# Assessment of Macro and Micro-Minerals Status of Milch Animals in Jodhpur District of Rajasthan

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*A study was conducted in Jodhpur district of Rajasthan, to assess the prevalence of macro and micro-minerals deficiency in milch animals, by collecting feed and fodder samples at random, from various locations following standard sampling procedure. The calcium content (0.20%) was low in concentrate ingredients, whereas, phosphorus content (0.42%) was higher. The average calcium content in straws (0.53%) was higher in comparison to phosphorus (0.09%). The calcium and phosphorus content in green fodders were 1.03 and 0.22 per cent, respectively. The magnesium content in roughages and concentrates was 0.45% and 0.23%, respectively. The survey area was rich in potassium content (1.33%). Sodium content was 0.091% and 0.31% in dry and green fodder, respectively. The sulphur content was low in crop residues (0.17%), whereas, adequate in most of the concentrate feed ingredients (0.24%). Cobalt (0.32 ppm) was occasionally deficient in the diet of animals. However, iron (382 ppm) and manganese (47 ppm) contents were adequate in the diet of animals, with traditional feeding system. The average copper content was low in dry roughages (6.67 ppm), whereas, green roughage (12.16 ppm) and concentrate ingredients (12.65 ppm) were better source of copper, except grains (9.11 ppm). Molybdenum content in feeds was within safe limit (average level < 0.89 ppm) and gave Cu:Mo ratio wider than 5.0. Selenium content in most of the feeds and fodder samples was adequate (0.65 ppm) and its supplementation in the diet was not necessary. Zinc was acutely deficient in most of the feedstuffs (average level < 22.0 ppm) and needed to be supplemented in the ration of animals for proper productive and reproductive functions. From the present study, it was apparent that the levels of certain minerals in the ration of animals, such as calcium, phosphorus, sodium, sulphur, zinc, copper and cobalt were inadequate, as per the estimates for the requirement of a cow yielding 8 kg milk (4% fat) per day. However, the levels of some other mineral elements such as magnesium, potassium, iron, manganese and selenium were found to be adequate in the arid zone of Rajasthan.*

**Keywords:** Phosphorus, sulphur, copper, zinc, selenium, arid zone, cow

## INTRODUCTION

For efficient production and reproduction and maintenance of normal health in dairy animals, it is essential to provide macro and micro-minerals in appropriate quantity. The minerals though required in small amounts, play important role in various metabolic activities of animal's body. As a result of intensive cultivation, soil concentration of minerals is getting depleted, leading to low mineral content in feeds and fodder, there by affecting mineral status of animals (Underwood and Suttle, 1999). At the same time, it is advisable not to supplement minerals in excess amount, which may lead to problem of animal waste and toxicity. Recommending supplemental elements without considering the base levels in feeds and fodders may not be the satisfactory system (Hinders, 1999). For supplementation of area specific mineral mixture, it will be useful to know the mineral status of locally available feed resources (Garg *et al.* 2005). Therefore, the present study was undertaken to know the mineral status of feeds and fodders and their availability to animals, so as to suggest area specific mineral mixture for Jodhpur district of Rajasthan.

## MATERIALS AND METHODS

### Sampling Procedure

At random, one village from each taluka of Jodhpur district was selected for taking representative samples of feeds and fodder. Total area of Jodhpur district is 22,850 sq.km., distributed into 6 talukas, having 863 villages. The district is having annual rainfall of 25 cm, having latitude of 27°80' and longitude of 73°45'. Atmospheric temperature ranges from 5 to 47°

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C during different seasons. Within the village, help was sought from village milk producers and Jodhpur District Cooperative Milk Producers' Union, for identification of 4 to 5 farmers. The recorded parameters were number of livestock, land area, irrigated facilities, fodder and other crops being grown etc. In identification of farmers, land location was considered essentially, one each from Northern, Eastern, Western and Southern directions, to cover soil types on each side of the selected villages.

Further information regarding the amount and types of feeds and fodder being offered to the animals, approximate rate of daily feed intake and milk yield of individual animals was collected from individual farmer, using standard sampling procedure. Total intake was compared against the requirements on dry matter basis (Campbell *et al.* 1999; NRC, 2001), so as to identify quantitative deficiency, sufficiency or even excess. In India, hardly any information on mineral requirements for milch cows is available, so NRC (2001) was taken as a base for calculation of mineral requirements of cows. The data were analyzed statistically as per Snedecor and Cochran (1967).

