.*, 2007; Quiroz-Rocha *et al.*, 2009; Imhasly *et al.*, 2014); season influence on blood parameters in cows.

Mazzullo *et al.* (2014) analyzed environmental factors (ambient temperature, relative humidity and temperature-humidity index) that affected haematological parameters in Piemontese cows aged 2-12 years. Lactation phase also have influence on biochemical parameters of the blood (Filipejová and Kováčik, 2009), but also level of production (Joźwik *et al.*, 2012).

Lumsden *et al.* (1980) studied age influence on hematology and biochemistry reference values for female Holstein cattles. Similar studies repeatedly showed up with more individuals or various factors to affect those blood parameters. Cozzi *et al.* (2011) has estimated the reference values for blood parameters in Holstein dairy cows: effects of parity, stage of lactation and season of production as a tool for an easier prediction to assess the metabolic status of lactating Holstein cows. Theoretically general estimated values and variation limits of blood parameters exists in dairy cows as descriptive data, with few or no physiological mechanisms to explain these variations or simply how are those correlated with health status or milk production. Anyway, varieties of factors are responsible for individual and herd variation in blood metabolite concentrations confounding interpretation (Van Saun, 2000).

Similar studies have been performed to another species. Sabasthin *et al.* (2012) studied blood haematological and biochemical parameters in normal cycling, pregnant and repeat breeding buffaloes (*Bubalus bubalis*) maintained in isothermic and isonutritional conditions. Metabolic profile in buffaloes has been also conducted for pre- and post-partum period (Coroian *et al.*, 2011).

In spite of many factors which have been evaluated in correlation with those blood parameters in cows or other species, technological aspects such lactation rank seems to present less interest, probably due to significant shortening of

productive life in cows during the past decades. Here we evaluated metabolic and biochemical changes that occur during different phase such colostral period and lactation in dairy cows, but also in terms of number of lactations.

MATERIALS AND METHODS

The biological material was represented by a total of 60 heads of dairy cows from a family farm from Sălaj County, Romania. The cows are all from Holstein breed and presented no clinical signs of any specific pathology. Blood samples were collected from the jugular vein of each cow and analyzed. 10 individuals from each of the six lactations have been randomly selected. Blood was collected in test tubes with EDTA as an anticoagulant in spring. Haematological and biochemical blood parameters were analyzed with the device Abacus Junior Vet Scan and VS-2 Abacsis.

RESULTS AND DISCUSSIONS

Haematological and biochemical parameters showed variations depending on factors analyzed in here. In Table 1 are shown the average values of blood hematological and biochemical parameters in dairy cows for a total of six lactations. MCHC (g/dl) ranged between 31.36 ± 0.40 in lactation 1 and 36.14 ± 0.41 in lactation 5. In lactation 1 HEM was 7.55 ± 3.05 (g/dL) and in lactation 6 the mean value was 12.5 ± 2.10 (g/dL). HCT ranged as follows: in lactation 1 the mean values were 28.50 ± 2.05 (%) and in lactation 6 they were 30.02 ± 2.05 (%). Lymphocytes under the influence of lactation varied within very wide limits, in lactation 1 they were 2.8 ± 1.56 ($\times 10^9$ /L) and in lactation 6 the mean values were 7.55 ± 1.80 ($\times 10^9$ /L). WBC ($\times 10^9$ /L) ranged between 7.80 ± 0.41 in lactation 1 and 15.10 ± 0.31 in lactation 6. Granulocytes varied between 4.64 ± 0.15 ($\times 10^3$ μ L) (lactation 1) and 7.82 ± 0.30 ($\times 10^3$ μ L) (lactation 6), similarly varied platelets showing an average of 287 ± 6.04 ($\times 10^3$ μ L) in lactation 1 and 327 ± 4.87 ($\times 10^3$ μ L) in lactation 6.

Ruginosu *et al.* (2011) studied the haematological profile in cattle which suffered by reproductive problems compared with healthy castles and observed changes in hematocrit, hemoglobin and erythrocytes under the influence of lactation and health. Hematological parameters (especially leukocytes and lymphocytes) were

influenced by the age of the animal, but also during pregnancy (Botezatu *et al.*, 2014). In our study WBC are higher in the 6 lactations compared to those reported in 2014 by Radkowska and Herbut, who observed hematological changes based on management system used.

