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THE EVOLUTION OF THE BLOOD SERUM INDICATORS DURING THE TRANSITION PERIOD IN DAIRY COWS

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Abstract

The aim of this research trial was to assess the nutritional and health status during the transition period of dairy cows. The transition period is characterized by increased energy requirements and a reduction in the intake of dry matter of the lactating cows. The study was carried out at the Experimental Farm of the Research and Development Institute for Bovine Balotesti, Romania. Blood samples were collected from a number of 50 purebred Romanian Black and Spotted dairy cows during the last 3 pre-partum and first 3 post-partum weeks (3 weeks pre-partum, 1 week pre-partum, at calving, 1 week post-partum and 3 weeks post-partum). A total of 250 blood samples were analysed for serum proteins (total proteins, albumin, urea) and mineral indicators (total calcium, phosphorus and magnesium). During the transition period, the obtained serum values for protein profile were not significantly (P>0.05). The concentration of calcium and phosphorus of blood did not show differences (P>0.05) between sampling period, except the level of magnesium (P<0.05) after partum period comparative with pre-partum period. Current results revealed the importance of the serum indicators as a potential tool for monitoring the nutritional status of the dairy cows at farm levels.

Key words*: dairy cows, blood, nutritional status, transition period.*

INTRODUCTION

Several nutritional strategies have been elaborated and studied in the last years with the aim of optimizing transition cow nutritional status, health and productivity.

One such nutritional strategy involves controlled or restricted energy feeding during the dry period (Cardoso et al., 2013; Roche et al., 2013; Goff, 2006; Goff and Horst, 1997; Bell, 1995; Grant and Albright, 1995; Grummer, 1995). Dairy cows go through physiological changes to prepare themselves for the onset of lactation and the climb to peak milk production (Abuelo et al., 2019).

The transition period for dairy cows has been defined as the period from 3 weeks pre-calving to 3 weeks post-calving (Van Saun, 2016; Quiroz-Rocha et al., 2009 a; Drackley, 1999). The period is characterized by marked changes in the endocrine status of the animal, and a reduction in the intake of dry matter and an increase in energy requirements of the cow for milk production (Huzzey et al., 2005; Smith and Risco, 2005; Cook and Nordlund, 2004; Grummer, 2004; Grummer, 1993).

The transition period is generally associated with poor health and reduced reproductive outcomes (Sheehy et al., 2017), periparturient management is essential for productivity and profitability of dairy farming (Reddy et al., 2016; Ferguson, 2001).

The periparturient period is considered the most critical period in the lactation cycle (Huzzey et al., 2005; Grummer, 1995) because 50 % until 75 % of this may be affected by disease during the first month after calving (Singh et al., 2015; LeBlanc, 2010).

These diseases can be of a metabolic, nutritional, or infectious nature (Andrieu, 2008; Mulligan and Doherty, 2008): ketosis, fatty liver, acidosis, displaced abomasum, milk fever, hypophosphatemia, hypomagmesaemia mastitis, metritis, endometritis and retention of fetal membrane.

It is imperative that nutritional strategies used for transition cows do not result in negatively altered calcium status. Several studies showed that serum calcium levels are important for cow health.

Concentrations lower than 2.0 mmol/L are associated with metritis, displaced abomasum, reduced milk production, reduced pregnancy rates to first service (Chapinal et al., 2012 b; Martinez et al., 2012) and have a detrimental effect on neutrophil function (Martinez et al.,

2014). The aim of this research work was to assess the nutritional and health status during the transition period of dairy cows.

MATERIALS AND METHODS

The experiment was performed in accordance with the Romanian Law no. 43/2014 and the Council Directive 2010/63/EU on the protection of animals used for scientific purposes.

Fifty purebred Romanian Black Spotted dairy cows were screened for blood serum indicators during the transition period, atthe following intervals: 3 weeks pre-partum, 1 week pre-partum, at calving, 1 week post-partum and 3 weeks post-partum.

The analyses were carried out in the Animal Physiology and Biochemistry Laboratory of the Research and Development Institute for Bovine Balotesti, Romania.

Blood samples were collected aseptically from the jugular vein (9 ml), in vacutainer tubes without anticoagulant for serum separation by centrifugation at 3000 rpm for 15 min and stored in aliquots at –20 °C till further analysis.

The serum proteins (total protein, albumin, urea) and mineral indicators (total calcium, inorganic phosphorus, magnesium) were estimated using a semiautomated biochemical analyzer StarDust MC 15 and DiaSys reagents in dedicated kits. Means ± standard deviations and coefficients of variation (CV) of blood indicators were calculated using Minitab® Statistical Software, version 18.