**Sample Preparation and Analytical Methods**

Composite samples of green fodder, dry fodder, individual concentrate ingredients and the compounded cattle feed (concentrate mixture) were collected from the surveyed area. Green samples were dried in oven at 80°C for 24 hrs and subsequently ground (1mm). Ground samples of concentrate and fodder were stored in airtight bags until analysis. Samples were prepared and digested using 5 ml concentrated $HNO_3$ plus 1 ml concentrated HCl by microwave digestion method for preventing evaporation of volatile elements and total volume of mineral extract was made to 25 ml with deionized water. All the samples were analyzed for Ca, P, Mg, Na, K, S, Cu, Zn, Mn, Fe, Co, Mo and Se using Inductively Coupled Plasma-Optical Emission Spectroscopy (Perkin-Elmer, OPTIMA – 3300 RL).

The word "critical" is used in this article to note concentration in feedstuffs below (or above with excesses) what is considered the requirement for animals. This assumes the expected consumption as estimated by the NRC (2001). Total grams/milligrams of minerals consumed per day determine the true adequacy of a mineral, not merely the forage concentration. Dry matter intake data was based on actual measurements made during the sample collection. Total intake of minerals was compared against the requirements on dry matter basis, to assess deficiency or adequacy.

## RESULTS AND DISCUSSION

**Feeding and Management**

The survey work revealed that most of the small farmers keep their animals on grazing and supplementation of straws of wheat, bajra, sorghum and local grasses, collected from the wasteland, as basal roughages. This practice was found to be common for other categories of farmers also. However, the medium farmers were supplementing the ration of animals with single unit concentrate ingredient in the form of crushed bajra (*Pennisetum spp.*) or whole cottonseed. Supplementation with home grown multiple unit concentrate mixture (crushed bajra and wheat, whole cottonseed, guar chuni/korma) was found to be practiced only by large farmers. Those farmers who don't feed multiple unit concentrate ingredients, were feeding compounded cattle feed manufactured by Jodhpur Cattle Feed Plant, a unit of Rajasthan Dairy Cooperative Federation Ltd., Jaipur, depending upon the level of milk production. It was noticed that some of the farmers practice feeding their animals with cultivated fodder like lucerne (*Medicago sativa*) or green *bajra*. The green fodder availability was only for limited period due to water scarcity and frequent droughts in that area. Those farmers, who don't have irrigation facility, were feeding local grasses, *sewan* (*Lasiurus sindicus*) grass and *ber* (*Zizyphus spp.*) leaves, to their animals available from the wasteland. These leaves are rich source of calcium, but its bioavailability needs to be studied as the leaves contain high level of tannins also. Interestingly, it was observed that few farmers supplemented the ration of animals with commercial mineral supplements.

**Macro and Micro-Minerals**

**Profile of Feeds and Fodder**

The survey work revealed that straws of wheat (*Triticum aestivum*), *bajra*, sorghum and local grasses amongst the dry roughages, lucerne and *bajra* amongst the green forages were being used most commonly by the farmers of this area. As concentrate supplements crushed *bajra*, wheat,

guar (*Cyamopsis tetragonoloba*) chuni and whole cottonseed or cottonseed cake were offered to the animals. The compounded cattle feed was also fed to milch animals, depending upon the level of milk production. The profile of Ca, P, Mg, Na, K, S, Co, Cu, Fe, Mn, Mo, Se and Zn in the feeds and fodder is presented in Tables 1 and 2.

The average calcium content in straws was higher (0.53%), but phosphorus was low (0.09%). Groundnut haulms (*Arachis herbaceum*)) showed exceptionally higher level of calcium (2.69%). Local grasses, including *sewan* grass contained 0.88 per cent Ca. The concentrate ingredients commonly fed to animal's contained low calcium (0.20%), but high phosphorus level (0.42%). Lucerne being leguminous family contained higher calcium, to the extent of 1.41 per cent (Table 1). *Moong* and *moth* pods were poor source of P as compared to calcium. Leaves of *ber* were rich source of calcium, but its availability to animals is doubtful, as it contains high level of tannins.

