ABSTRACT

The present study was carried out to assess the levels of some macro and micro minerals in blood plasma of water buffaloes and forage consumed by these ruminants in the central region of Punjab, India using apparently health animals during two consecutive seasons of the year. Blood plasma samples were obtained from the animals twice during each season, and analyzed for calcium, inorganic phosphorous, copper, inorganic iodine, zinc, manganese and iron levels. The results showed that concentrations of all the minerals studied in plasma were comparable in both the seasons with the exception of zinc and phosphorus which were significantly higher in winter. Analysis of forages collected showed that the variations in the fodder mineral concentrations corresponded to the plasma mineral variations, indicating a direct plant-animal relationship and showing the need of supplementation of the deficient minerals during summer season for these animals at the place where the livestock were being reared.

Keywords: buffaloes, minerals, profile, plasma, forage

INTRODUCTION

Farm animals derive most of their mineral requirements from their feed and fodder. Therefore, all the factors that influence mineral content of the fodder determine the mineral intake of animals, especially the agro-climatic and environmental factors like climate, soil type, species and stage of maturity (Suttle, 2010) and the adequacy of the diet in essential minerals can be determined by analysis of animals’ plasma mineral status and of forages which are the sole sources of minerals for the requirements of the animals.

Mineral imbalances have been established in many parts of Punjab, India (Singh, 2002), where intensive agricultural practices having been practiced for over decades but only fragmentary data is available concerning the mineral status of livestock and forages. There is need for information on this aspect, in which problems of mineral nutrition exist. The main objectives of this investigation were, therefore, to determine mineral imbalances and particularly to find out the effect of season on the levels of some essential minerals in forages and plasma of animals.
MATERIALS AND METHODS

A base line survey on mineral (Ca, Pi, Zn, Cu, Fe, Mn and PII) status of dairy animals and fodder was conducted in a total of 67 dairy units of 29 villages of central Punjab during months of June in summer and January in winter. Average temperature during the experimental year was 38 ± 5ºC during summer and 14 ± 5ºC during winter. A total of 188 buffaloes were selected randomly without considering any health problem or mineral deficiency symptoms.

Chemical Analyses

Blood

Blood samples from 188 buffaloes were collected in sterile test tubes containing anticoagulant (heparin). The samples were centrifuged at 3000 rpm for 30 minutes at room temperature to separate plasma. The plasma samples were stored in small aliquots in mineral free glass vials at -10º C until analysis. Two milliliters of plasma was digested with nitric acid and perchloric acid and after digestion the volume was made upto 10 ml with double distilled water for micro-mineral analysis, whereas plasma was used as such for Ca and Pi of estimations. Concentrations of various plasma minerals viz. Zn, Cu, Fe and Mn were measured by Atomic Absorption Spectrophotometer (SpectraAA 20 plus, Varian, Melbourne, Australia) and plasma Pi was estimated by method of Taussky and Shorr (1953). Plasma Ca was estimated by Autoanalyser using diagnostic reagent kits (Bayer Diagnostic India Ltd., Baroda) by cresolphthalein complexone method whereas plasma inorganic iodine (PII) was determined by the method of Aumont and Tressol (1987).

Fodder

Fodder which was being fed to these animals was collected, oven dried (overnight at 65ºC) and ground fodder samples were digested on hot plate with sulphuric acid and hydrogen peroxide and their mineral contents (Cu, Mn, Zn, Fe, Ca) were estimated by Atomic Absorption Spectrophotometer. Phosphorus content of fodder was estimated by Vanado molybdate phosphoric yellow colour method in nitric acid system using Spectronic-20.

Statistical analysis

Statistical analysis of the data was done by method described by Singh et al. (1998).

RESULTS

The mineral contents of blood plasma and forage samples are summarized in Table 1 and 2, respectively. The plasma samples contained higher levels (P<0.05) of Zn and Pi during winter as compared to summer. The variations in Zn and P in the forage were also found to be significant (P<0.05), with higher levels of these elements during winter compared to during summer. Forage had statistically non-significant (P>0.05) levels of Ca, Fe, Cu and Mn during both seasons; contents of the Ca, Fe, Cu were higher during winter than those during summer though the difference was not statistically significant. The concentrations of other minerals in the plasma between the seasons was not statistically significant (P>0.05), with non-statistically significant higher levels of Ca, Fe and PII minerals during winter than during summer.

DISCUSSION

The functions of the minerals in animal
Table 1. Mean plasma concentrations (Mean ± SE) and deficiency rate of different minerals during summer and winter seasons in buffaloes.

<table>
<thead>
<tr>
<th>Element</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn (μmol/l)</td>
<td>10.90 ± 0.45 (76.19)</td>
<td>22.20* ± 2.53 (21.81)</td>
</tr>
<tr>
<td>Fe (μmol/l)</td>
<td>47.53 ± 2.07 (4.17)</td>
<td>51.93 ± 5.92 (9.57)</td>
</tr>
<tr>
<td>Cu (μmol/l)</td>
<td>12.68 ± 0.35 (23.81)</td>
<td>12.68 ± 1.45 (23.40)</td>
</tr>
<tr>
<td>Mn (μmol/l)</td>
<td>0.82 ± 0.04 (20.83)</td>
<td>0.80 ± 0.09 (13.30)</td>
</tr>
<tr>
<td>PII (ng/ml)</td>
<td>43.44 ± 3.15 (88.69)</td>
<td>49.09 ± 4.05 (84.57)</td>
</tr>
<tr>
<td>Ca (mg/dl)</td>
<td>8.92 ± 0.26 (41.07)</td>
<td>9.74 ± 0.30 (26.06)</td>
</tr>
<tr>
<td>Pi (mg/dl)</td>
<td>4.27 ± 0.20 (56.55)</td>
<td>4.99* ± 0.20 (37.77)</td>
</tr>
</tbody>
</table>

Figures in parenthesis show prevalence rate of deficiency.
* Winter v/s summer difference (P<0.05)

Table 2. Mean concentrations (Mean ± SE) of different minerals in summer and winter fodders.

