

EFFECT OF LACTATION STAGES ON SOME BLOOD SERUM BIOCHEMICAL PARAMETERS AND MILK COMPOSITION IN DAIRY COWS

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ABSTRACT

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This study was conducted using Forty five dairy cows selected randomly from small different farms. Blood and milk samples were collected during three stages of lactation (early, middle and late), on each serum sample total proteins, albumin, glucose, urea, total lipids, cholesterol, triglycerides, calcium, phosphorus and magnesium were determined. In each milk sample fat %, total proteins, calcium, phosphorous, and magnesium levels were measured. A significant effect of the lactation stages were observed on glucose, urea, total lipids, cholesterol, triglycerides, and calcium, while there were no significant differences during the three lactation stages on serum total protein, albumin, phosphorus and magnesium. In case of the examined milk samples there were no significant differences in fat %, urea, calcium, phosphorus and magnesium in the different lactation stages. While, there was a significant increase in milk protein in the middle and late lactation stages.

Key words: Dairy cows, lactation stages, biochemical alterations, milk composition.

INTRODUCTION

At the beginning of lactation, dairy cows have to cope with the high energy and protein demands for milk synthesis at the time when nutrient intake is low. In an effort to obtain the energy necessary for milk production, the cows use up their bodily reserves, predominately fats. An energy deficit at the beginning of lactation negatively impacts, health efficiency and reproduction performance of dairy cows (Lubojacká *et al.*, 2005 and Mulligan *et al.*, 2006).

Mobilizing energy and protein from body tissue stores and repartition of nutrients away from extra-mammary tissues are the primary alternatives to supply sufficient nutrients for milk production during the first weeks of lactation (Kessel *et al.*, 2008). The main problem of that period is the limited intake capacity for dry matter, as a consequence of which dairy cows are unable to cover their energy need from feeds (Wathes *et al.*, 2009).

Blood biochemical attributes are important indicators of the metabolic activity in lactating animals (Karapehliyan *et al.*, 2007). During lactation, secretory cells of mammary gland utilize 80% of the blood circulating metabolites for milk synthesis, depending on the speed of infiltration of

precursors of milk compounds (i.e. free amino acids, glucose and fatty acids).

All animals require minerals such as calcium (Ca), magnesium (Mg), and phosphorus (P) for growth, reproduction and lactation, which often affect specific requirements, and serve as catalytic components of enzymes or regulate several mechanism involved just in pregnancy and lactation (Tanritanir *et al.*, 2009 and Samardzija *et al.*, 2011). Especially at the beginning of lactation, mobilization of Ca from bone and increased absorption from the gastrointestinal tract are required to re-establish homeostasis, which have to react to a tremendous increase in demand for Ca (Liesegang, 2008 and Lohrenz *et al.*, 2010).

Milk, the outcome of various biochemical activities in mammary secretory cell is composed of fat, protein, carbohydrates, enzymes, vitamins and various minerals. The composition of milk is influenced by various factors, i.e., stage of lactation, lactation number, breed, feeding pattern, environmental and diseased condition of the udder (Brinez *et al.*, 2003).

The fat, protein and urea contents of milk vary according to stage of lactation. Fat content is high immediately after calving but soon begins to fall, and continues to do so for 10 to 12 weeks, after

which it tends to rise again until the end of the lactation (Chilliard *et al.*, 2003, 2007).

The aim of the present work to study the effect of the different lactation stages on some biochemical serum constituents and some milk composition.

MATERIALS and METHODS

Forty five dairy cows selected randomly from small different farms and divided into three groups, depending on the day postpartum of sampling, each group consists of fifteen dairy cow: group I: 3-6 weeks after calving (early stage of lactation), group II: 15-20 weeks after calving (middle stage of lactation), group III: 22-38 weeks after calving (late stage of lactation).

Blood samples:

Jugular blood samples were collected in plain vacutainer tubes for blood serum biochemistry. The blood was allowed to clot and centrifuged, then clear blood serum was separated and stored at -20 °C until analysed.

