TRACE ELEMENT AND ELECTROLYTE CONCENTRATIONS IN DIFFERENT PHYSIOLOGICAL STATES OF SAHIWAL CATTLE

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SUMMARY: The study was conducted on seven healthy Sahiwal cattle at their different physiological states (calves, ≤ 1 year; pregnant in first trimester; primiparous lactating and dry, not pregnant). The blood samples were collected from Jugular vein in heparinized test tubes. Plasma was separated and used for analysis. Non significant differences were observed in blood plasma Zn^{2+}, Fe^{2+} and Na^{+} concentrations in calves, pregnant and milking animals. The present study also reports a non significant difference in Cu^{2+} concentration between the four physiological states. Significant differences in Ca^{2+} concentration was observed in all the animals at different physiological states. No significant differences were observed in blood plasma Mg^{2+} concentration between calves and milking cows. Potassium (K^{+}) concentration was not significantly different between the pregnant and milking cows but significantly different among the calves and the dry cows.

Key Words: Pregnancy, Zinc, Fe, Na, K.

INTRODUCTION

Physiological concentrations of trace elements must always be maintained for proper maintenance of the cellular functions of the animal. The normal concentrations of these trace elements in different tissues mainly depends on the dietary concentration, absorption and also on concentration of other tissue elements, homeostatic control mechanism of the body and the species of animal involved (23). There is a general consensus that low production and sub-optimal reproductive efficiency of our livestock is due to inadequate nutrition, particularly deficiency of minerals. The ovarian activity of buffalo is influenced by mineral deficiency (8).

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Serum levels of major and trace elements in dairy cows during lactation and pregnancy were studied by Agnes and Tozzi (1). They observed a significant increase in copper concentration during lactation. Distribution of trace elements in whole blood, plasma and erythrocytes of buffalo heifers was studied by Kumar and Rattan (11). They concluded that plasma was the index for trace elements estimation.

Although normal hemogram and biochemical profiles of Sahiwal hiefers have been reported (26) yet, very little information is available on the trace elements profile in Sahiwal cow during different physiological states. Therefore, the present study was designed to estimate the plasma essential trace elements and electrolytes in apparently healthy calves, pregnant, milking and dry Sahiwal cattle.

MATERIALS AND METHODS

The blood samples from seven cattle at each of the following physiological states, calves ($\leq$ 1 year), pregnant (first trimester), milking (primiparous) and dry (not pregnant) were collected from Jugular vein in heparinized test tubes. The plasma was separated and used for the analysis of zinc (Zn^{2+}), copper (Cu^{2+}), iron (Fe^{2+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}) after wet digestion with nitric and perchloric acid (18).

Average and standard error of mean of each parameters were calculated. The analysis of variance technique was used to find out any significant difference ($p \leq 0.05$) in trace elements and electrolytes concentrations between physiological states (22). In case of significant differences, Duncan's Multiple Range Test (4) was used to compare the mean values.

RESULTS AND DISCUSSION

The results of plasma trace elements and electrolytes profiles of four physiological states of Sahiwal cattle have been presented in Table 1. In the present study, non significant differences were observed in blood plasma Zn^{2+}, Fe^{2+} and Na^{+} concentrations between calves, pregnant and milking animals. Similar results for Zn^{2+} and Na^{+} were reported by Agnes and Tozzi (1) in pregnant and lactating cows. Van Aken *et al.* (24) also reported non significant differences in Zn^{2+} concentration in young and adult cattle. The present results are also in line with those reported by Husnain *et al.* (8) in buffalo. Hanif *et al.*, (6) reported the highest concentration of Zn^{2+} (1.08 $\pm$ 0.25 mg/dl) in dry and the lowest concentration (0.74 $\pm$ 0.13 mg/dl) in pregnant buffaloes.