Magnesium (mg/dL) ranged from 2.24 ± 0.09 (mg/dL) in lactation 1 up to 3.59 ± 0.03 (mg/dL) in lactation 6. Albumin presented the lowest average values of 2.85 ± 0.10 (g/dL) in lactation 2 and the highest 3.69 ± 0.08 (g/dL) in lactation 6. Total protein (g/dL) showed the lowest averages in lactation 1 and 4 (6.82 ± 0.18 , respectively 6.86 ± 0.24) and highest in lactation 5 (7.67 ± 0.35). These values are higher than those reported by Wiziri *et al.* (2010) for total protein, function of gestation week. The lowest values for γ globulin (g/dL) were in lactation 3 (2.47 ± 0.12) and lactation 6 (2.89 ± 0.09). ALT (U/L) exhibited the lowest average values in lactation 1 and 3, while

in lactations 4, 5 and 6 the average values were highest. For GGT (U/L) and AST (U/L), the lowest average values were in lactation 1, while the highest were in lactation 6. Botezatu *et al.* (2014) observed changes for biochemical indexes also between individuals, not only function of age, line and breed studied.

Biochemical parameters for colostral period in cows (days 1-7)

In figures 1-4 are given the average values of blood biochemical parameters of cow colostrum for the first seven days. Calcium in the first three days of colostral period presented the lowest values, while the highest values were in days 4-7. Both lactation rank and post-partum day have influence on this parameter.

Phosphorus presented the lowest average values on day 1 post-partum (6.93 mg/dL) and the highest on day 7, with an average of 9.52 (mg/dL).

Tab. 1. Haematological and Biochemical parameters in cows function of lactation rank

Parameter	Hematological parameters					
	Lactation					
	1	2	3	4	5	6
MCHC (g/dl)	31.36 ± 0.40	33.64 ± 0.70	34.68 ± 0.63	34.22 ± 0.61	36.14 ± 0.41	35.97 ± 0.42
HEM (g/dl)	7.55 ± 3.05	9.67 ± 0.31	10.06 ± 0.14	10.03 ± 0.38	11.46 ± 0.39	12.5 ± 2.10
HCT (%)	28.50 ± 2.05	27.54 ± 0.73	28.66 ± 0.73	29.08 ± 0.40	29.16 ± 0.27	30.02 ± 2.05
WBC ($\times 10^9/L$)	7.80 ± 0.41	9.80 ± 0.48	11.74 ± 0.52	13.44 ± 0.53	14.22 ± 0.27	15.10 ± 0.31
Lymphocytes ($\times 10^9/L$)	2.8 ± 1.56	3.82 ± 0.27	4.12 ± 0.11	5.98 ± 0.14	6.22 ± 0.14	7.55 ± 1.80
Granulocytes ($\times 10^9/L$)	4.64 ± 0.15	6.22 ± 0.29	6.80 ± 0.10	6.33 ± 0.34	7.18 ± 0.25	7.82 ± 0.30
Platelets ($\times 10^3 \mu L$)	287 ± 6.04	294 ± 2.46	309 ± 3.93	323 ± 3.14	316 ± 8.66	327 ± 4.87
Parameter	Biochemical parameters					
	Lactation					
	1	2	3	4	5	6
Magnesium (mg/dL)	2.24 ± 0.09	2.69 ± 0.12	2.91 ± 0.13	3.05 ± 0.08	3.39 ± 0.08	3.59 ± 0.03
Calcium (mg/dl)	8.34 ± 0.24	8.48 ± 0.19	8.97 ± 0.18	9.52 ± 0.32	10.17 ± 0.15	10.52 ± 0.20
Phosphorus (mg/dl)	5.19 ± 0.19	5.23 ± 0.15	6.05 ± 0.27	5.77 ± 0.10	5.92 ± 0.10	6.06 ± 0.09
Cholesterol (mg/dl)	110.6 ± 1.08	115.4 ± 1.96	121 ± 5.68	118.6 ± 4.7	122.6 ± 4.18	128.8 ± 3.37
Urea (mg/dl)	19.18 ± 0.78	20.33 ± 0.71	22.92 ± 0.64	23.2 ± 0.86	25.20 ± 2.13	26.4 ± 0.75
Albumin (g/dl)	2.92 ± 0.17	2.85 ± 0.10	2.90 ± 0.21	3.11 ± 0.16	3.54 ± 0.19	3.69 ± 0.08
Total protein (g/dl)	6.82 ± 0.18	7.05 ± 0.17	7.27 ± 0.28	6.86 ± 0.24	7.67 ± 0.35	7.49 ± 0.28
γ Glob (g/dl)	2.67 ± 0.07	2.52 ± 0.05	2.47 ± 0.12	2.63 ± 0.12	2.72 ± 0.10	2.89 ± 0.09
ALAT (U/L)	23 ± 0.68	24 ± 1.07	23 ± 0.86	25 ± 1.0	26 ± 0.97	25.8 ± 1.46
GGT (U/L)	32.6 ± 0.81	36.6 ± 0.87	33.8 ± 0.86	34.8 ± 1.43	36 ± 1.64	37 ± 0.89
ASAT (U/L)	50.8 ± 0.58	53.8 ± 1.07	52.6 ± 1.99	55 ± 1.10	56.2 ± 0.66	57 ± 1.55