On each serum sample total proteins, albumin, glucose, urea, total lipids, cholesterol, triglycerides, calcium, phosphorus and magnesium were determined by means of commercial kits (STANBIO laboratories, diagnostic company, USA) and measured using the spectrophotometer (Coles, 1986).

Milk samples:

Fresh 100 ml raw milk was obtained from cows. Samples of milk were cooled down until 6 °C was reached. Samples were kept at the same temperature during the determination of milk fat% by milkoscan analyzer. Within an hour after milking, milk was skimmed by centrifugation at 3000 r.p.m for 15 min to remove their creams and cells. Samples were then treated with 0.1 M hydrochloric acid at the controlled pH of 4.8 for casein precipitation. Treated samples were recentrifuged and the supernatants (Whey) were collected. Total protein, urea, calcium, phosphorus magnesium levels were measured by using spectrophotometer through reagent kits

supplied commercially by (STANBIO laboratories, diagnostic company, USA).

Statistical analysis:

All the results were expressed as mean values and standard deviation (SD). Recorded data were analyzed statistically using analysis of variance (ANOVA). Differences among the groups at $p < 0.05$ and $p < 0.01$ were considered as significant. The statistical differences between means were estimated by Duncan's Multiple Range test. The computation was facilitated by statistical package SPSS (2000).

RESULTS

As shown in Tables 1, 2 and 3, all serum investigated parameters were significantly ($P < 0.05$) and ($P < 0.01$) influenced by stage of lactation except serum total proteins, albumin, phosphorus and magnesium.

Serum glucose (Table 1) was significantly ($P < 0.05$), increased in both the middle and late stage of lactation in comparing with the early stage of lactation. Serum urea (Table 1) was significantly ($P < 0.01$), increased with the progress of lactation.

Serum total lipids and cholesterol (Table 2), were significantly ($P < 0.05$), increase in the middle stage of lactation and showed highly significant ($P < 0.01$) increase with the late stage of lactation. Serum triglycerides (Table 2) was significantly higher ($P < 0.05$) at the late stage of lactation.

Ca serum levels (Table 3) showed a significant ($P < 0.05$) increase in both the middle and late stage of lactation. There were no significant changes in both phosphorus and magnesium in the different lactation stages.

No significant differences in milk, fats%, urea (Table 4), calcium phosphorus and magnesium (Table 5), in the different lactation stages were detected. While there was a significant ($P < 0.05$) increase in milk protein in the middle and late lactation stages.

Table 1: Mean values (\pm SD) of total proteins, albumin, glucose and urea serum contents in dairy cows during different stages of lactation.

Parameter	Early stage of lactation (3-6) week	Middle stage of lactation (15-20 week)	Late stage of lactation (22-38 week)
Total proteins (g/dl)	7.91\pm1.37	7.58\pm1.33	7.47\pm1.38
Albumin (g/dl)	3.08\pm0.44	2.7\pm0.34	2.6\pm0.37
Glucose (mg/dl)	36.47\pm5.9	40.0\pm5.5*	42.5\pm6.1*
Urea (mg/dl)	25.85\pm8.91	29.85\pm9.6**	29.83\pm9.4**

*Significant at ($P < 0.05$) and ** ($P < 0.01$)

Table 2: Mean values (\pm SD) of total lipids, cholesterol, and triglycerides serum contents in dairy cows during different stages of lactation.

Parameter	Early stage of lactation (3-6) week	Middle stage of lactation (15-20 week)	Late stage of lactation (22-38 week)
Total lipids(mg/dl)	292.16\pm15.03	307.8\pm15.98*	320.98\pm17.67**
Cholesterol(mg/dl)	123.4\pm42.1	130.1\pm34.6*	135.2\pm36.4**
Triglycerides(mg/dl)	9.4\pm0.72	9.85\pm1.7	10.8\pm1.8*

*Significant at (P <0.05) and ** (P <0.01)

Table 3: Mean values (\pm SD) of calcium (Ca), phosphorus (P) and magnesium (Mg), serum contents in dairy cows during different stages of lactation.

