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Assessment of Micro and Macro-Nutrient Status of Soil and Fodder of Udaipur District of Rajasthan, India

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A B S T R A C T

An investigation was carried out to estimate the level of selected macro and micro-nutrients in the soil and fodder of ten tehsils of Udaipur district of Rajasthan. The soil analysis indicated that moderate amount of major nutrients like Phosphorous, Potassium, Magnesium and calcium were present in these soils. This study indicated that the soils of this region were rich in micronutrients viz., Fe and Pb whereas, Mn, Cu and S contents were intermediate in quantity. On the other hand Zn was found to be deficient in these soils. The average Ca content in straws (0.45%) was higher, whereas, concentrate ingredients were particularly low in Ca (0.29 %), except sesame cake. The P content in crop residues (11 %) and green fodder (35 %) was lower in comparison to concentrate ingredients (67 %). K content in all fodder was found higher. Fe and Mg level in most of the fodder was adequate. Fodders were found to be deficient in Zn (except barseem) in comparison to concentrate ingredients and the average Mn content was deficient in most of fodders (except grass, wheat straw and Rice straw). The average Cu content was low in straws (6.61%) whereas, concentrate ingredients were better source of Cu (16.32 ppm). Co level in most of the fodder was adequate.

Introduction

Among fertilizers, macronutrients including: nitrogen (N), phosphorus (P) and potassium (K) play important role in foliar growth, root development, cell division, flowering, and seed and fruit formation (Brady, 1984). Similarly, micronutrients, such as, zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), etc. are essential for plant growth, transportation of nutrients, cell formation, uptake and retention of other minerals, transformation of compounds, metabolism and energy cycles. Deficiency in any single micronutrient may hamper plant growth and subsequently foliage yield (Cioroi and Florea, 2003; Mousavi, 2011). The deficiency or unavailability of these micronutrients are probably the result of various factors, like calcareous nature and alkaline reaction soils, introduction of high yielding varieties and heavy imbalanced application of macronutrients and low organic matter. Among the macronutrients, excessive and indiscriminate use of P-fertilizers can

affect chemical or physiological interactions in soil-plant systems. These interactions, known as phosphorus induced micronutrients disorder (Timmer and Teng, 1990) reduce solubility of micronutrients (Zn, B, Cu, Fe and Mn), which leads toward their non-availability to plants. This phosphorus induced micronutrients deficiency has been proved in various soils and crops (Wang *et al.,* 1990; Ajouri *et al.,* 2004). The health and degree of productivity of dairy cows and buffaloes are dependent on balanced and adequate quantities of all necessary nutrients to meet their requirement for a given physiological stage. The usual feed nutrients given to livestock are proteins for growth and repair of body tissues, carbohydrates and fats as sources of energy, minerals and vitamins for different metabolic functions including supporting structure of body plus water. Minerals and vitamins are the most important nutrients of lactating animals, which are required in very minute quantity, but have a great role in metabolism, milk production, and reproduction and even for microbial fermentation in the rumen. Livestock in India do not receive supplements, except for common salt and calcite/dolomite powder (Garg *et al.,* 2003b). Hence, dairy animals depend on forages for their mineral requirements. A number of researchers have reported a high incidence of forage samples below critical levels for different mineral elements, especially Cu, Zn, P (Miles and McDowell, 1983; Underwood and suttle, 1999; Garg *et al.,* 2002). On the other hand, constant efforts are being made to increase crop yield per hectare through scientific means for maximizing yields, ensuring more economic returns to the farmers. However, in the process of intensive farming practices, soils from all over the country are getting depleted for one or more mineral element resulting in imbalances of mineral elements in soil, plants and animals. The quantity of minerals, thus, present in forages may not be sufficient for optimum growth, milk yield and reproduction of animals. More than 90 percent of minerals and vitamins deficiency exists at sub-clinical level in livestock (Underwood and Suttle, 1999). Even small imbalances or deficiencies can develop into reproduction, health and milk production problems.

