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Research Article

Seasonal Variations of Macro and Micro Minerals in Different Feeds and Fodders in Sub Tropical Region

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ABSTRACT

The study was conducted at Cattle Yard of Livestock Farm located at National Dairy Research Institute, Karnal. There are four major seasons in the year viz. winter (December to March), summer (April to June), rainy (July to September) and autumn (October to November). The fodders and feed fed to Karen fries cattle are collected in all seasons. Four samples of each fodder (green and dry) mentioned above were collected in each month (one sample per week) in the respective season. Concentrations of calcium, phosphorus, zinc, copper and manganese were determined. All the four season calcium, phosphorus, copper levels were observed above the critical level. But zinc and manganese level were observed below the critical level in dry roughages in rainy, autumn and winter season. It can be concluded, from the results of the present study, that the dry fodders reared in different seasons were deficient in zinc and manganese minerals and supplementation of required minerals is essential for optimum production.

Keywords: *Fodders, season, Minerals, Karen fries cattle, Sub tropics*

INTRODUCTION

India has rich animal diversity (7%), making her a hub for global domestic animal diversity. Crossbreeding of zebu cattle with exotic bulls of high genetic merit for increasing productivity was initiated as part of our breeding policy in trans-gangetic plain region of India. Crossbreds appear to be more prone to infectious disorders as compared to purebreds. Metabolic and deficiency diseases are quite common in high producing animals and are mainly due to non-availability of balanced diet or imbalance of specific nutrients in soil and fodder. Mineral content of soil reach to serum through grazing (Baruah et al., 2000). Cropping pattern, soil type, rainfall and feeding system are different in different agro-climatic conditions and hence the extent and type of mineral deficiency is likely to be different (Ramana et al., 2001; Garg et al., 2005).

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The extent of mineral deficiency in the ration of the animals is dependent on the mineral levels in the feed and fodders and the level of feeding and physiological status of animals (Garg et al., 2008).

In India, dietary concentration of macro and micro minerals are highly variable in its availability depends on season, location and forage intake through feed apart from non-nutritional factors such as age, weight, pregnancy and lactation stages (Khan, 1995). Mineral deficiency is an area problem (Mc Dowell et al., 1983). Information regarding herd health and systematic data with seasonal variation, disease incidence and blood profile of high yielding Karan Fries cattle in herd level is lacking in India.

The present investigation was carried out to at Karan Fries herd at NDRI, Karnal to analyse the seasonal variation in essential minerals in feeds and fodders fed to these animals.

MATERIALS AND METHODS

The study was conducted at Cattle Yard of Livestock Farm located at National Dairy Research Institute, Karnal. A subtropical climate prevails in the area. There are four major seasons in the year *viz*. winter (December to March), summer (April to June), rainy (July to September) and autumn (October to November).

Samples of various fodders fed to KF cattle were collected in different seasons.

Season: I Rainy - Maize, Jowar, Maize Dry, Wheat Bhusa and Concentrate

Season: II Autumn - Maize, Jowar, Maize Dry, Jowar Dry, Cowpea and Concentrate

Season: III Winter - Maize, Jowar, and Jowar dry, Mustard, Turnip, Berseem, Wheat bhusa, Lucerne, Oats and concentrate

Season: IV Summer - Maize, Berseem, Lucerne, Wheat bhusa, Cowpea dry, and concentrate

Four samples of each fodder (green and dry) mentioned above were collected in each month (one sample per week) in the respective season. The individual fodder samples were weighed before to dry in a hot air oven at 100 ± 5 ˚C for 8 hrs, and weighed after drying to estimate dry matter content of feed and fodder sample. From the four sample collected in a month, a representative sample was obtained after thoroughly mixing samples of a particular fodder. Then dried samples grinded and stored in air tight polythene packets for analysis on dry matter basis. The fodder samples were digested by the method of Trolson (1969). Concentrations of calcium, zinc, copper and manganese were determined using Atomic Absorption Spectrophotometer (Perkin Elmer A Analyst 100) with standard solution of different concentrations of elements in order to estimate the final concentration of minerals. The concentration was expressed as parts per million (ppm). Phosphorus was estimated following the method of Fiske and Subbarow (1925).