The magnesium levels as estimated in the samples of crop residues were adequate (Table 1). Groundnut haulms were rich in magnesium (1.21%). Amongst the green fodders, lucerne green (0.24%) had the highest Mg content, followed by *bajra* green (0.21%), showing that considerable quantities of Mg were available from the livestock requirement point of view. Grains of *bajra*, barley, oat and wheat were found to contain low levels of Mg (0.13%). Whole cottonseed (*Gossypium herbaceum*) and cottonseed cake were good sources of Mg (Table 1). *Sarasdan*, compounded cattle feed contained 0.64 per cent magnesium, a level that is higher than required as a supplement, because of its sufficiency in feed ingredients. Recommended concentrations for dietary magnesium are within the range of 0.2-0.4% of total DMI (Underwood and Suttle, 1999; Goff, 2000). Magnesium is considered an important factor in the occurrence of grass tetany in animals (Garcia and Williams, 2000) and is necessary for all phosphate transfer reactions (NRC, 1980). Ruminants are generally at risk from hypomagnesaemia when the forage contains less than 0.20 per cent of Mg and high in K content (Michal, 1999; Garg *et al.* 2003a).

The sodium content was unduly low in all the feeds and fodders, ranging from 0.015 to 0.15 per cent. Only lucerne contained sodium as high as 0.48 per cent. Compounded cattle feed had an appropriate quantity of sodium to the extent of 0.67 per cent, because of added sodium chloride (Table 1). Higher K content of feedstuffs may be due to its selective uptake from the soil and due to application of potassium based fertilizers to the soil. Similar findings were also reported by Singh *et al.* (2002). Potassium content in straws and stovers was higher than the concentrate feed ingredients (Table 1) and seemed to be another element like Mg, which did not require additional supplementation in the ration of animals. However, excessive levels of K may be the greatest dietary risk factor for milk fever. The levels of sodium, potassium, sulphur and chlorine in the diet play an important role in the dietary cation-anion difference (DCAD), which is responsible for incidence of clinical milk fever at the time of calving (McNeill *et al.* 2002).

The sulphur content was low in most of the crop residues (0.17%), the reason being its transfer to seed proteins. The concentrate ingredients fed to livestock in this area contained 0.24 per cent sulphur, however, lucerne and bajra green from various locations had around 0.34 per cent sulphur (Table 1). The variation in S content of plants depends largely on the amount of S in plant proteins in the form of S-containing amino acids (McDowell, 1992).

The cobalt levels in this zone ranged from 0.14 to 0.23 ppm in straws, 0.37 to 0.51 ppm in green fodders and 0.16 to 0.71 ppm in concentrate ingredients (Table 2). Sarasdan, compounded cattle feed contained 1.44 ppm Co.

Copper quantity was recorded consistently low in almost all the collected feedstuffs. Straws of bajra, sorghum and wheat contained very low level of copper (5.46 ppm). Lucerne and bajra green contained around 12.16 ppm copper (Table 2). Whole cottonseed (12.01 ppm), guar chuni (11.20 ppm) and guar korma (16.62 ppm) were better source of copper. In grains, the level was again very low (Table 2). Copper content below the critical of 8 ppm (Cuesta *et al.* 1993) was found in most of the feeds and fodder (Table 2), hence its supplementation in the ration of animals is very essential.

Distribution of iron was found to be unique

Table 1: Macro-Mineral Content in Feedstuffs Collected from Jodhpur District (DM basis)