Materials and Methods

A survey to assess micro and macro nutrient status of the soil was conducted in ten tehsils of Udaipur district. The soil samples collected from each tehsil were dried and digested in tri acid and then volume was made to 50 ml. The nutrients viz., P, Ca, Mg, Fe, Zn, Mn, Cu, Pb and S were estimated by Atomic Absorption Spectrophotometer. Phosphorus in soil samples was estimated colorimetric by AOAC (1975). At random, one village from each of the five taluka of Udaipur district was selected for taking representative samples of feeds and fodder. Then fodder samples were dried and ground and digested in tri- acid then volume was made to 50 ml. Ca, Mg, Cu, Zinc, Mn and Fe in fodders samples were estimated by Atomic Absorption Spectrophotometer. Phosphorus in fodder samples was estimated colorimetric by AOAC (1975).

Results and Discussion

Mean nutrient status of different micro and macro nutrients in ten tehsils of Udaipur district of Rajasthan is presented in the table 1. Under Indian conditions, the mineral deficiency diseases are quite common and are mainly due to non-availability of balanced diet or deficiency of minerals in the soil and fodder. Phosphorus is the second most important major nutrient required by plants after nitrogen for proper growth and development and like nitrogen, phosphorus (P) is also an essential part of the process of photosynthesis, involved in the formation of

all oils, sugars, starches etc. Phosphorous content was found to be deficient the soils of Udaipur. The low available phosphorous content soils might be due to fixation of available phosphorous by free oxides and exchangeable aluminium. Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium. Potassium contents were highest in the soils of Kotada, while it as low in Surada. Higher potassium may be due to higher organic carbon content as well as due to addition of potassium bearing fertilizers in surface horizons. Similar results were observed by Pal and Singh (1993). The surface soils of all most all pedons except hill and valley were generally rich in potassium content which may be because of management practices followed in cultivated soils (Gaikwad *et al.,* 1974). Similar results have also been observed by Rathore (1993) and Sharma (1994). The soils of this district were deficient in Calcium. Magnesium contents were considerably medium in soils of Udaipur. These results indicate that P, K and Ca has to be supplied externally through organic or in organic fertilizers.

All the investigated micronutrients (Fe, Cu, Zn and Mn) are influenced by the soil environment (Brady, 1995). Fe level in all the soils was adequate. Average Zinc content of soils of this district was found to be deficient indicating the need to supply this mineral externally through Medium manganese content was found in this district and was highest in the soils of Mavali and Sallumber. Cu contents were found to be intermediate in all tehsils. Soil analysis indicated higher Pb content in the soils of Udaipur and was highest in Surada. This study indicated that the soils of this district were intermediate in S contents except Rishabhdeo.

These findings are in agreement with the findings of Bhanderi *et al.,* (2016) for Ca, Sharma *et al.,* (2015) for Ca, P and Mg, Panda *et al.,* (2015) for Ca and P, Devi *et al.,* (2014) for Cu Ramesh *et al.,* (2014) for Cu, and Sharma *et al.,* (2006) for Ca, P, Mg, Cu and Zn were found below the critical level.

The variation in the mineral content in different soil may be due to herbage plant species, cultivar differences, soil and climatic conditions in which plants are grown (Turner et al.1978). Higher concentration Fe, Mg Cu and Zn soils reported by Choudhary *et al.,* (2015), Panda *et al.,* (2015) and Ramesh *et al.,* (2014) in Soils of Rajasthan, Odisha and Andhra Pradesh, respectively. Bhat *et al.,* (2011) AND Yatoo *et al.,* (2011) had also reported higher concentration of Ca, P, Mg, Cu and Zn in Kashmir soils, for Cu in Kashmir. Similar reports were also reported earlier by various workers (Shukla *et al.,* 2010) and Yatoo *et al.,* (2011) had also reported higher concentration of Ca, P, Mg, Cu and Zn in Kashmir soils, for Cu in Kashmir. Similar reports were also reported earlier by various workers (Shukla *et al.,* 2010, Gowda *et al.*, 2001. al. (2015), Panda *et al.,* (2015) and Devi *et al.,* (2014). Yatoo et al.(2011) reported lower Fe and Zn in Kashmir, and P in Assam (Kalita *et al.*, 2003), which was less as compared to present investigation.

