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CU^{2+} STATUS IN SOIL, PLANTS AND ANIMALS DURING WINTER AND SUMMER SEASONS

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Abstract

To study the relationship among soil, plants and animals regarding translocation of copper, the samples of soil, forage and animals were collected from livestock farm Rukh Ghulama (Distt. Bhakhar, Punjab) during winter and summer seasons. Results indicated that copper (Cu^{2+}) status in soil was 0.24 μg/g below the critical level (0.5 μg/g) during summer season. While in forage Cu^{2+} concentrations were above the critical level (7.66 μg/g) and the animals fed with this forage had Cu^{2+} concentration in plasma (0.1 μg/g), milk (0.2 μg/g), urine (0 μg/g) and faeces (30 μg/g) and were almost within the critical limits. The essentiality of copper was suggested to prevent various diseases of animals including anemia and may produce numerous copper dependent metabolic enzymes.

Introduction

Pakistan is facing a serious shortage of meat and milk for which buffaloes are the rich and cheapest source in Pakistan. The milk and meat of animals fed on good forage is also helpful in providing essential mineral nutrients necessary for the health and development of human beings. In animals, optimum nutrition, especially micro-elements are known to affect growth and reproduction (Bicknell, 1995). Minerals bear significant role in animal nutrition because their excess or deficiency produces detrimental effects on the livestock. Mineral imbalance in soil and forage can cause impaired performance among the ruminants such as infertility, noninfectious abortions, anemia and bone abnormalities often due to the deficiencies of minerals in the livestock feed (McDowell, 1983; Bicknell, 1995). Trace mineral imbalance exert a significant effect on the health and productivity in tropical countries (McDowell *et al.*, 1993), especially, in grazing animals not fed with other supplement. After major elements, the deficiency of copper is limiting to grazing livestock in the tropics (McDowell, 1993). The deficiency of copper and zinc is common in plants grown in calcareous and alkaline soils as animal fodders are often cultivated on such soils in Pakistan due to heavy demands of food crops due to heavy load of population on fertile soils.

This experiment was conducted to study the relationship among soil, plants and animals regarding Cu^{2+} translocation.

Materials and Methods

Soil, forage, animal feed as well as animal samples *viz.* blood, milk, urine and faeces were collected from livestock farm (Rukh Ghulama, District Bhakker) during winter and summer seasons to study the relationship among soil, plant and animals. Sampled animals were of different age groups *i.e.* lactating and non-lactating buffaloes. Samples were collected at fortnightly intervals from soil, plants and animals for two months.

Plant and faeces samples were digested according to Wolf (1982) and copper estimated with the help of Atomic Absorption Spectrophotometer. Blood and milk samples were analyzed by using the methods of Mpofu *et al.* (1998) and Stelwagen *et al.* (1999). Mean values were compared with least significance difference test (LSD) following Snedecor & Cochran (1980).

Results

Copper concentration in soil, forage plants and different water samples varied significantly in both seasons (Fig. 1). During winter, a consistent decrease in Cu^{2+} was recorded in soil but during summer no definite pattern was found, however, Cu^{2+} concentration was highest at the fourth fortnight and lowest at the 3rd fortnight during winter. Cu^{2+} concentration was generally higher in canal water than in tube-well water in both seasons. Cu^{2+} concentration of tube-well water was not affected by time factor during the entire winter and summer seasons. However, Cu^{2+} concentration of canal water did not vary during the summer season, but during the winter season considerable fluctuation was observed with time. The highest Cu^{2+} concentration was found in canal water during the winter, however, the differences during summer in canal and tube-well water were not prominent (Fig. 1b).

During winter, Cu^{2+} concentration in forage varied considerably with time, forage Cu^{2+} was significantly high at 2nd fortnight and was almost double than that at 1st fortnight (Fig. 1c). Cu^{2+} concentration in feed did not show a consistent pattern during summer, however, in winter it increased with time except at 3rd fortnight, where the Cu^{2+} concentrations were slightly lower than at 2nd fortnight (Fig, 1d). Cu^{2+} concentrations were higher during summer than those in winter at all fortnights except 4th where Cu^{2+} concentrations were statistically similar in summer and winter. In summer, maximum Cu^{2+} concentration was at 2nd and minimum at 1st fortnight. While in winter, highest Cu^{2+} was at 4th fortnight and lowest at 1st.

Plasma and urine contained significantly lower concentrations of Cu^{2+} in both lactating and non-lactating buffaloes (Fig. 2). Milk contained a negligible amount of Cu^{2+} during both winter and summer. Pattern of Cu^{2+} concentration (Fig. 2) in faeces of lactating and non lactating buffaloes was similar during both winter and summer, but lactating buffaloes excreted slightly more Cu^{2+} through faeces, as compared to non-lactating ones during both seasons. The highest excretion of Cu^{2+} was observed through the faeces of lactating and non-lactating buffaloes. Excretion of Cu^{2+} through faeces was markedly higher in both lactating and non lactating buffaloes during summer and winter.