| FEED | Ca (%) | P (%) | Mg (%) | Na (%) | K (%) | S (%) |
|---|---|---|---|---|---|---|
| Critical level[a] | <0.30 | <0.25 | <0.20 | <0.06 | <0.80 | <0.20 |
| I. Dry and Green Roughages | | | | | | |
| *Bajra* straw (18) | 0.52 ±0.03 | 0.093 ±0.014 | 0.32 ±0.02 | 0.057 ±0.011 | 2.30 ±0.15 | 0.15 ±0.005 |
| Sorghum straw (11) | 0.54 ±0.053 | 0.09 ±0.011 | 0.25 ±0.011 | 0.033 ±0.005 | 1.39 ±0.14 | 0.12 ±0.008 |
| Wheat straw (14) | 0.25 ±0.02 | 0.083 ±0.041 | 0.15 ±0.013 | 0.25 ±0.058 | 1.81 ±0.10 | 0.12 ±0.037 |
| Groundnut haulms (1) | 2.69 | 0.18 | 1.21 | 0.14 | 0.92 | 0.27 |
| Local grasses (13) | 0.62 ±0.071 | 0.13 ±0.011 | 0.37 ±0.029 | 0.13 ±0.025 | 1.63 ±0.13 | 0.18 ±0.020 |
| *Sewan* grass (2) | 1.15 ±0.19 | 0.064 ±0.004 | 0.29 ±0.016 | 0.092 ±0.001 | 1.05 ±0.069 | 0.23 ±0.0 |
| *Moong* pods (5) | 1.62 ±0.075 | 0.075 ±0.004 | 0.53 ±0.018 | 0.023 ±0.0009 | 1.59 ±0.058 | 0.10 ±0.004 |
| *Moth* pods (3) | 2.83 ±0.088 | 0.087 ±0.005 | 0.63 ±0.01 | 0.072 ±0.030 | 1.11 ±0.075 | 0.11 ±0.005 |
| *Ber* leaves (8) | 2.64 ±0.063 | 0.11 ±0.007 | 0.41 ±0.016 | 0.027 ±0.001 | 0.70 ±0.058 | 0.17 ±0.005 |
| Lucerne green (10) | 1.41 ±0.15 | 0.24 ±0.026 | 0.36 ±0.027 | 0.48 ±0.076 | 2.59 ±0.23 | 0.44 ±0.05 |
| *Bajra* green (2) | 0.66 ±0.13 | 0.21 ±0.008 | 0.46 ±0.016 | 0.15 ±0.087 | 3.35 ±0.024 | 0.25 ±0.04 |
| II. Concentrate Feed Ingredients | | | | | | |
| *Bajra* grain (8) | 0.038 ±0.006 | 0.30 ±0.013 | 0.12 ±0.003 | 0.016 ±0.001 | 0.44 ±0.01 | 0.15 ±0.01 |
| Barley grain (2) | 0.04 ±0.002 | 0.33 ±0.012 | 0.13 ±0.008 | 0.088 ±0.001 | 0.50 ±0.045 | 0.20 ±0.004 |
| Wheat grain (7) | 0.055 ±0.004 | 0.32 ±0.008 | 0.14 ±0.002 | 0.026 ±0.004 | 043 ±0.023 | 0.18 ±0.01 |
| Oat grain (2) | 0.067 ±0.009 | 0.26 ±0.004 | 0.12 ±0.004 | 0.06 ±0.0004 | 0.50 ±0.016 | 0.18 ±0.016 |
| Cotton seed, whole (11) | 0.24 ±0.03 | 0.46 ±0.02 | 0.30 ±0.008 | 0.041 ±0.006 | 1.27 ±0.029 | 0.26 ±0.013 |
| Cotton seed cake (3) | 0.34 ±0.041 | 0.50 ±0.018 | 0.44 ±0.06 | 0.074 ±0.033 | 1.18 ±0.081 | 0.21 ±0.013 |
| *Guar* chuni (6) | 0.47 ±0.038 | 0.44 ±0.035 | 0.22 ±0.013 | 0.015 ±0.0008 | 1.49 ±0.024 | 0.27 ±0.024 |
| *Guar* korma (4) | 0.40 ±0.084 | 0.74 ±0.092 | 0.36 ±0.055 | 0.020 ±0.00004 | 1.34 ±0.11 | 0.47 ±0.05 |
| Cattle feed (15) | 0.94 ±0.14 | 1.18 ±0.065 | 0.64 ±0.031 | 0.67 0.04 | 0.97 ±0.03 | 0.50 ±0.03 |

Figures in parentheses indicate no. of samples analyzed.
[a]Critical level = concentrations below which are low or considered deficient or excessive in the case of Mo (McDowell et al., 1993), based on requirements for cattle (NRC, 2001).

in the sense that it exceeded the requirement in all the feedstuffs, fed to livestock (Table 2). Even straw samples were quite rich in Fe (307 ppm). Lucerne and bajra green showed an average of 478 ppm Fe. Grains contained 81 ppm Fe, while whole cottonseed (168 ppm) and guar chuni (632 ppm) were rich in iron. Thus, Fe seems to be quite rich in this district, as also reported from other parts of the country (Mandal *et al.* 2004; Garg *et al.* 2005). The Fe concentration in majority of feed ingredients was very high and could probably interfere with the copper absorption (Bremmer *et al.* 1987; Youssef *et al.* 1999), which need to be investigated.