The statistical analysis of data of differential was carried out by least squares method (Harvey, 1979). Product movement correlations were carried out as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The various macro and micro minerals *i.e.* calcium, phosphorus, zinc, copper and manganese profile of concentrate and fodders (green fodders, roughages) were analysed in different season *i.e* rainy (July-Sept), autumn (Oct- Nov), winter (Dec- March) and summer (April- June) and are presented in table 1to4.

Table 1: Mineral profile in concentrate and fodders of rainy season (on DM basis)

Fodder	Ca (%DM)	P (%DM)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Maize fodder	0.72±0.01	0.29±0.01	31.89±1.52	25.47±2.06	47.49±0.48
Jowar fodder	0.64±0.02	0.30±0.01	27.78±2.15	24.18±1.47	44.66±3.37
Wheat bhusa (Chaffed wheat straw)	0.46±0.03	0.27±0.03	18.50±0.77	12.92±1.91	32.12±0.01
Maize dry **(**Maize stover**)**	0.51±0.01	0.28±0.03	19.0±0.09	14.68±0.12	37.0±0.21
Concentrate	0.51±0.05	0.53±0.01	39.66±1.88	31.30±2.36	58.59±2.14

The calcium content of concentrate and different fodders were found to be in the normal range (0.30 - 0.70 %). Inorganic phosphorus level in concentrates was higher and green fodders and straws were poor source of phosphorus. In this study, it was apparent that the most of dry fodder, particularly wheat bhusa (12.92 ppm) and maize dry (14.68 ppm) was also low in zinc content. Amongst green fodders maize (31.89 ppm) had highest zinc content followed by jowar (27.78 ppm) in this season. Zinc content in concentrate mixture was 39.66±1.88 ppm. Wheat bhusa and maize dry were low in copper content in comparison to green fodders maize (25.47 ppm) and jowar (24.18 ppm). Higher manganese level was found in concentrate (58.59 ppm) followed by green fodders maize (47.49 ppm), green jowar (44.6 ppm), wheat bhusa (32.12 ppm) and maize dry (37.0 ppm). Manganese content was above the critical levels (<40 ppm) in all green fodders and slight deficient in dry fodders to meet the dietary requirements of animals.

Minson (1990) reported average values of 1.42 and 1.01 per cent for temperate and tropical legumes and correspondingly 0.37 and 0.38 per cent calcium for grasses. Joseph (1995) reported in natural feed stuffs from plants, calcium quite often exists as complexes with phytate and oxalate, which reduce its availability. Except for diets high in legume forages, feeds fed to ruminants are always deficient in calcium, unless supplemented. Calcium deficiency mostly occurs in areas of high rainfall and humidity (Sharma et al., 2003a). In Haryana, calcium content of feeds and fodders were found to be normal range in Panipat, Rohtak, and Hissar and Rewari districts. However, animals in Panipat and Rewari showed below normal concentration of serum calcium. The levels in feeds and fodders were in normal range in Jhajjar and Fatehabad districts of Haryana, however, buffaloes showed sub optimal concentration of this mineral (Kapoor et al., 2004).

In this study most of the green and dry fodders are poor source of phosphorus (critical level <0.25%) and responsible for acute to sub acute deficiencies in animals. Similar findings also reported by Singh and Pal (2006) in the arid and semiarid regions of India. Phosphorus deficiency is the most widespread and cause economically important mineral problems in those animals fed predominantly on forages. About 50-80% of phosphorus present in concentrates is well utilized by ruminants. Generally, temperate forages contain more phosphorus than tropical one's (0.35 vs. 0.23%) and legume slightly more than grasses (0.32 vs. 0.27%) (Minson, 1990). Phosphorus is one of the costliest mineral nutrients in the diet of animal and its deficiency effects the livestock production and health in many parts of India (Joshi et al., 1991). Moderate to severe deficiency of phosphorus has been recorded in UP plain (Sharma *et al.*, 2009), Haryana (Yadav et al., 2002; Lall et al., 1994; Mann et al., 2003) and sufficient in Uttarakhand (Sharma et al., 2002).