Discussions

Copper, an essential micronutrient is a constituent of the chloroplast protein, plastocyanin as well as a part of the electron transport system linking photo systems I and II. it also participates in protein and carbohydrate metabolism and nitrogen fixation. Similarly, in animals it plays a key role in optimizing the function of reproduction system, regulation of certain metabolic enzymes and hormones. Its deficiency may cause many disorders in plants and animals. it was observed that soils used for cultivation of fodder should contain copper more than 0.5 µg/g, while the soils used in the present study contained Cu^{2+} concentration ranging from 0.25-0.36 µg/g and the water used for irrigation contained 0.090.18 µg/g of Cu^{2+}. Tiffany (1999) reported that soils are often deficient in Cu^{2+}. They used soils that contained Cu^{2+} from 0.073-0.078 µg/g in the first year and from 0.080-0.108 µg/g in second year.

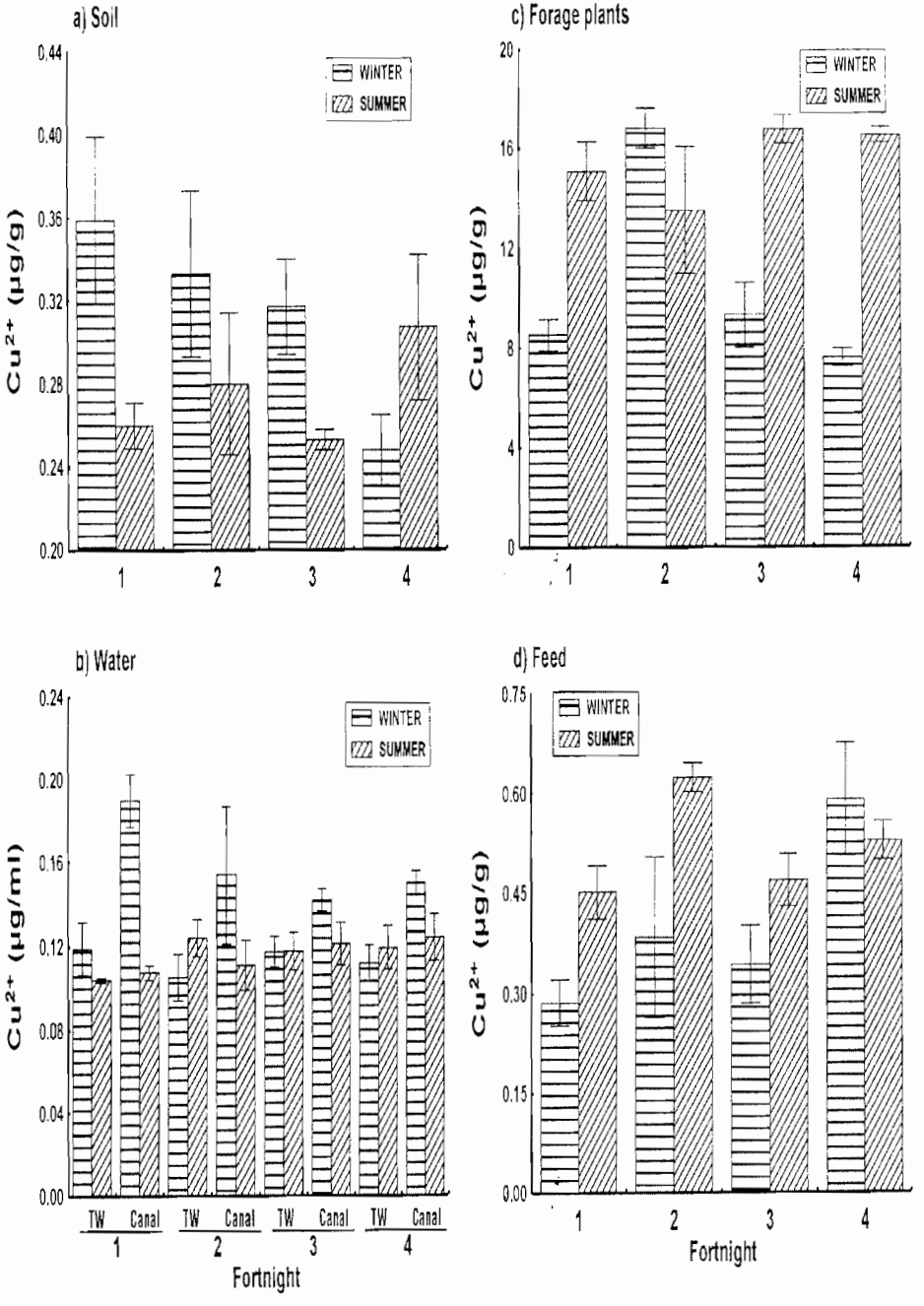

Fig. 1. Mean Cu^{2+} concentration in (a) soil, (b) water, (c) forage plants and (d) feed during winter and summer seasons.