Most of the straws offered to animals contained around 52 ppm Mn. However, higher Mn level was found in bajra (115.4 ppm) and lucerne green (37.47 ppm). Ber leaves contained around 97 ppm Mn. Amongst the concentrate ingredients, cottonseed cake (49.73 ppm) and wheat grain (36.51 ppm) had the highest Mn content, followed by guar korma (24.45 ppm), barley grain (23.85 ppm), oat grain (22.50 ppm) and bajra grain (13.56 ppm).

The molybdenum level as estimated in the samples of crop residues was within the safe limit (Table 2). Amongst the dry fodders, moth pods (1.34 ppm) had the highest Mo content, followed by moong pods (1.19 ppm), groundnut straw (1.12 ppm) and wheat straw (0.39 ppm). Lucerne and bajra green contained 1.14 and 0.97 ppm Mo, respectively. Cottonseed cake (0.40 ppm), whole cottonseed (0.31 ppm) and guar chuni (1.65 ppm) and guar korma (4.25 ppm) contained high Mo (Table 2). Most of the feedstuffs contained Mo level within the safe limit and gave Cu:Mo ratio wider than 5.0. Molybdenum, an integral part of various enzyme systems like xanthine oxidase and aldehyde oxidase, which catalyze basic metabolic reaction in the nitrogen, sulphur and carbon cycles of body, has obtained more importance in animal nutrition, because of its inhibitory role on the other trace elements, particularly copper. Suttle (1991), stated that a Cu:Mo ratio below 2.0 would be expected to cause conditioned Cu deficiency in cattle. Mo levels