RBC (Red blood cells) – eritocyte; MCHC – mean corpuscular hemoglobin concentration;
HEM – hemoglobin; HCT – hematocrit; WBC (White blood cells) – leukocytes.

Magnesium evolved similarly, reaching the highest values at day 7 post-partum.

Cholesterol presented the lowest average values on day 3 post-partum (106.3 mg/dl) and the highest on day 7 post-partum (126.4 mg/dl). Cholesterol is influenced by the state of pregnancy, the time and number of lactations according to studies by Pysera *et al.* (2000)

and Nath *et al.* (2005). Rowlands *et al.* (1980) analyzed cholesterol evolution, which is lower in the period immediately after calving and increase with lactation, reaching the highest values at the end of lactation. Ruginosu *et al.* (2011) shown that elevated cholesterol values showed liver and metabolic malfunctions. Urea varied as follows: 18.95 (mg/dl) on day 1 post-partum and 27.2

Fig. 1. Magnesium (mg/dL), Calcium (mg/dL) and Phosphorus (mg/dL) values on 1-7 post-partum days in dairy cows

Fig. 2. Cholesterol (mg/dL) and urea (mg/dL) values on 1-7 post-partum days in dairy cows

Fig. 3. Albumin (g/dL) and total proteins (g/dL) values on 1-7 post-partum days in dairy cows

Fig. 4. γ -globulin (g/dL), ALAT (U/L), GGT (U/L) and ASAT (U/L) values on 1-7 post-partum days in dairy cows

(mg/dl) on day 7. These values are superior to those reported by Wiziri *et al.* (2010). Post-partum period revealed changes in serum albumins and urea (Ruginosu *et al.*, 2011).

Total protein presented the lowest average values at day 1 post-partum (6.62 g/dl) and increased in the coming days post-partum reaching the highest values on day 7 (7.88 g/dl). High levels of total proteins may be caused by various diseases, mastitis, the influence of the metabolism, and nutrition and lactation (Rowland *et al.*, 1975; Hagawane *et al.*, 2009). γ Globulin (g/dl), ALT (U/L), GGT (U/L) and AST (U/L) showed lowest average values in the first days post-partum and the highest in day 6 and 7 post-partum. Ruginosu *et al.* (2011) found a low level of total serum protein and urea in diseased cows versus healthy ones. Total proteins and albumin are influenced by diet when there are gaps (Coroian *et al.*, 2011).

CONCLUSIONS

The number of lactations and lactation rank have influenced blood biochemical and hematological parameters in dairy cows. Biochemical parameters are influenced by post-partum day, showing the lowest values in the early days of colostral period and the highest in the last few days of the same period.

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