Original Research

Variation in Plasma Macromineral, Micromineral and Electrolyte Profile of Mehshani Buffalo (*Bubalus bubalis*) during Different Stages of Lactation

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Abstract

Minerals are important constituents of feed and play significant role in maintaining reproductive efficacy and optimizing milk productivity. The study was executed in 18 clinically healthy lactating Mehshani buffaloes. Plasma samples were separated from the collected blood samples of the experimental buffaloes for estimating concentration of different macrominerals, electrolytes and microminerals. It was observed that although the level of different minerals and electrolytes varied numerically during the three lactation stages, only Ca was found to be significantly ($P < 0.05$) lower in early stage unlike the Cl, which was significantly higher in early lactation stage. The values of microminerals were found to be within the physiological range. Although, the copper and zinc concentrations were found to be the apparently lowest in early stage of lactation, the concentrations of Co, Mn and Fe were also significantly lower in this stage. Data generated in the study may assist in monitoring the health and prognosis as well as diagnosis of deficiency diseases.

Key words: Electrolyte, Lactation, Mehshani Buffalo, Mineral, Plasma

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Introduction

Lactation is one of the most important stages in the life of dairy animals, which affect metabolism resulting in the alteration of the haemato-biochemical profile (Krajnicakova *et al.*, 2003; Iriadam, 2007). There are numerous reports on the effects of different phases of the reproductive cycle and pregnancy on haemato-biochemical indices in domestic animal species including buffalo (Jain *et al.*, 2009, Das *et al.*, 2016). However, no such study could be traced investigating the blood picture during different stages of lactation in Mehshani buffalo, a unique milch breed of Gujarat, India. It is well established that milk and milk

components are directly and indirectly synthesized from blood. The rate at which blood flows to the mammary gland is one of the key-factors in determining milk synthesis. Approximately, 400 to 500 liters of blood circulate through mammary gland to produce one liter of milk (Fernandez and Hoeffler, 1998). There is a 2 to 6 folds increase in blood flow in the mammary gland starting 2 to 3 days prepartum. During lactation, the mammary gland secretory cells utilize 80% of the blood metabolites for milk synthesis depending on the infiltration of precursors of milk components like amino acids, glucose and fatty acids (Piccione *et al.*, 2009). Hence, blood biochemical parameters including total protein, triglycerides, free fatty acids and urea are important indicators of the metabolic activity in lactating animals (Karapehlivan *et al.*, 2007, Samardzjia *et al.*, 2011). Since the milk yield and composition varies across the length of lactation stage, it is, therefore, imperative, to study haematolo-biochemical constituents during different stages i.e. early, mid and late stage of lactation in the different milch breed of cattle and buffalo. Mehshani buffaloes are one of high yielding native milch breed of India, which is considered to be cross between Surti and Murrah buffalo. In view of the above, the present study was undertaken to investigate the variations in mineral and electrolyte profile during different stages of lactation in Mehshani buffalo.

Materials and Methods

Eighteen clinically healthy lactating Mehshani buffaloes of about 4-5 years of age were selected from the herd maintained at Livestock Research Station, SDAU, Sadarkrushinagar, Gujarat, India. The buffaloes were in various stages of lactation and based on the length of their lactation, the animals were identified as in early (7 to 105 days), mid (106 to 210 days) and late (211 to 315 days) lactational stage.

Accordingly, they were categorized into three different groups of six animals each viz. group-I (early lactation), Group II (mid lactation) and Group III (late lactation). Approximately 10 ml of blood samples were collected aseptically once from each of the experimental animal via jugular vein puncture into sterile vials containing K_3 EDTA (1 mg/ml of blood). Subsequently, the plasma was separated from the blood samples by centrifugation at 3,000 rpm for 20 min. The plasma samples were then frozen at -20^{o}C till analysed. The electrolytes and macrominerals viz. sodium (Na), potassium (K), chloride (Cl), calcium (Ca), phosphorus (Pi) and magnesium (Mg) were estimated by using diagnostic kits from M/s Crest Biosystems, India by following standard protocols viz. Na and K by colorimetric method, Cl by Thiocyanate method, Ca by o-cresolphthalein complexone method, Pi by Molybdate U.V. method, and Mg by Calmagite method) by using a UV-Vis Spectrophotometer (Chemito-Spectroscan, 2600). The micro minerals viz. copper (Cu), iron (Fe), manganese (Mn), cobalt (Co), molybdenum (Mo) and zinc (Zn) were estimated employing atomic absorption spectrophotometer (Model AAS-4141, ECIL-INDIA). The data obtained were statistically analyzed using one-way ANOVA as per the method of Snedecor and Cochran (1994).

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Result and Discussion

The concentrations (Mean ± SE) of macrominerals and electrolytes recorded in the three experimental groups have been shown in Table 1.