The Tukey's test was applied to obtain the significance of difference between analyzed intervals. The differences between mean values in the periods were considered significant at $P<0.05$.

RESULTS AND DISCUSSIONS

The total protein, albumin and urea values of dairy cows during the transition period are presented in Table 1. The means of total protein concentrations were 7.18 g/dL (3 weeks pre-partum), 7.07 g/dL (1 week pre-partum), 6.98 g/dL (calving), 7.21 g/dL (1 week post-partum) and 7.98 g/dL (3 weeks post-partum) without statistically significant differences ($P>0.05$) between periods. The obtained means for serum albumin level (3.54 g/dL-3 weeks pre-partum, 3.37 g/dL-1 week pre-partum, 2.95 g/dL-calving, 3.50 g/dL-1 week post-partum and 3.63 g/dL-3 weeks post-partum did not differ significantly ($P>0.05$) during the transition period. In the assessed period, normal values of the urea were registered, without statistical significance ($P>0.05$).Non-protein nitrogen circulating in blood it has effects on the integrity of the liver and mammary tissue, and alter the reproductive behaviour with decreases in the pregnancy rates and an elevation of the uterine pH after oestrus (Biswajit et al., 2011). These values may reflect the good nutritive diet given to the dairy cows examined during the present work. The obtained serum protein indicators in the present investigation were in agreement with the reports of Coroian et al., 2017. Also, similar values of serum protein indicators were reported by Onita and Colibar (2009), in the peripartum period (for albumin, the obtained values were between 2.4-2.6 g/dL and 22.6-24.3 mg/dL for urea).

Table 1. Serum protein indicators in dairy cows during the transition period (n=50)

Period/Serum indicators	Total Protein (g/dL)		Albumin (g/dL)		Urea (mg/dL)	
	X̄±sd	CV%	X̄±sd	CV%	X̄±sd	CV%
3 weeks pre-partum	7.18±0.70[a]	9.75	3.54±0.49[a]	13.84	27.36±5.22[a]	19.08
1 week pre-partum	7.07±0.68[a]	9.62	3.37±0.51[a]	15.13	27.06±5.43[a]	20.07
Calving	6.98±0.64[a]	9.17	2.95±0.52[a]	17.63	26.94±5.24[a]	19.45
1 week post-partum	7.21±0.60[a]	8.32	3.50±0.52[a]	14.86	27.28±5.94[a]	21.77
3 weeks post-partum	7.98±0.62[a]	7.77	3.63±0.56[a]	15.43	27.52±5.19[a]	18.86
Reference values	6.80 – 8.40		2.90- 3.80		20.00 – 40.00	

means that do not share a letter are significantly different

The values for the coefficient of variation, for total protein, were below that critical threshold of 10%, indicated a very homogeneous population. The coefficient of variation calculated for albumin was lower than 17.63%, expressing a homogeneous population. However, for the urea, the coefficient of variation was between 18.86 and 21.77%. The means values of

serum calcium, inorganic phosphorus and magnesium in dairy cows during the transition period are presented in Table 2.

Low calcium, inorganic phosphorus and magnesium levels in the blood of peripartum cows can lead to a decrease in food intake, low ruminal activity and intestinal motility (Goff, 2006).

The calcium, phosphorus and magnesium requirements, depending on the body weight of the animal, production, milk composition and the pregnancy stage (Parvu et al., 2003; Dumitru, 1996). The homeostasis of calcium is important for neuromuscular excitability and for hormonal secretion (Wu et al., 2008).

Serum calcium concentration decreases at calving (7.99 mg/dL) and increases (8.24 mg/dL) at the 3 weeks post-partum period (P>0.05).

This evolution is a result of calcium passing in the mammary gland, using it for milk synthesis and consumption in other tissues (Onita and Colibar, 2009).

In the present study, were not found subnormal values of calcemia during the transition periods.

The coefficient of variation calculated for serum calcium was lower than 10%, expressing a very homogeneous population.