Most part of Indian soil and feed stuffs are deficient in zinc and its supplementation is essential. Pasture and forages contain about 20 to 50 ppm zinc. In India, most of the feeds and fodders in Tarai region of UP, J&K, Punjab, Haryana and Gujarat has been found to be zinc deficient (Ranjha and Gopalkrishna, 1980).

The Zinc content of green fodder is varied from 20.45 to 38.50 ppm in our study. Tropical forage is low in Zinc (McDowell, 1985). The Zinc concentration of concentrate feeds lies between 30 to 40 ppm (Underwood & Suttle, 1999). Zinc is one element, which is found to be acutely deficient in many geographical zones of India (Ramana et al., 2001; Garg et al., 2005). Zinc concentration of fodder and concentrate in the present findings in rainy season are agreement with Raju (2002) *i.e.* 26.62 ppm in Karnal district followed by 22.57 ppm at Rohtak district and 22.19 ppm at Sonepat district. The overall concentration of zinc in fodder was 20.12 ppm in Haryana. Garg et al. (2008) reported that most of the feed ingredients, particularly straws, were unduly low in zinc content (17.80 ppm). These mineral levels in rainy season were in agreement with findings of Shinde and Sankhyan (2008) in eastern plains of Rajasthan. Zinc content during pregnancy and lactation stages in the diet was deficient (14-16%). Cattle and buffaloes required 30 ppm during heifer and dry stages and 40 ppm during pregnant and lactation in the diet. Most of the feed and fodders in this season showed lower zinc level. Zinc has specific action in activating enzyme system that assist in maintaining the activity of hypophyseal hormones in blood, deficiency of zinc caused reproduction failure in animals (Mc Dowell, 1992). Arora (1981) has recommended supplementation @ 80ppm to overcome the deficiency in Karnal.

Copper concentration was higher than the normal range for feed and fodder. However, Raju (2002) reported that the highest copper in fodder was observed in Rohtak 13.73ppm followed by 11.61ppm at Sonepat district. The copper concentration in fodder was 7.64ppm in Karnal. This may be due to different cropping pattern like wheat and rice system. In NDRI, the land is mostly used for fodder cultivation with sufficient rest period and regular use of cow dung as organic manure. Though the soil of Karnal is very high in pH (8.5 to 10.5), however, the situation in NDRI is not that serious. Copper availability to the plant from the soil is affected by alkaline pH or due to presence of excess molybdenum. A copper molybdenum ratio of 2:1 in feed is normal and higher molybdenum tends to bind copper, making it unavailable for absorption**.** Copper concentration in leguminous and oilseed cakes is more (15-35 ppm). The copper content of plant varies with plant species. Temperate grasses tend to be lower in copper than legumes (4.7 vs. 7.8 ppm) but under tropical condition the situation is reverse (Minson, 1990). At Central Institute of Research on Buffaloes farm, Hissar, copper content in soil and feeds was sufficient but blood serum levels of buffaloes were low (Lall et al., 1994). In Haryana state, copper concentrations in legumes and oil seed cakes are more (15-30 ppm). About 84-100% of roughages and 8-28% of concentrate feed stuffs were deficient in copper in Rohtak, Haryana. The overall deficiency of copper in fodders was 60.64% (Sharma *et al.*, 2003c). Copper deficiency has been observed in feeds and fodders and also in the plasma of buffaloes in varying degrees in Jhajjar (Kapoor et al., 2004).

The manganese concentration in green fodder and concentrate is within the normal range for fodder, however, dry fodder are deficient in manganese. A primary dietary deficiency of manganese are seen with excess of calcium or phosphorus in the diet and soils containing less than 3 ppm of manganese and herbage containing less than 50 ppm are incapable of supporting normal body functions. As above we have seen calcium content of fodder are very high in our study, it may affect the absorption of manganese from the fodder due to high calcium. In Karnal district of Haryana, manganese content in various concentrates, green fodders and tree leaves was found to be highly deficient (Singhal & Mudgal, 1984), However, the situation in NDRI is within the normal range due to the land utilized only fodder cultivation. Bedi and Khan (1989) observed that manganese content (Uttar Pradesh) in dry and green roughages of Bareilly district was 36.14 and 76.86 ppm respectively. The manganese level was found to be adequate in most of feeds in Kota, Rajasthan. However, green fodders were provided adequate quantities of manganese, but straws were deficient (Garg et al., 1999).

