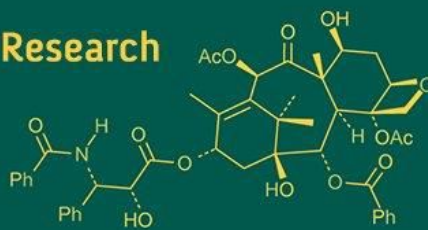


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(4): 218-221
www.biochemjournal.com
Received: 19-02-2026
Accepted: 22-03-2026

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Mineral composition of green fodder in the paddy-wheat growing zone of Haryana

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i4c.8095>

Abstract

Minerals are essential nutrients required for the maintenance, growth, reproduction, and lactation of dairy animals. The present study assessed the mineral composition of commonly available green fodders—sorghum, maize, bajra, sugarcane tops, and grasses—in eight districts of the paddy-wheat growing zone of Haryana, India. Feed samples were collected, dried, and analyzed for calcium (Ca), phosphorus (P), zinc (Zn), copper (Cu), iron (Fe), and manganese (Mn). Sorghum and sugarcane tops provided adequate Ca and P, whereas trace minerals Zn, Cu, and Mn were deficient in bajra and grasses. The results highlight the need for strategic mineral supplementation to improve livestock health and productivity in this agro-climatic zone.

Keywords: Green fodder, mineral composition, cattle, buffalo, Haryana, India

Introduction

Livestock plays a crucial role in rural livelihoods, contributing significantly to milk production, household income, and agricultural sustainability in India (Ramsawroop, 2019) [13]. In Haryana, the paddy-wheat growing zone supports 0.74 million cattle and 1.33 million buffaloes, representing 38.65% and 30.47% of the state's population, respectively. Proper mineral nutrition is vital for maximizing genetic potential and sustaining milk yield, reproduction, and overall health (Maan, 2000; Sherasia *et al.*, 2016) [9, 14].

Minerals are classified into macrominerals, required in higher quantities (Ca, P, Mg, Na, K, Cl), and microminerals or trace minerals, required in smaller amounts (Zn, Cu, Mn, Fe, Co, I, Se, Mo) (Underwood, 1981) [17]. Macrominerals are structural components of bones, teeth, and soft tissues, while microminerals act as enzyme cofactors, antioxidants, and regulators of physiological processes. Deficiencies or imbalances in these minerals reduce milk production, impair reproductive efficiency, and increase susceptibility to diseases (Bhandari, 2007; Garg *et al.*, 2011) [2, 7].

The mineral content of fodder is largely influenced by soil mineral status, crop species, and agronomic practices. In the paddy-wheat growing zone, soils are subjected to high cropping intensity, fertilizer use, and environmental stresses, leading to variable mineral availability in forages (Shukla *et al.*, 2014) [15]. Understanding the mineral composition of locally available green fodder is essential to develop supplementation strategies that meet the nutritional requirements of lactating cattle and buffaloes.

Material and Methods

The study was conducted across eight districts: Ambala, Panchkula, Yamunanagar, Kurukshetra, Kaithal, Panipat, Karnal, and Sonapat. Representative samples of sorghum, maize, bajra, sugarcane tops, and grasses were collected from multiple farms in each district. All blocks in these districts were covered to ensure a representative sample. Feed samples were dried at 100±5 °C for 24 hours and ground. Proximate analysis was conducted using AOAC (2007) methods. Mineral content was determined as follows:

- Calcium (Ca) by Arsenazo III method (McLeans and Hastings, 1935) [11]
- Phosphorus (P) by UV-phosphomolybdate method (Daly and Ertingshausen, 1972) [4]
- Zn, Cu, Fe, Mn using standard digestion and atomic absorption techniques

Data were expressed as mean $\pm$ standard error. Correlations between mineral content in feed and biological samples from animals were calculated using standard statistical methods (Snedecor & Cochran, 1994) [16].