Parameter	Early stage of lactation (3-6) week	Middle stage of lactation (15-20 week)	Late stage of lactation (22-38 week)
Calcium (mg/dl)	5.6\pm0.64	6.1\pm0.29*	6.01\pm0.79*
phosphorus(mg/dl)	3.49\pm0.20	3.95\pm0.85	3.34\pm0.19
Magnesium(mg/dl)	1.9\pm0.05	2.11\pm0.14	2.10\pm0.19

*Significant at (P <0.05)

Table 4: Mean values (\pm SD) of fat %, total protein, and urea, in milk contents in dairy cows during different stages of lactation.

Parameter	Early stage of lactation (3-6) week	Middle stage of lactation (15-20 week)	Late stage of lactation (22-38 week)
Fat %	2.68\pm0.65	2.48\pm0.54	1.97\pm0.42
Total proteins (g/ dl)	3.93\pm 038	4.78 \pm0.41*	4.97 \pm 0.29*
Urea (mg/dl)	5.9\pm1.5	5.6\pm1.42	5.5\pm1.43

*Significant at (P <0.05)

Table 5: Mean values (\pm SD) of calcium, phosphorus and magnesium, in milk contents in dairy cows during different stages of lactation.

Parameter	Early stage of lactation (3-6) week	Middle stage of lactation (15-20 week)	Late stage of lactation (22-38 week)
Calcium (mg/dl)	1.9 \pm 0.23	2.3 \pm 0.27	2.05 \pm 0.24
Phosphorus (mg/dl)	1.45\pm0.22	1.79\pm0.19	1.74\pm0.21
Magnesium (mg/dl)	1.33\pm0.20	1.64\pm0.23	1.46\pm0.23

DISCUSSION

Lactation stage is one of the important causes of variation in concentrations of blood metabolites in dairy cows (Vazquez-Anon *et al.*, 1994 and Yaylak *et al.*, 2009). Lactation phases affect significantly the metabolic profile and so the variation recorded during different physiological phases is expected.

The substantial decreases in serum concentrations of total protein, albumin with the progress of lactation were agreeable with previous studies (Cavestany *et al.*, 2005). These decreases may reflect the maternal requirements of proteins for milking and providing immunoglobulins (Roubies *et al.*, 2006 and Mohri *et al.*, 2007).

The most important indicators of energy status of ruminants are glucose, cholesterol and triglycerides (Pechová and Pavlata, 2005). The blood glucose was significantly higher in middle and late lactation than the early lactation dairy cows Slanina *et al.* (1992), revealed the same results which agree with the present findings. The lowered means of blood glucose concentrations in early stage of lactation were due to large amount of blood glucose with drawl by the mammary gland for the synthesis of milk lactose (Kapple *et al.*, 1984 and Nale, 2003).

The urea nitrogen values differ significantly among different groups of lactating cows. The mean blood urea value in the middle and late lactation stages was significantly increased as compared to the early lactation stage. Poso and Lindberg (1994) revealed lowered urea concentration after parturition which agrees with the present findings. Increase in blood urea nitrogen levels in middle and late lactation periods could be either due to increased deamination or increased protein intake (Roubies *et al.*, 2006). Both increased levels of serum urea and low percentage of serum proteins confirm that urea was not fully used for the milk protein production, which points to energy deficiency conditions (Wathes *et al.*, 2009).

Total lipids, and cholesterol were significantly affected by the physiological status, both showed substantial increases during the middle and late stage of lactation, while triglycerides showed a significant increase in the late stage of lactation. Probably because, around calving, there is an increase in the demands for regulatory mechanism, responsible for all the processes involved with preparation for milking (Roche *et al.*, 2009). At this purpose, characteristic changes in lipid metabolism were found during pregnancy and lactation in most mammals, where Endocrine profiles change and lipolysis and lipogenesis are regulated to increase lipid reserve during pregnancy, and, subsequently, these reserves are utilized following parturition and

the initiation of lactation (Nazifi *et al.*, 2002 and Roche *et al.*, 2009).