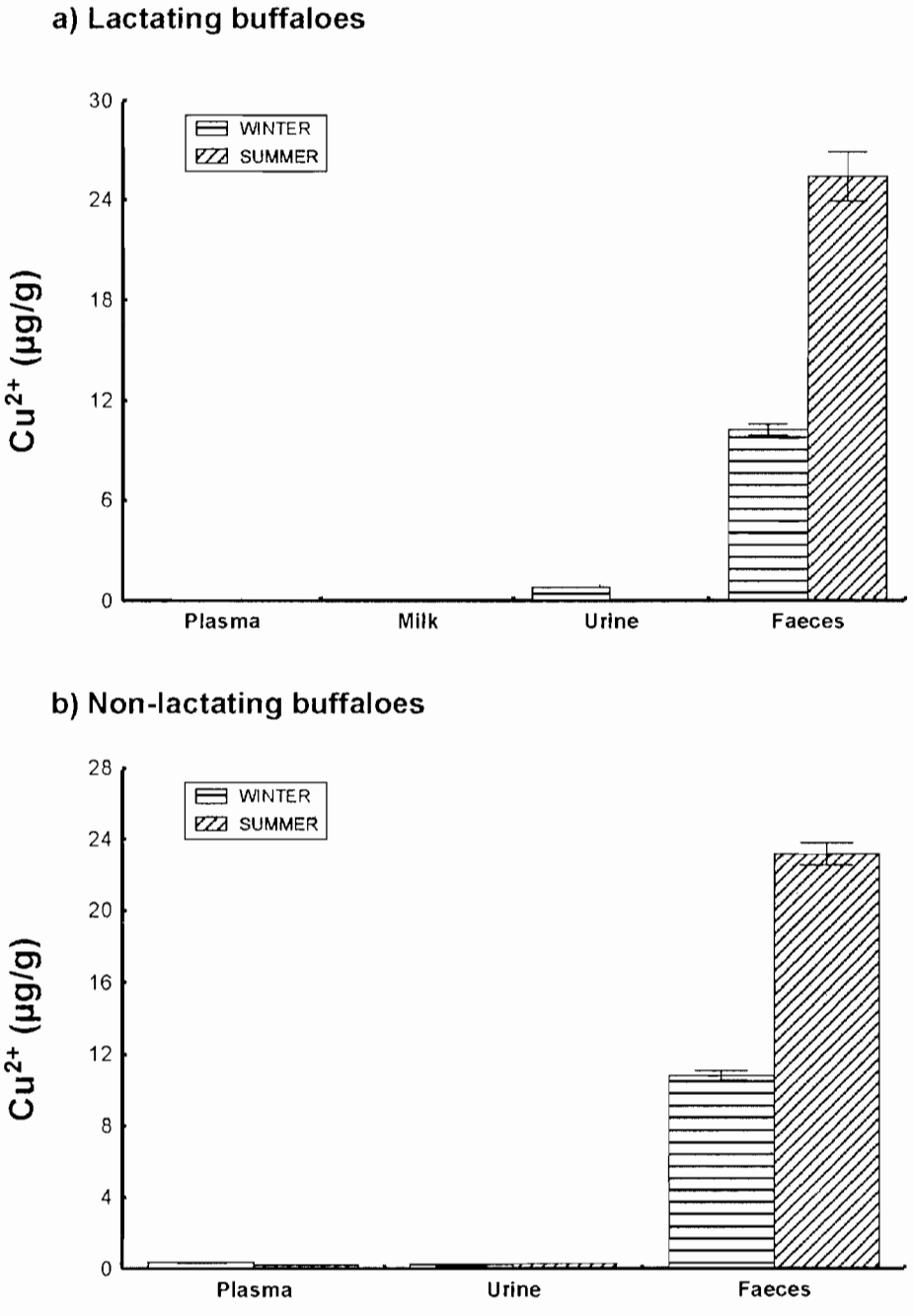

Fig. 2. Mean Cu^{2+} concentration in plasma, milk, urine and faeces samples of (a) lactating (b) non-lactating buffaloes during winter and summer seasons.

Variation in Cu^{2+} is not common in animal feed, because most of the feed supply adequate amounts and it reflected the content of the soil on which they were grown. So the animal fed with optimum supply of copper remained safe from diseases like anemia and had functional copper dependent enzymes essential for metabolic activities (O,Dell, 1976, Kidwai & Ahmed, 1999). Plasma copper concentration was significantly lower in the animals under study which may cause some physiological disorders (Underwood, 1997, Jafri & Shaikh, 1998). The relatively large liver observed in the buffalo may be due to the Cu^{2+} deficiencies recorded in Venezuela (McDowell *et al.*, 1989). It was also observed that soil concentrations of Cu^{2+} were influenced by the dry season showing increase in dry season in Guatamala (Mpofu *et al.*, 1998). Goodrich *et al.* (1972). Cu^{2+} absorption may be influenced by age, some hormones, pregnancy and some diseases not observed in the present study. Hill and Matrone (1970) noted that Zn and Ag are antagonistic to Cu^{2+} absorption so the plants growing on the soils having higher concentrations of Zn and Ag might be deficent in Cu^{2+}. In soils where Cu^{2+} is deficient like in Zimbabwe (McDowell 1993) the dficiencies can be conditioned by the presence of dietary factors which interfere with the utilization of Cu^{2+} by the animal.

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