Common feed resources available for feeding of animals in Udaipur districts located in tribal belt of Rajasthan were cereal grains, cereals straws, forest tree leaves and green grasses. Mineral content of these locally available feeds and fodder resources fed to cattle, buffaloes and goats in the tribal belt are presented in table 2. The average Calcium content in straws was higher, however P content was lower in green fodders, straw, tree leaves and grasses and had wider Ca: P ratio. Soybean straw showed exceptionally higher level of calcium (2.08 %). The concentrate ingredients commonly fed to

animals contained low calcium except sesame and mustard cake, but high in phosphorus level. It has been reported that wider Ca: P ratio interferes in the utilization of these minerals in animal system. Singh et al (2006) reported that most of the feedstuffs in the arid and semiarid regions are poor in P and responsible for acute to sub acute deficiencies in animals.

The magnesium levels as estimated in the samples of crop residues were adequate, the grains of maize, barley and wheat were found to contain low levels of mg (0.14 %) and cottonseed, mustard cake and sesame cake were good sources of Mg. Earlier studies in different agro-climatic zones of Rajasthan also indicated that common feed resources of semiarid Rajasthan are adequate in Mg (Shinde *et al.,* 2006). Magnesium is considered to be an important factor in the occurrence of grass tetany in animals (Garcia and Williams, 2000) and necessary for all phosphate transfer reactions (NRC, 1980). Fe contents were reasonably higher in all the feedstuffs of the region. Similar higher Fe contents of feedstuff across the country have been reported by several workers (Ramana *et al.*, 2001, Garg *et al.*, 2005, Shinde *et al.*, 2007). It has been reported that almost all the fodders contained higher Fe than required concentration in semiarid region of rajasthan (shinde *et al.*, 2006) (Table 3 and Fig. 1–6).

Table.1 Mean nutrient status of different micro and macro nutrients in ten tehsils of Udaipur district of Rajasthan

S.N	Udaipur TEHSIL	P (kg/ha)	K(kg/ha)	Ca (cmol/kg)	Mg (cmol/kg)	Fe(ppm)	Zn(ppm)	Mn(ppm)	Cu(ppm)	pb (ppm)	S (ppm)
Critical limits		**10-25 (kg/ha)**	**140-280 (kg/ha)**	**1.5-30 (cmol/kg)**	**1-12 (cmol/kg)**	**0.5-1.0 (ppm)**	**2.5-5.8 (ppm)**	**2-4 (ppm)**	**0.2-0.5 (ppm)**	**1-2 (ppm**	**10-15 (ppm)**
1	Udaipur	8.50	208.90	17.50	6.74	2.45	0.41	4.15	0.33	2.30	10.60
2	Mavali	8.30	208.30	14.95	5.79	2.19	0.36	4.41	0.40	2.44	10.70
3	Gogunda	7.40	202.20	15.34	5.94	2.92	0.51	2.27	0.37	2.44	10.70
4	Kotada	6.90	214.40	15.64	6.82	3.01	0.38	3.18	0.18	2.81	13.00
5	Kerwada	7.70	208.30	13.89	8.39	1.85	0.34	1.97	0.15	3.25	11.50
6	Jhadol	11.90	207.00	13.69	7.66	2.07	0.41	4.20	0.44	3.43	11.90
7	Lashadi	8.90	212.40	11.81	7.14	2.10	0.26	3.86	0.44	3.81	10.00
8	Surada	10.50	201.30	13.86	4.58	2.28	0.24	3.79	0.46	3.97	10.40
9	Rishabhdeo	8.70	201.90	16.27	9.52	2.25	0.42	3.37	0.44	3.95	9.90
10	Sallumber	7.80	208.40	14.54	10.44	2.29	0.52	4.41	0.35	3.93	12.20