Concerning the electrolytes serum levels, all animals require minerals for growth, reproduction and lactation (Samardzija *et al.*, 2011). There was drop in calcium level during early stage of lactation, as the stage of lactation progresses the serum calcium level increased which corroborates with the findings of Nale (2003). These results could be due to impaired absorption of food metabolites from the gastrointestinal precursor, excessive losses through urine, colostrums as it was much more drained in the colostrums during excessive milking and due to insufficient mobilization from the skeleton (Liesegang, 2008 and Brezezinska and Krawczyk, 2009). Moderate depression in the levels of phosphorus might be due to the necessity of it for the colostrums synthesis (Rook and Thomas, 1983 and Szenci *et al.*, 1994) and enhanced carbohydrate metabolism.

Magnesium plays a vital role during the metabolism of carbohydrates, lipids, nucleic acids and proteins. In present investigation serum magnesium concentration in different lactation stages of dairy cows did not differ significantly.

Stage of lactation significantly influences the composition of raw milk of dairy cows (Brinez *et al.*, 2003). Factors predisposing to general or mammary gland diseases should be evaluated in combination with the major milk components (fat and protein) by measuring urea in milk as indicators of a balanced diet (Haman and Krömker, 1997).

Milk fat can increase or decrease depending on ration composition. Early lactation cows have a tendency to mobilize body reserves while ingesting rations that are low in effective fiber will tend to decrease milk fat levels (Eicher, 2004).

Lower milk fat content is frequently used in farms as an indicator of sub-acute ruminal acidosis and to predict the effectiveness of diet structure for chewing (Bergamini, 1987 and Merterns, 1997). Low milk fat content is caused by a lack of major precursor-acetic acid in rumen that is produced in insufficient quantity (Illek, 2008). Generally, if milk protein content increased and milk fat content decreased it leads to sub-clinical acidosis (Pavlata *et al.*, 2008).

The significant increase in the levels of milk proteins, with the different stages of lactation are constant with the observation made by (Marenjak *et al.*, 2006).

Monitoring of urea in milk is an indicator of metabolic nitrogen balance of cows (Jílek *et al.*, 2006), which characterise their health, and reproductive ability (Hanuš *et al.*, 2000). Acquired

results of milk urea were without significant confirmation.

Milk calcium and phosphorus output is directly related to milk yield, as milk phosphorus concentration is constant (Valk *et al.*, 2002). In fact, increasing the milk production, more minerals from the ingested amount is transferred to milk and less is excreted with faeces. The decreasing in phosphorus and magnesium concentration in mature milk was likely in part due to dilution resulting from increased milk production (Valk *et al.*, 2002).

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تأثير مراحل الحليب على بعض المعايير البيوكيميائية ومكونات اللبن في الإبقار الحلابة

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اشتملت هذه الدراسة على عدد ٤٥ من الإبقار الحلابة التابعة للعديد من المزارع الصغيرة وقد تم تجميع عينات الدم واللبن من هذه الإبقار خلال ثلاث مراحل للحليب (المبكرة والوسطى والمتأخرة) وقد تم قياس قيمة البروتين الكلى والاليومين والجلوكوز واليورينا والدهون الكلية والكوليستيرول والدهون الثلاثية والكالسيوم والفسفور والماغنيسيوم في كل عينة من عينات سيرم الدم. وقد تم تقدير وقياس كل من نسبة الدهن والبروتين الكلى واليورينا والكالسيوم والفسفور والماغنيسيوم في كل عينة من عينات اللبن قيد الدراسة. وقد اوضحت النتائج ان هناك تأثير معنوي لمرحلة الحليب المختلفة على الجلوكوز واليورينا والدهون الكلية والكوليستيرول والدهون الثلاثية والكالسيوم بينما لم يحدث تغير معنوي في كل من البروتين الكلى والاليومين والفسفور والماغنيسيوم. ووضحت نتائج عينات اللبن انه لا يوجد تغير معنوي في كل من نسبة الدهن واليورينا والكالسيوم والفسفور والماغنيسيوم بينما وجد تغير معنوي في نسبة البروتين في مراحل الحليب المختلفة.