Table 1: Concentration of macrominerals and electrolytes of the three experimental groups of Mehshani buffalo

Parameters	Early Lactation (Group-I)	Mid Lactation (Group-II)	Late Lactation (Group-III)
Calcium (mg/dl)	5.6±0.64[a]	6.1±0.29[b]	6.01±0.79[b]
phosphorus(mg/dl)	3.49±0.20[a]	3.65±0.85[a]	3.34±0.19[a]
Magnesium (mg/dl)	1.9±0.05[a]	1.92±0.14[a]	2.10±0.19[a]
Sodium (mEq/L)	160.25 ±0.54[a]	161.58± 0.38[a]	156 ± 0.46[a]
Potassium (mEq/L)	6.16 ±0.34[a]	5.75 ±0.44[a]	6.23 ± 0.31[a]
Chloride (mEq/L)	142.60 ± 2.2[a]	121.63± 0.94[b]	126 ±0.89[b]

[a, b] means within the same row with different superscript differ significantly

It was observed that plasma calcium levels showed a significant (P <0.05) increase in both the middle and late stage of lactation. However, there were no significant changes in the level of both phosphorus and magnesium during different lactation stages. 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. Blood level and 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 apparently lower level of phosphorus and magnesium concentration in early and mid-stage of lactation was likely in part due to their drainage with milk (Valk *et al.*, 2002). Concerning the electrolytes plasma 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 plasma 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 (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 plasma magnesium concentration in different lactation stages of dairy cows did not differ significantly.

The plasma level of electrolytes recorded in different experimental groups of the study was within the reference interval reported by Ellah *et al.* (2014a and 2014b). However, there were no significant

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differences in the level electrolytes except chloride. Apparently higher sodium level was observed in late lactation stage, which was in agreement with the study of Mikniene *et al*. (2014). Conversely, the plasma concentration of chloride was significantly higher in early stage of lactation than mid and late stage. Similar pattern of variation was also reported by Kulkarni *et al.* (1984). Jabbar *et al.* (2012) observed that chloride concentration was not affected by age. Arosh *et al.* (1998) reported that anoestrous cows had significantly low concentration of chloride. They stated that the mineral plays an intermediate role in action of hormones and enzymes at sub cellular levels. The minerals act in integrated fashion in the synthesis of reproductive hormones, with positive action of such hormones on reproductive organs and initiation of estrus in animals. The recoded values of the micro minerals were found to be within the physiological range prescribed for healthy adult ruminants (Table 2).

Table 2: Concentration of microminerals of the three experimental groups of Mehshani buffalo

Parameters (ppm)	Early Lactation (Group-I)	Mid Lactation (Group-II)	Late Lactation (Group-III)
Copper	0.40±0.21[a]	0.430±0.18[b]	0.41±0.32[b]
Iron	1.19±0.08[a]	1.95±0.12[b]	2.34±0.19[b]
Zinc	1.10±0.16[a]	1.21±0.14[a]	1.24±0.19[a]
Cobalt	0.52 ±0.24[a]	0.68± 0.38[b]	0.72 ± 0.26[b]
Manganese	0.23 ±0.14[a]	0.38 ±0.19[b]	0.39 ± 0.17[b]
Molybdenum	0.55 ± 0.04[a]	0.58± 0.07[a]	058. ±0.012[a]

[a, b] *means within the same row with different superscript differ significantly*

The copper and zinc concentrations were found to be the lowest in early stage of lactation, which may be attributed to higher progesterone level and/or to the increased fetal demands and utilization of maternal copper and zinc for development of fetal nervous system (Elnageeb and Abdelatif, 2010). These two minerals play significant role in regulating progesterone production by luteal cells via involvement of superoxide dismutase (Sales *et al.*, 2011). Further, as a component of antioxidant arsenals, they contribute in counteracting pregnancy induced oxidative stress (Pathan *et al.*, 2011). Copper is also involved in steroidogenic enzymes like cytochrome P450, 17α-hydroxylase and cytochrome P450 side-chain cleavage and lysyl oxidase (Kendall *et al.*, 2006). Zinc is important for reorganization of ovarian follicles which are the source of progesterone. This occurs through the involvement of metalloproteinase-2 (MMP-2) enzyme, which is a member of zinc endopeptidase family (Gottsch *et al.*, 2000).

Similarly, manganese is also required for skeletal growth and development. In the present study, significantly lower level of manganese and cobalt was recorded in initial stage of lactation. This may be attributed to their utilization by the young growing calves for proper bone formation (Hansen *et al.*, 2006, Nagabhusana *et al.*, 2008). Involvement of manganese in the synthesis and production of oestrogen and progesterone may be due to the fact that it acts as a cofactor of the enzyme required for synthesis of

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cholesterol (Karkoodi *et al.*, 2012). Correspondingly, the concentration of iron was also significantly lower in early lactation stage, which corroborates earlier report (Qian *et al.*, 2001). This may be due to the utilization of iron to neutralize free radicals like peroxides, super oxides or hydroxyl ions produced during pregnancy (Yatoo *et al.*, 2013). Iron is a key component of catalase and peroxidase thereby plays significant role in combating oxidative stress (Harvey, 2000; Antonyuk *et al.*, 2009). It is also necessary for ovarian activity (Qian *et al.*, 2001). Role of iron in immunity is reported by Eisa and Elgebaly (2010).

Conclusion

It may be concluded that lactation stages alter the plasma level of macrominerals, electrolytes and micro-mineral in Mehshani buffalo. Therefore, such variation must be taken into consideration before supplementation of mineral mixture for proper maintenance of health, optimization of productive and reproductive activities.

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