Table 2: Mineral profile in feeds and fodders of autumn season (on DM basis)

Feeds and fodder	Ca (%)	P (%)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Maize fodder	0.64±0.02	0.30±0.01	29.04±0.64	23.86±0.14	47.77±0.32
Jowar fodder	0.65±0.03	0.29±0.02	24.29±0.74	18.82±0.38	43.21±0.58
Cowpea dry	0.76±0.01	0.38±0.03	42.88±3.03	27.38±0.40	61.10±0.06
Jowar dry (Jower stover)	0.44±0.01	0.28±0.02	18.24±0.68	14.81±0.96	34.04±0.68
Concentrate	0.44±0.02	0.52±0.01	43.82±3.15	31.25±0.53	62.51±0.48

The calcium content of green fodder maize and jowar was (0.64%) and (0.65%) respectively. In cowpea calcium level was highest (0.76%) compared to other green fodders. In general, leguminous fodders are rich in calcium content as compared to non-leguminous fodders. Phosphorus level was within normal limits in feed resources (> 0.25). The present study indicate that majority of roughages in this season found to be deficient in zinc (critical level <30 ppm). The level of zinc in cowpea is above normal range in all the fodder in autumn season.

The copper level was highest in concentrate mixture (31.25 ppm) followed by cow pea (27.38 ppm), maize (23.86 ppm) and lowest level in jowar green fodder (18.82 ppm) and jowar stover (14.81 ppm). Concentration of manganese in feeds and fodders was found to be adequate. The highest level found in concentrate mixture (62.51 ppm) followed by cow pea (61.10 ppm). In green fodders manganese content is moderate and the dry roughages jowar stover (34.04 ppm) is a deficient level.

Cowpea is an important fodder legume and an integral part of traditional cropping systems in the semi-arid regions of the tropics in rainy season. Farmers often grow a short-duration spreading variety for grain and a long-duration spreading variety for fodder, but the grain and fodder yields are poor due to low yield potential of the spreading varieties and also due to early cessation of rains. Despite the high grain and fodder yields, the improved dual-purpose varieties have similar crude protein content (17-18%) and dry matter digestibility (64-71%) compared to the local varieties. This season is a green fodder deficient season in Karnal as green maize and sorghum become matured and animals are mostly feed as dry maize and sorghum fodder. From the table it is evident that there is deficiency of zinc during these two months from the fodder. Another implication of non availabity of these minerals to the animals was due to poor quality of fodder. However, no such data about the fodder quality is available for this region from field condition and its impact on animal productivity and health status is also not available.

However, at NDRI herd milk productivity was lowest during this period in all breeds of cattle and buffaloes. Cowpea can be grown though productivity is low in summer to supply cowpea as green fodder during this period to supply quality nutrient from green fodder or late variety maize can be grown to supply green maize during this season.

Table 3: Mineral profile in feeds and fodders of winter season (on DM basis)

Feeds and fodder	Ca (%)	P (%)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Maize fodder	0.60±0.01	0.30±0.01	30.14±0.62	24.69±0.67	48.19±0.92
Berseem	1.33±0.02	0.37±0.06	38.92±0.02	26.43±0.39	79.14±0.96
Oats	0.58±0.01	0.38±0.05	33.80±0.43	20.56±0.67	42.31±0.48
Lucerne	0.76±0.04	0.35±0.01	39.97±0.12	26.10±0.21	69.40±0.02
Mustard fodder	0.56±0.03	0.34±0.03	31.04±0.68	22.15±0.38	50.17±0.81
Turnip	0.54±1.12	0.35±0.11	33.72±0.34	25.79±0.67	48.14±0.34
Wheatbhusa (Chaffed wheat straw)	0.41±0.02	0.35±0.07	11.77±0.03	11.62±1.68	27.74±0.93
Jowar dry (Jowar stover)	0.61±0.02	0.30±0.02	26.93±0.96	19.49±1.60	40.24±0.95
Concentrate	0.49±0.01	0.51±0.03	47.80±0.02	27.72±0.79	59.13±0.64