**Table 2: Trace Mineral Content in Feedstuffs Collected from Jodhpur District (DM basis)**

| FEED | Co (ppm) | Cu (ppm) | Fe (ppm) | Mn (ppm) | Mo (ppm) | Se (ppm) | Zn (ppm) | Cu:Mo |
|---|---|---|---|---|---|---|---|---|
| Critical level* | <0.10 | <8.0 | <50.0 | <40.0 | >6.0 | <0.20 | <30.0 | ... |
| I. Dry and Green Roughages | | | | | | | | |
| *Bajra* straw (18) | 0.23 ±0.019 | 5.64 ±0.22 | 269.94 ±19.13 | 59.37 ±6.43 | 0.15 ±0.048 | 0.22 ±0.016 | 15.26 ±2.36 | 37.60 |
| Sorghum straw (11) | 0.21 ±0.022 | 6.49 ±0.34 | 349.45 ±29.86 | 58.46 ±4.12 | 0.086 ±0.032 | 0.33 ±0.078 | 13.42 ±1.69 | 75.46 |
| Wheat straw (14) | 0.17 ±0.018 | 4.27 ±0.24 | 304.7 ±27.89 | 38.67 ±2.92 | 0.39 ±0.31 | 0.87 ±0.25 | 10.85 ±2.92 | 10.94 |
| Groundnut haulms(1) | 0.28 | 9.04 | 653.0 | 53.60 | 1.12 | 0.64 | 26.30 | 8.03 |
| *Moong* pods (5) | 0.14 ±0.055 | 6.55 ±0.33 | 379.20 ±101.4 | 53.56 ±5.44 | 1.19 ±0.13 | 0.38 ±0.005 | 10.50 ±0.73 | 5.50 |
| *Moth* pods (3) | 0.20 ±0.013 | 6.98 ±0.47 | 493.0 ±29.11 | 80.80 ±7.57 | 1.34 ±0.39 | 0.63 ±0.065 | 14.23 ±0.26 | 5.20 |
| Local grasses (13) | 0.41 ±0.065 | 8.01 ±0.63 | 531.0 ±37.79 | 58.31 ±5.85 | 0.62 ±0.16 | 0.57 ±0.21 | 22.97 ±2.88 | 12.90 |
| *Sewan* grass (2) | 0.15 ±0.008 | 5.99 ±0.49 | 230.0 ±43.40 | 45.20 ±0.24 | 0.38 ±0.18 | 0.40 ±0.036 | 10.12 ±1.28 | 15.76 |
| *Ber* leaves (8) | 0.27 ±0.045 | 7.13 ±0.37 | 605.12 ±63.75 | 97.13 ±8.81 | 1.95 ±0.59 | 0.46 ±0.046 | 13.31 ±0.49 | 3.65 |
| Lucerne green (10) | 0.37 ±0.10 | 12.45 ±1.10 | 515.50 ±51.36 | 37.47 ±6.39 | 1.14 ±0.32 | 2.88 ±0.78 | 25.99 ±3.09 | 10.92 |
| *Bajra* green (2) | 0.51 ±0.19 | 11.87 ±3.05 | 441.0 ±6.55 | 115.40 ±30.79 | 0.97 ±0.55 | 0.25 ±0.049 | 40.25 ±7.90 | 12.23 |
| II. Concentrate Feed Ingredients | | | | | | | | |
| *Bajra* grain (8) | 0.27 ±0.038 | 6.08 ±0.32 | 68.30 ±4.20 | 13.56 ±0.72 | 0.03 ±0.029 | 0.48 ±0.10 | 26.67 ±2.13 | 202.60 |
| Barley grain (2) | 0.71 ±0.13 | 11.60 ±0.32 | 85.65 ±6.26 | 23.85 ±1.51 | 0.061 ±0.023 | 1.16 ±0.016 | 27.24 ±1.92 | 190.16 |
| Wheat grain (7) | 0.16 ±0.027 | 8.10 ±0.75 | 83.80 ±7.81 | 36.51 ±3.22 | 0.0 ±0.0 | 0.56 ±0.17 | 29.84 ±3.24 | — |
| Oat grain (2) | 0.46 ±0.19 | 10.69 ±1.23 | 87.95 ±8.88 | 22.50 ±1.63 | 0.90 ±0.32 | 0.30 ±0.22 | 30.85 ±7.00 | 11.87 |
| Cotton seed, whole (11) | 0.26 ±0.022 | 12.01 ±1.33 | 168.81 ±21.08 | 17.48 ±0.75 | 0.31 ±0.28 | 0.71 ±0.34 | 32.01 ±1.54 | 38.70 |
| Cotton seed cake (3) | 0.53 ±0.17 | 10.77 ±1.08 | 1067.5 ±446.0 | 49.73 ±14.71 | 0.40 ±0.33 | 0.50 ±0.15 | 32.73 ±0.68 | 26.92 |
| *Guar* chuni (6) | 0.53 ±0.023 | 11.20 ±0.60 | 632.66 ±61.54 | 23.66 ±0.99 | 1.65 ±0.25 | 0.69 ±0.19 | 30.48 ±2.07 | 6.78 |
| *Guar* korma (4) | 0.39 ±0.054 | 16.62 ±2.18 | 315.75 ±60.2 | 24.45 ±1.23 | 4.25 ±1.29 | 0.32 ±0.12 | 54.42 ±5.71 | 3.91 |
| Cattle feed (15) | 1.44 ±0.12 | 22.11 ±1.52 | 867.40 ±46.09 | 117.80 ±6.41 | 0.97 ±0.18 | 1.26 ±0.48 | 102.24 ±8.94 | 22.79 |

Figures in parentheses indicate no. of samples analyzed.
*Critical level = concentrations below which are low or considered deficient or excessive in the case of Mo (McDowell et al., 1993), based on requirements for cattle (NRC, 2001).

of 5 to 6 ppm inhibit Cu storage and produce signs of molybdenosis (NRC, 1980). Even 2 ppm or less Mo can be toxic, if forage Cu is sufficiently low (Youssef *et al.* 1999). In case of ruminants, Mo reacts with sulphur in the rumen and forms mono-, di-, tri- and tetra-thiomolybdates (Suttle, 1991). Thiomolybdates can cause Cu deficiency by reacting with dietary copper in the digestive tract and making it unavailable for absorption and utilization (Nelson, 1988).