<table>
<thead>
<tr>
<th>Element</th>
<th>CLa</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Meanb ±SEc</td>
<td>Meanb ±SEc</td>
</tr>
<tr>
<td>Cu (ppm)</td>
<td>&lt;10.0</td>
<td>3.03 ± 0.17</td>
<td>3.83 ± 0.29</td>
</tr>
<tr>
<td>Mn (ppm)</td>
<td>&lt;30.0</td>
<td>19.25 ± 1.19</td>
<td>15.60 ± 1.03</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>&lt;30.0</td>
<td>7.93 ± 0.61</td>
<td>17.39* ± 1.77</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>&lt;30.0</td>
<td>239.18 ± 12.88</td>
<td>294.81 ± 40.48</td>
</tr>
<tr>
<td>Ca(%)</td>
<td>0.30</td>
<td>0.46 ± 0.05</td>
<td>0.77 ± 0.11</td>
</tr>
<tr>
<td>P(%)</td>
<td>0.25</td>
<td>0.24 ± 0.01</td>
<td>0.31* ± 0.01</td>
</tr>
</tbody>
</table>

a = Critical level (McDowell 2003)
b = Least square mean from samples from all the districts in both the seasons
c = SE of least square means
* = Winter v/s summer difference (P<0.05)
physiology are interrelated: seldom can they be considered as single minerals with independent and self-sufficient roles (Ozdemir et al., 2006). The mineral elements are not synthesized in the body but are supplied by the feed. Their concentrations in the body fluids will therefore depend on the mineral contents of feed and forage, the level of dietary sources intake, and the availability of minerals (Suttle, 2010). Plant forages make up the bulk of the diet consumed by the livestock. Many environmental and plant factors affect the mineral concentrations of forage plants; these include species or strain/variety, soil type, the climatic of seasonal conditions during plant growth, stage of maturity of forage plants and other management practices.

The data reported here indicate that most of the macro and micro minerals studied are higher in the winter season both in the animal blood and forages compared to those during summer season indicating a direct plant-animal relationship. Mean plasma Zinc (Zn) level was significantly higher in winter (Table 1). Considering the critical limit of 12.2 μmol/l, the prevalence rate of Zn deficiency among buffaloes was 21.81 and 76.19 percent in winter and summer, respectively (Table 1). These findings could be correlated to significantly higher plasma Zn levels in winter season. Yadav et al (2002) had also reported lower incidence of Zn deficiency among buffaloes during winter.

Plasma iron levels varied non-significantly among both the seasons but the mean plasma Fe values in the present study were much higher than the normal range of 17.9 - 35.8 μmol/l (Radostits et al., 2000). High Fe contents of fodder (Table 2) against the dietary requirement of 50 ppm (NRC 1989) appeared as the main factor behind elevated plasma Fe concentrations.

Overall mean plasma Cu levels during both seasons were within the normal physiological range as per McDowell (1992). Baruah and Baruah (1997) also recorded no seasonal variation in mean plasma Cu levels of Jersey heifers. On the other hand, Goswami et al (1993) observed significant seasonal changes in plasma Cu levels. The overall prevalence of hypocuprosis among buffaloes was 23.40 and 23.81 percent in winter and summer, respectively (Table 1).

Similar overall mean plasma Mn levels in buffaloes during both the seasons (Table 1) were above the critical level of 0.37 μmol/l (Hidiroglou 1979). There was a wide variation in the plasma Mn levels (0 – 2.48 μmol/l) among buffaloes whereby many of the buffaloes were found to have non-detectable plasma Mn values in both the season. The overall deficiency percentage of Mn during winter was lower (13.30%) than that in summer (20.8%). These results corroborated with findings of Sawhney and Kehar (1961) who reported that Mn stores in liver and kidneys got depleted in hot and dry season and got repleted in winter.

Mean plasma inorganic iodine (PII) level was higher during winter. The values during both the seasons were well below the critical level of 104.9 ng/ml (Rogers, 1992). Lundgren and Johnson (1964) had reported that the low levels of PII could be due to higher environmental temperature. Jain (1990) found low iodine content of soil in Punjab which supports the present findings. High percentage of sub-clinical iodine deficiency was observed during summer (88.7) as well winter (84.6) seasons.

Overall mean plasma Ca level in winter was higher. Higher plasma Ca levels in winter could be attributed to the significantly (P<0.01) higher levels of Ca found in winter fodder (Table 2). Earlier, Behera et al (2005) had also reported higher plasma Ca during winter season in sheep.
Overall mean plasma inorganic phosphorus (Pi) level in winter was significantly (P<0.05) higher than the summer season (Table 1). Higher winter levels could be attributed to the significantly (P<0.05) higher fodder levels (Table 2) The overall prevalence of hypophosphataemia among buffaloes was 37.77 and 56.55 percent in winter and summer, respectively (Table 2). These findings of low prevalence in winter could be due to significantly higher Pi levels in plasma and fodder in the winter season. Similar prevalence rate (38.0%) of deficiency had been reported by Yadav et al (2002) among buffaloes of Haryana during winter.

Thus, it can be concluded that alteration in the levels of different micro and macro minerals in the plasma corresponded to the fodder mineral variations, indicating a direct plant-animal relationship and showing the need of supplementation of the deficient minerals during summer season for these animals at the place where the livestock were being reared.

REFERENCES


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