Table.2 Mean nutrient status of different micro and macro nutrients in fodders of Udaipur district of Rajasthan

Element	P%	K%	Ca%	Mg%	Mn(ppm)	Zn(ppm)	Fe(ppm)	Cu(ppm)	Co(ppm)
Critical limit	<0.25	<0.80	<0.30	<0.20	<40 ppm	<30 ppm	< 50 ppm	<8 ppm	<0.10
Grass	0.09	1.13	0.47	0.23	43.02	26.80	266.83	6.48	0.14
Wheat straw	0.06	1.69	0.48	0.26	41.42	11.46	312.83	6.02	0.21
Maize straw	0.19	1.69	0.41	0.25	37.07	24.82	234.67	6.72	0.08
Barseem straw	0.09	1.33	0.89	0.40	34.13	18.11	465.25	6.87	0.29
Soyabean straw	0.35	2.52	2.08	0.43	47.06	36.40	554.80	6.92	0.25
Sorghum straw	0.16	1.66	0.37	0.28	31.71	25.36	183.20	6.63	0.084
AVG.	**0.19**	**1.67**	**0.78**	**0.31**	**39.07**	**23.82**	**336.26**	**6.61**	**0.176**

Table.3 Mean nutrient status of different micro and macro nutrients in concentrate feed of Udaipur district of Rajasthan

SN	Fodder	P (%)	K (%)	Ca (%)	Mg (%)	Mn (ppm)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Co (ppm)
1	Maize seed	0.32	0.39	0.021	0.14	10.12	25.21	90.12	6.12	0.33
2	Wheat grain	0.37	0.42	0.08	0.15	36.97	35.12	114.25	9.01	0.30
3	Guar churi	0.59	1.42	0.20	0.28	16.42	58.21	490.87	16.45	0.62
4	Barley grain	0.59	1.42	0.22	0.29	23.78	31.12	130.12	12.64	0.60
5	Mustard cake	1.21	1.51	0.89	0.45	72.12	82.14	701.12	17.45	0.35
6	Sesame cake	1.10	1.21	2.71	0.61	42.12	114.27	950.12	38.12	0.60
7	Cotton seed	0.52	1.44	0.33	0.33	28.02	38.01	440.32	14.45	0.35
	AVG.	0.67	1.12	0.64	0.33	32.79	54.87	416.70	16.32	0.45