The selenium content of the crop residues varied from 0.22 to 0.87 ppm (Table 2). However, Se level was recorded 2.88 and 0.25 ppm, in green lucerne and bajra, respectively. Grains had around 0.62 ppm Se. Whole cottonseed (0.71 ppm) and guar chuni (0.69 ppm) had high Se content (Table 2). Selenium acts as an antioxidant and is essential constituent of glutathione peroxidase, which destroys peroxides before they can attack cellular lipid membranes.

The minimum dietary Se requirements of all classes of ruminant livestock ranges from 0.10 to 0.30 ppm (NRC, 1980). Accepting the minimum requirements of 0.30 ppm Se, which is the level considered adequate for preventing deficiency in dairy cattle (NRC, 2001), most of the feeds and fodders would satisfy requirement of Se. Therefore, its supplementation in the ration is not advocated.

Zinc is one element, which is found to be acutely deficient in many geographical zones of India (Ramana *et al.* 2003; Garg *et al.* 2003b; Udar *et al.* 2003). From this surveillance (Table , it was apparent that most of the feed ingredients, particularly straws, were unduly low in Zn content (13.2 ppm). The zinc content of the green fodders varied from 26 to 40 ppm (Table 2). Grains contained 28.52 ppm Zn, while guar korma was an exception with higher Zn content (54.42 ppm). Whole cottonseed, cottonseed cake and guar chuni contained around 32 ppm Zn. Zinc content was found below the critical level (30 ppm) in most of the crop residues and needed to be supplemented @ 80 ppm in the total ration (Arora, 1981) of animals, to overcome its deficiency.

**Requirement Status of Macro and Micro-Minerals for Large Ruminants**

A cow yielding 8 kg milk per day would need 41.68 g Ca, whereas, feeds and fodders available in the area when fed as per diet formulation ven in Table 3, would provide 45.19 g Ca, showing adequacy. Calcium was found deficient in the ration of animals, when green fodder was not available. Under such conditions, milk production is likely to be affected and freshly calved animals may suffer from milk fever (McDowell *et al.* 1993). The estimated value of phosphorus from feedstuffs was 19.18 g against the requirement of 26.84 g per day for a milch cow yielding 8 kg milk, showing a deficiency of 7.16 g per day (Table 3). Furthermore, bioavailabilty of P from plant sources has been reported to be low due to phytic acid-P (McDowell, 1992), leading to problems of pica, infertility and haemoglobinuria in animals (Garg *et al.* 2005).

The Mg requirement of a milch cow yielding 8 kg milk per day was 22.0 g (Table 3), whereas, feeds and fodders fed in that area provided 26.60 g of Mg per day.

Unlike K, the availability of Na from feed sources was 15.94 g against the requirement of 19.80 g per day, showing a deficiency of 3.86 g per day, for milch cow yielding 8 kg milk per day (Table 3). However, Na was found to be adequate in the diet of animals, when compounded cattle feed was fed.

The availability of S from feed sources was 18.20 g and the requirement was 22.0 g per day, showing a deficiency of 3.80 g per day, for a milch cow yielding 8 kg milk per day. Hence, sulphur supplementation was necessary in the

**Table 3: Ca, P, Mg, Na, K and S Requirements for a Milch Cow (400kg) Producing 8 kg Milk (4% fat) per day**

| Attribute | Tentative daily DMI (kg) | Ca (g) | P (g) | Mg (g) | Na (g) | K (g) | S (g) |
|---|---|---|---|---|---|---|---|
| Maintenance | 11.0 | 16.00 | 11.00 | — | — | — | — |
| Milk production | — | 25.68 | 15.84 | 22.00 | 19.8 | 99.0 | 22.00 |
| Daily requirement | 11.0 | 41.68 | 26.84 | 22.00 | 19.8 | 99.0 | 22.00 |
| Feedstuffs | | | | | | | |
| Bajra straw | 2.0 | 10.40 | 1.86 | 6.40 | 1.14 | 46.0 | 3.0 |
| Sorghum straw | 1.0 | 5.40 | 0.90 | 2.50 | 0.33 | 13.9 | 1.2 |
| Wheat straw | 4.0 | 10.0 | 3.32 | 6.00 | 10.0 | 72.4 | 4.8 |
| Lucerne green | 0.5 | 7.05 | 1.20 | 1.80 | 2.40 | 12.95 | 2.2 |
| Local grasses | 1.0 | 6.20 | 1.30 | 3.70 | 1.30 | 16.30 | 1.8 |
| Bajra grain | 0.5 | 0.19 | 1.50 | 0.60 | 0.08 | 2.20 | 0.75 |
| Whole cottonseed | 1.5 | 3.60 | 6.90 | 4.50 | 0.61 | 19.05 | 3.90 |
| Guar chuni | 0.5 | 2.35 | 2.20 | 1.10 | 0.075 | 7.45 | 1.35 |
| Total availability | 11.0 | 45.19 | 19.18 | 26.6 | 15.94 | 190.25 | 18.20 |