Table 2. Mineral indicators in dairy cows during the transition period (n=50)

Period/Serum indicators	Total Calcium (mg/dL)		Phosphorus (mg/dL)		Magnesium (mg/dL)	
	X̄±sd	CV%	X̄±sd	CV%	X̄±sd	CV%
3 weeks pre-partum	8.09±0.71^{a}	8.78	4.14±1.37^{a}	33.09	1.96±0.68^{ab}	34.69
1 week pre-partum	8.07±0.86^{a}	10.66	3.94±1.24^{a}	31.47	1.97±0.71^{ab}	36.04
Calving	7.99±0.73^{a}	9.14	3.84±1.23^{a}	32.03	1.73±0.71^{b}	41.04
1 week post-partum	8.12±0.72^{a}	8.87	3.92±1.26^{a}	32.14	1.91±0.73^{ab}	38.22
3 weeks post-partum	8.24±0.74^{a}	8.98	4.06±1.29^{a}	31.77	2.19±0.62^{a}	28.31
Reference values	8.00-11.00		4.60-7.00		2.10-2.80	

means that do not share a letter are significantly different

About 80% to 86% of phosphorus present in the body of the animal is found in bones, teeth, and in soft tissue (Álvarez, 2001). In the present work, the inorganic phosphorus (Figure 1) had lower values than normal physiological limits (3.84-4.14 mg/dL) without statistical differences between periods (P>0.05). The risk of phosphorus deficiencies increases at the beginning of lactation when calcium and phosphorus are mobilized through bone resorption to meet the demand for those nutrients (Ekelund et al., 2006).

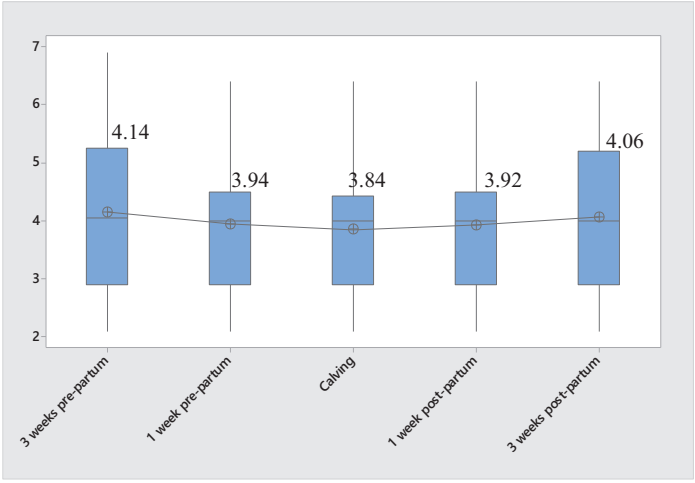

Figure 1. Average values of serum phosphorus in dairy cows during the transition period (mg/dL)

The requirement for magnesium depends on age, production and biological availability of the mineral in the diet, but also on the levels of phosphorus and calcium in the provided feed, if

these levels increase, then the need for magnesium also increases (Álvarez, 2001). Maintaining the plasma concentration of magnesium depends more on the constant flux of this mineral present in the diet offered to the animal than on the mobilization from the skeletal system.

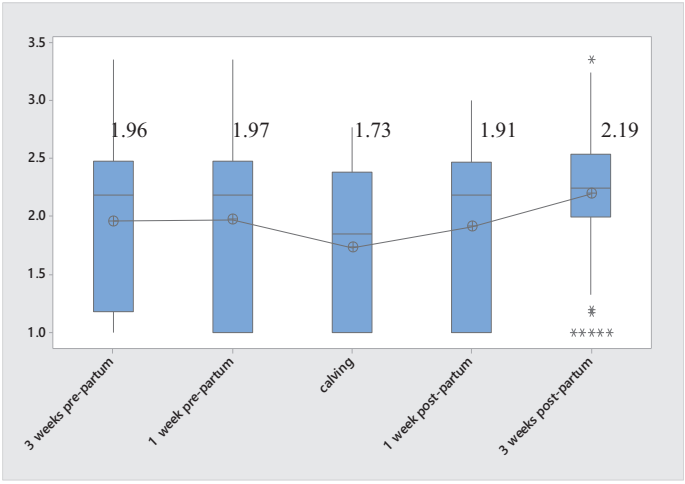

Figure 2. Average values of serum magnesium in dairy cows during the transition period (mg/dL)

The registered values for the serum magnesium level (Figure 2) during the transition period were below normal physiological limits followed by an increase ($P<0.05$) of 3 weeks post-partum (2.19 mg/dL). For inorganic phosphorus and magnesium, the coefficient of variation was situated between 31.47-33.09% (phosphorus) and 28.31-41.04% (magnesium).

CONCLUSIONS

In the present research trial, the obtained serum values for serum proteins were situated in normal physiological limits, without significant differences between periods. The level of calcium and phosphorus of blood did not show differences between sampling period, except the level of magnesium after partum period comparative with pre-partum period. Current results revealed the importance of the serum indicators as a potential tool for monitoring the nutritional status of the dairy cows at farm levels. For a more complex assessment of nutritional status in dairy cows, research will continue with other investigations (haematological profile, energy profile, enzymatic profile) on a higher number of animals in order to develop a guide of reference values for dairy cows.

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