Winter season starts from December and by end in March. In the beginning of December situation of fodder supply is also not very favorable, limited quantity of green maize is available and are mostly supplied to animals in milk and other animals are supplemented with dry fodder. In late December first cut berseem mixed with mustard is supplied in limited quantity to all groups of animals. However, from January good quality fodder is available to the animals. In late January oats fodder is supplied along with berseem. In whole winter season highest calcium concentration was observed in berseem (1.33%) and lucerne (0.76%) followed by other cereal green fodders and dry roughages. Phosphorus level was higher in concentrate mixture (0.51%) compare to the green fodders and roughages. Calcium and phosphorus were found to be above the critical level (Ca< 0.30 and P<0.25) in all feeds and fodders. Zinc was found to be deficient in all cereal straws and highest level in concentrate mixture (47.80 ppm) and below critical level (<30 ppm) in wheat bhusa (11.77 ppm). Copper was higher in concentrate mixture (27.72 ppm) and lower in wheat bhusa (11.62 ppm). All the feed sources contained adequate level of copper content in winter season. Manganese was highest in berseem (79.14 ppm) followed by lucerne (69.40 ppm) and green fodders and roughages. In wheat bhusa manganese was (27.4 ppm) below the critical level (<40 ppm). Legumes contained higher levels of zinc and copper than non-legumes (McDowell., 1985). The present findings of low zinc content in dry roughages and have higher concentration of calcium and manganese in berseem is agreement with findings of (Garg *et al.*, 2008) in Gujarat.

Table 4: Mineral profile in feeds and fodders of summer season (on DM basis

Feeds and fodder	Ca (%)	P (%)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Maize fodder	0.70±0.01	0.31±0.02	29.61±0.27	20.79±0.97	47.14±0.02
Berseem	1.38±0.02	0.28±0.01	38.90±0.03	26.69±0.23	73.19±0.02
Jowar fodder	0.59±0.01	0.28±0.03	32.52±0.48	21.05±0.26	59.66±0.72
Oat silage	0.58±0.02	0.35±0.02	34.92±0.49	10.96±0.87	41.46±0.02
Wheat bhusa (Chaffed wheat straw)	0.41±0.04	0.49±0.01	11.80±0.02	10.67±0.80	25.81±0.03
Cowpea dry	0.41±0.02	0.30±0.32	28.30±0.45	35.65±0.12	39.64±0.32
Concentrate	0.48±0.01	0.58±0.05	38.52±0.37	26.14±0.03	55.49±0.52

Summer season starts from April to June which is a dry summer in Karnal. This is also a lean period of green fodder in the month of April as berseem become matured with very less leafy parts though in large quantity, however left over is more during this period as animal unable to consume the stems. Only in late May green Maize and Jowar is available. Sometime wheat bhusa and Jowar dry preserved in the previous season is supplied to meet the fodder requirements in this season without much leguminous fodder. In summer season calcium level is higher in berseem (1.38%) and lower in wheat bhusa (0.41%) and cowpea dry (0.41%). Phosphorus also observed above the critical level (>0.25%) in all feed sources but higher in concentrate mixture (0.58%) and dry roughages contain poor source of phosphorus. Zinc was below the critical level in dry roughages and higher levels are found in berseem and concentrate mixture. The overall zinc content was above the critical level in summer season, which is still below the normal level for fodder. The higher copper level was in cowpea (35.65ppm) followed by concentrate mixture (26.14ppm) and berseem (26.69ppm). The copper level was above the critical level (<8ppm) in feeds and fodders .The higher manganese content observed in berseem (73.19ppm) and below the critical level observed in wheat bhusa (25.81ppm). In oat silage calcium and phosphorus levels were sufficient and zinc, copper and manganese levels were just above the critical level observed. Therefore, no specific data on mineral content of different green fodder is available in this season.

CONCLUSION

It can be concluded, from the results of the present study, that the dry fodders reared in different seasons were deficient in zinc and manganese minerals and supplementation of required minerals is essential for optimum production. Further, the present study established the relationship between different season and fodder and dairy cattle in subtropical region.

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