Fig. 1

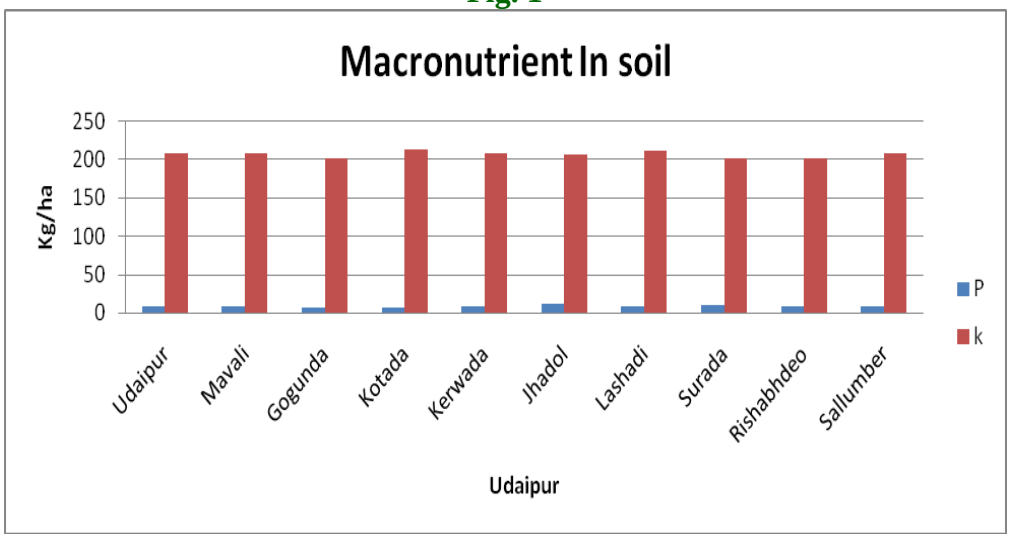


Fig. 2

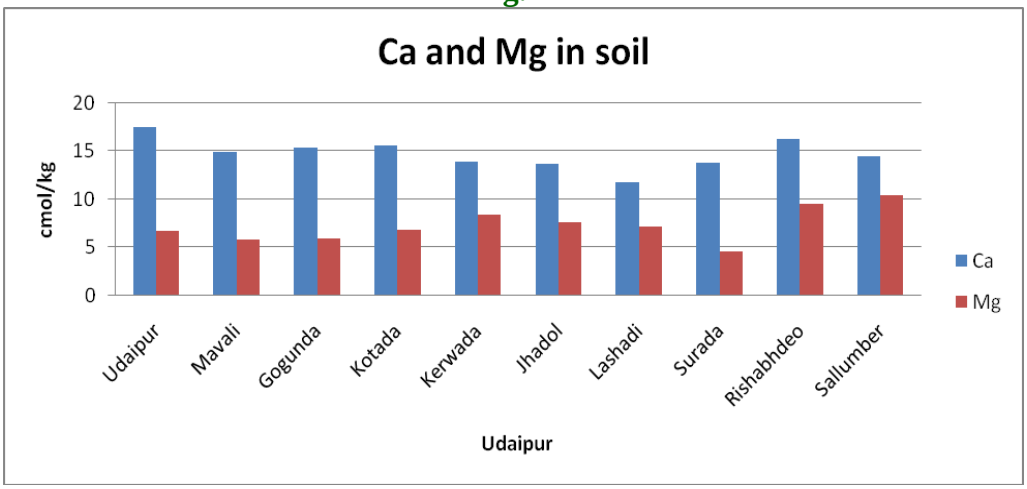


Fig. 3

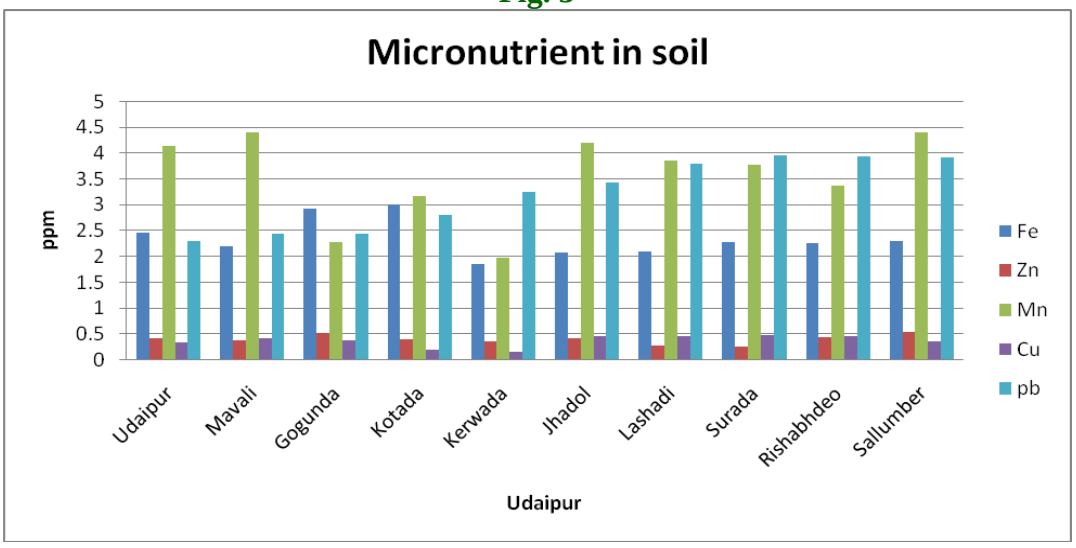


Fig. 4

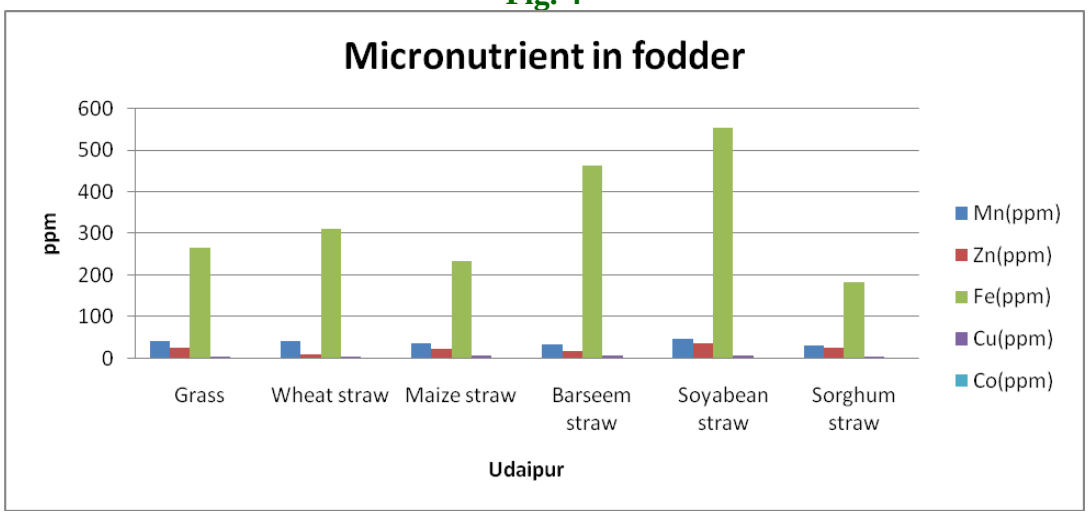


Fig. 5

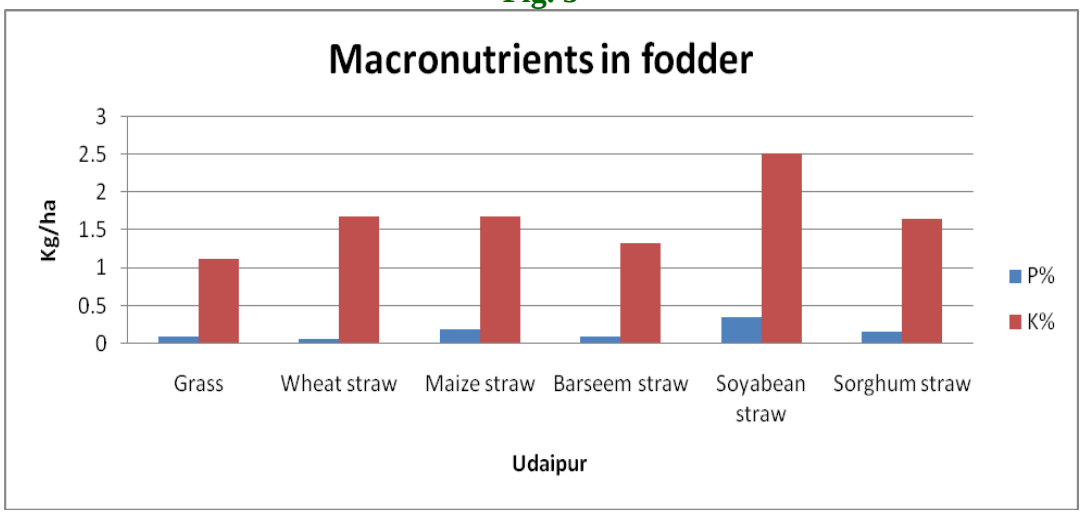
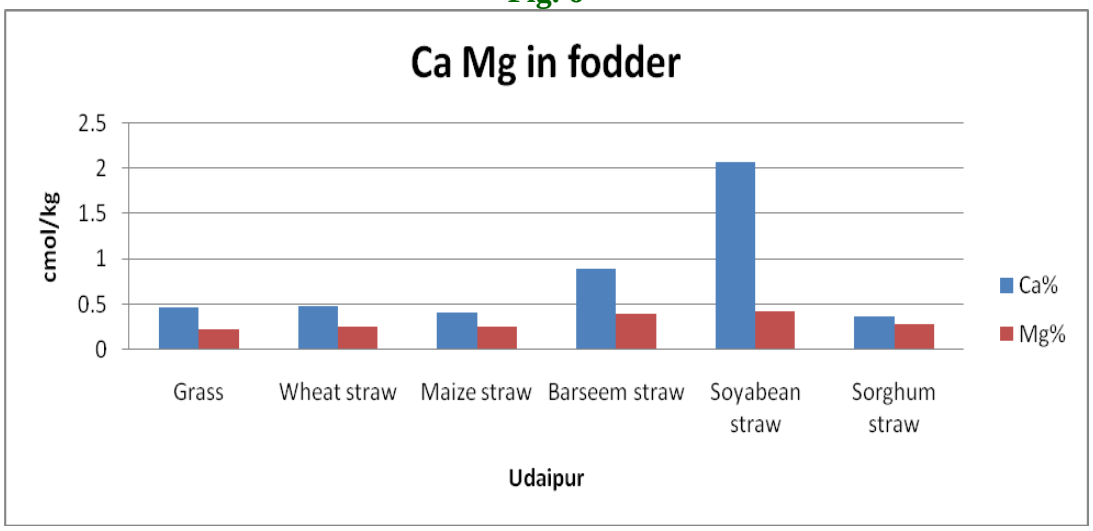


Fig. 6



The probable explanation could be contamination of feeds with soil or inert and insoluble iron dust of machinery origin while harvesting in field to processing in mills and other extraction plants. It has been reported that higher content of Fe in the feed interfered the copper absorption and metabolism in animals (Youssef *et al.*, 1999). Zinc was deficient in all fodders except maize and sorghum straw. Grains had around 31 ppm Zn, while mustard and sesame cakes were an exception with higher Zn content (98 ppm). 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. Zinc deficiency in fodder of many agro-climatic zones of the country has been reported (Ramana *et al.*, 2001, Garg *et al.*, 2003 and udar *et al.*, 2003). Mn content in fodder was inadequate except Grass, wheat straw and Soyabean. Amongst the concentrate ingredients, mustard cake (72.12 ppm) had the highest Mn content, followed by sesame cake (42.12 ppm), wheat grain (36.97 ppm), cottonseed (28.02 ppm) and barley grain (23.78 ppm). Copper quantity was recorded low especially in dry roughages. Straw of rice sorghum, maize, soybean and wheat contained very low level of copper and concentrate ingredients were better source of copper. The cobalt levels in this zone ranged from 0.081 to 0.29 in straws and high ranged in concentrate ingredients. A buffalo, yielding 8 kg milk daily would need 6.0 mg cobalt per day, as per the standard requirements, whereas, feeds and fodders available in the area when fed, provide 3.29 mg, showing a deficiency of cobalt (Garg *et al.*, 2003).

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