Significantly low concentration of Na^{+} (22.13 $\pm$ 1.13 mmol/l) and K^{+} (3.10 $\pm$ 0.25 mmol/l) was observed in the dry cows. Highest, Na^{+} concentration (42.35 $\pm$ 2.50 mmol/l) was observed in milking cows as compared to dry animals and highest K^{+} concentration (10.56 $\pm$ 0.67 mmol/l) in calves. Na^{+} plays a central role in water and osmotic regulation in the study. The kidney determines the volume of extra cellular fluid (ECF) by regulating the quantity of Na^{+} in the body. The sensors for the regulation of body Na^{+} are similar to those that regulate tonicity. The volume receptors located in the carotid sinus, aortic arch, great pulmonary veins and especially the left atrium (21) are capable of altering Na^{+} excretion. A decrease in ECF volume signals the kidney to conserve Na^{+}, whereas an increase in ECF volume signals the kidney to excrete Na^{+} (13). There is evidence that Na^{+} excretion is also influenced by prostaglandin and by the kallikrein-kinin system (21). The major regulators, however, are internal mechanisms of glomerulotubular balance. Diet of herbivores is very low in Na^{+} content and supplementation with a source of Na^{+} is necessary for optimal production particularly in summer. This is also especially true for high producing dairy cows in which appreciable losses of Na^{+} occur in milk (9). The ruminants are not only capable of very effective recovery of large amounts of Na^{+} from the digestive tract but like other species, are capable of conserving body Na^{+} by action of the kidney. The combination of the two processes can reduce Na^{+} excretion to nearly zero. On the other hand, there is an obligatory excretion of potassium (K^{+}) by cattle, both in the faeces and urine (3). Forbes *et al.*, (5) found small negative balances for K^{+} in most cases with lactating cows and generally positive balances for non lactating cows. The kidney is also of primary importance in the regulation of K^{+} balance like Na^{+}. Approximately 98 to 98.5% of the total body K^{+} is located within the intracellular compartment, leaving only 1.5 to 2.0% in the extra cellular fluid. Under normal conditions more than 90% of the total ingested K^{+} is excreted by the kidney while only 8% is excreted in the faeces (19). Several other endogenous and exogenous factors influence the regulation of K^{+} excretion such as aldosterone, delivery of Na to the distal tubule, secretion of hydrogen ion, unreabsorbed anions, urine flow rate, K^{+} intake and administration of diuretics (13). Of the above described factors which were responsible for the high Na^{+} concentration in the milking cows and which were responsible for the lowest level of both Na^{+} and K^{+} in the dry cows is an aspect which requires further research on this line. However, the most probable reason of low concentration of blood plasma Na^{+} and K^{+} in dry cows might be the lowest metabolic rate during this physiological state.

The present study reports a non significant difference in Cu^{2+} concentration between the four physiological states. The dependency of physiological processes on cupro-enzyme activities creates the need for a continued supply of Cu^{2+} from the diet. In quantitative terms that this need alters as the animal develops. Intake of Cu^{2+} will also vary due to the seasonality of plant growth, despite human interventions to attain a continuous supply of food for man and beast. Changes in food type will be associated with changes in the availability of Cu^{2+}, creating further fluctuations in the supply of Cu^{2+} to the tissue. The mammalian body adapts to changes in the supply of Cu^{2+} relative to needs. Just as it does to variations in the supply of other nutrients, in order to stabilize the supply of Cu^{2+} to the tissue (10). Pregnancy is a Cu^{2+} dependent process and the body demands additional Cu^{2+} from conception onwards. However, it is not clear, whether a relationship exists between the Cu^{2+} status and fertility of Cu^{2+} deficient cows. Hunter (7) reported a significant effect of Cu^{2+} supplementation on the fertility of dairy cows but Phillipo *et al.*, (16) found no relationship between herd serum Cu^{2+} concentration and the conception rate of the herd. Our results are also in line with those reported by Hanif *et al.*, (6).