ration of animals (McDowell, 1992, Garg *et al.* 2003a).

Similarly, the cow yielding 8 kg milk day, would need 5.5 mg cobalt per day, as per the standard requirements, whereas, feeds and fodders available in the area when fed, provide only 2.73 mg Co, showing a deficiency of cobalt (Table 4). Copper status from traditional feeds and fodders fed to a cow, with this level of milk production, was 75.7 mg against the requirement of 110 mg per day (Table 4).

Availability of Fe from feed resources was 3495 mg and the requirement was only 550 mg per day (Table 4). Adequate Mn availability from feeds and fodder was recorded in other parts of country (Garg *et al.*, 2000; Yadav *et al.* 2002). The milch cow yielding 8 kg milk per day, require 440 mg Mn per day, whereas feed sources provided 453.8 mg (Table 4), showing adequacy of manganese.

For the milch cow with 8 kg milk per day, requirement difference for Zn was to the extent of 680.1 mg per day with the traditional feeding system (Table 4). Mastitis, night blindness, parakeratosis and reproductive failure are the ailments, which may result from its deficiency (McDowell, 1992; Singh and Pachauri, 2001). The role of Cu and Zn in augmenting production and reproduction is well documented and are known to have a significant correlation with reproductive hormones (progesterone and estradiol), as they are specific activators of enzyme systems that assist in maintaining the activity of hypophyseal hormones in blood (McDowell, 1992). Probably that is the reason that majority of the animals in this area had reproductive problems like anestrus and repeat breeding.

## CONCLUSION

It was apparent from the present study that the milch cows yielding 8 kg milk per day in various talukas of arid zone (Jodhpur district) were deficient in calcium, phosphorus, sodium, sulphur, cobalt, copper and zinc with the available feed resources in that area. Therefore, it is necessary to supplement these minerals in the diet by formulating area specific mineral mixture, having highly bioavailable mineral salts. However, the levels of some other mineral elements such as magnesium, potassium, iron, manganese and selenium were found to be adequate/excess in the diet of animals and may not be supplemented in the ration.

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Table 4: Availability and Requirement of Co, Cu, Fe, Mn and Zn for a Milch Cow (400 kg) Producing 8 kg Milk (4% fat) per day

| Feedstuffs | Tentative daily DMI (kg) | Daily intake (mg) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cobalt | Copper | Iron | Manganese | Zinc | Selenium |
| Bajra straw | 2.0 | 0.46 | 11.28 | 539.8 | 118.7 | 30.52 | 0.44 |
| Sorghum straw | 1.0 | 0.21 | 6.49 | 349.0 | 58.46 | 13.42 | 0.33 |
| Wheat straw | 4.0 | 0.68 | 17.08 | 1216 | 154.6 | 43.4 | 3.48 |
| Lucerne green | 0.5 | 0.185 | 6.22 | 257.5 | 18.73 | 12.99 | 1.44 |
| Local grasses | 1.0 | 0.41 | 8.01 | 531 | 58.31 | 22.97 | 0.57 |
| Bajra grain | 0.5 | 0.135 | 3.04 | 34.15 | 6.78 | 13.33 | 0.24 |
| Whole cottonseed | 1.5 | 0.39 | 18.01 | 252 | 26.22 | 48.01 | 1.06 |
| Guar churi | 0.5 | 0.26 | 5.60 | 316 | 11.95 | 15.24 | 0.34 |
| Daily availability | 11.0 | 2.73 | 75.74 | 3495.4 | 453.8 | 199.9 | 7.91 |
| Daily requirement | 11.0 | 5.50 | 110 | 550 | 440 | 880 | 3 |

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