Significant differences in Ca^{2+} concentration were observed among the four physiological states. Calcium is particularly important in dairy nutrition because of high Ca^{2+} content of milk and its relationship to parturient paresis (milk fever). Likewise, parathyroid hormone (PTH) acts on the kidney tubule to increase renal reabsorption of Ca^{2+}. PTH also stimulates synthesis of 1.25-OH vitamin D_3, which stimulates intestinal Ca^{2+} absorption. In dry cow, 1.25-OH-D_3 blood levels are very low but increase dramatically when lactation begins (15). Remberg *et al.*, (17) reported an outflow of Ca^{2+} into milk at the onset of lactation accompanied by a reduction in the pool size of Ca^{2+} in the plasma. In the present study no such type of decrease in the plasma Ca^{2+} content in the milking cows was observed. Poor digestion of fat also may reduce Ca^{2+} absorption through the formation of insoluble Ca^{2+} soaps, however, small amounts of fat may improve Ca^{2+} absorption (12). Sheikh *et al.*, (20) reported that the difference in average content of Ca^{2+} in the blood of lactating, lactating pregnant, dry pregnant and dry non pregnant Nili-Ravi buffaloes were non significant. Comparison of blood Ca^{2+} content in pregnant and non pregnant cows revealed non significant difference (14). Ward (25) found negative Ca^{2+} balance during the prepartum period for cows which subsequently succumbed to milk fever. In the present study the lowest Ca^{2+} concentration (1.30 ± 0.11 mg/dl) was observed in pregnant cows. The low concentration of Ca^{2+} during pregnancy could be explained that during the first stage of pregnancy dairy animals milk yield is maximum and is therefore, in negative balance in regards to calcium. The blood mineral profile, however, improves without supplement when milk yield starts declining after about 90 days postpartum (6).

Table 1: Mean trace elements and electrolytes concentrations of plasma of sahiwal cattle during different physiological states.

	CALVES	PREGNANT	MILKING	DRY
Zn^{2+}, mg/dl	1.19a ± 0.03	1.32a ± 0.06	1.17a ± 0.07	0.50b ± 0.02
Cu^{2+}, mg/dl	0.23 ± 0.02	0.25 ± 0.01	0.26 ± 0.02	0.27 ± 0.01
Fe^{2+}, mg/dl	0.83b ± 0.14	0.76b ± 0.08	0.63b ± 0.13	0.33a ± 0.20
Ca^{2+}, mg/dl	170bc ± 0.21	1.30c ± 0.11	2.10b ± 0.07	2.75a ± 0.12
Mg^{2+}, mg/dl	0.36a ± 0.02	0.27b ± 0.01	0.35a ± 0.03	0.16c ± 0.01
Na^{+}, mmol/l	38.73a ± 1.27	37.29a ± 1.15	42.35a ± 2.58	22.13b ± 1.13
K^{+}, mmol/l	10.56a ± 0.67	6.20b ± 0.66	6.75b ± 0.35	3.10c ± 0.25

a,b,c : Similar alphabets in rows are not significantly different from each other at $p \leq 0.05$.

Non significant differences were observed in blood plasma Mg^{2+} concentration between calves and milking cows. Significant differences were observed among rest of the groups with the highest concentration (0.35 ± 0.03 mg/dl) in milking and the lowest concentration (0.16 ± 0.01 mg/dl) in dry cows. Approximately 70% of the Mg^{2+} in the animal body is in bone. In addition cardiac muscle, skeletal muscle a nervous tissue depends on a proper balance between Ca^{2+} and Mg^{2+} ionsDietary deficiency may result in a marked reduction in blood Mg^{2+} before the level in bone is affected. On continued deficiency, the Mg^{2+} contents of the bone decreases and the Ca^{2+} content increases. However, the bone Mg^{2+} is rapidly replenished when the animals are fed a diet high in Mg^{2+} (2). Overall Mg^{2+} concentration in the plasma of different physiological groups in the present study as compared to the values in literature was quite low. The most probable reason of low Mg^{2+} content may be the low level of Mg in the diet.

In brief, the present study has shown variations in blood plasma trace elements and electrolytes profiles during different physiological states. Non significant differences were observed in plasma Zn^{2+}, Fe^{2+} and Na^{+} contents among calves, pregnant and milking animals. Significantly low concentrations of Zn^{2+}, Mg^{2+}, Na^{+} and K^{+} were observed in dry animals while higher concentrations of Fe^{2+} and Ca^{2+} were observed in these animals. Magnesium and potassium contents were significantly high in calves. Significantly high concentration of Zn^{2+} and low concentration of Ca^{2+} was found in pregnant cows. In milking cows significantly high concentration of Na^{+} was observed in the present study.

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