Results

Home grown sorghum was the major green roughage being fed by farmers in almost all the districts of the zone under investigation. Mineral composition of sorghum in different districts of the zone is given in Table 1. The Ca content in sorghum ranged from 0.37 to 0.60% and had an average value of 0.47%. Among districts, the mean Ca concentration ranged from 0.43% in Sonipat district to 0.53% in Karnal district. The concentration of P in sorghum ranged from 0.29% to 0.52%. Among districts, the mean P content ranged from 0.38% in Karnal to 0.42% in Ambala, Kaithal and Panipat. The Ca and P concentrations are more than their critical level in all the districts i.e., 0.30% and 0.25%, respectively.

The mean value of Zn concentration in sorghum of the zone

was 23.08 ppm. Concentrations of Zn, considering the whole data, ranged from 16.06 to 31.05 ppm. The mean Zn concentration was lowest in Sonipat (19.62 ppm) while highest in Ambala district (25.38 ppm). Zn was highly deficient in all the samples of the zone as its level was below critical level i.e., 30 ppm. The Concentration of Cu, considering the whole data, ranged from 23.10 to 42.00 ppm. Thus, sorghum fodder had adequate Cu content. Mean Cu content was lowest in Yamunanagar district while highest in Ambala district although none of the district had mean Cu level below critical Cu level i.e., 8 ppm. The average Fe content of the zone was 159.58 ppm and ranged from 140.08-178.94 ppm. None of the samples were deficient in the zone from its critical level (50 ppm). The concentration of Mn in sorghum ranged from 35.01 to 60.99 ppm and had an average value of 48.98 ppm. Among the districts, the mean Mn concentration ranged from 42.26 in Kaithal to 51.21 ppm in Panipat district. A few samples were below critical value (40 ppm). Otherwise, as a whole data, sorghum had good Mn content.

Table 1: Mineral Composition of sorghum fodder in different districts of paddy-wheat growing zone

	N	Ca(%)	P(%)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Mn(ppm)
Ambala	49	0.52 $\pm$ 0.01	0.42 $\pm$ 0.01	25.38 $\pm$ 0.30	36.60 $\pm$ 0.48	159.36 $\pm$ 1.57	49.63 $\pm$ 0.82
Karnal	69	0.53 $\pm$ 0.01	0.38 $\pm$ 0.01	24.28 $\pm$ 0.26	30.42 $\pm$ 0.45	159.63 $\pm$ 1.38	50.24 $\pm$ 0.72
Kaithal	60	0.50 $\pm$ 0.01	0.42 $\pm$ 0.01	20.71 $\pm$ 0.26	35.84 $\pm$ 0.46	159.24 $\pm$ 1.43	42.26 $\pm$ 0.88
Yamunanagar	57	0.44 $\pm$ 0.01	0.41 $\pm$ 0.01	23.16 $\pm$ 0.25	29.32 $\pm$ 0.50	160.67 $\pm$ 1.38	50.37 $\pm$ 0.83
Sonipat	66	0.43 $\pm$ 0.01	0.39 $\pm$ 0.02	19.62 $\pm$ 0.27	32.31 $\pm$ 0.39	158.67 $\pm$ 1.48	47.94 $\pm$ 0.74
Panipat	54	0.45 $\pm$ 0.01	0.42 $\pm$ 0.01	22.58 $\pm$ 0.47	31.20 $\pm$ 0.57	159.12 $\pm$ 1.59	51.21 $\pm$ 0.82
Kurukshetra	55	0.46 $\pm$ 0.01	0.41 $\pm$ 0.01	24.16 $\pm$ 0.25	33.64 $\pm$ 0.48	159.89 $\pm$ 1.64	49.89 $\pm$ 0.77
Panchkula	21	0.46 $\pm$ 0.01	0.40 $\pm$ 0.02	24.80 $\pm$ 0.51	36.23 $\pm$ 0.75	161.49 $\pm$ 2.26	50.31 $\pm$ 1.71
Mean	431	0.47 $\pm$ 0.00	0.40 $\pm$ 0.00	23.08 $\pm$ 0.14	33.19 $\pm$ 0.20	159.58 $\pm$ 0.55	48.98 $\pm$ 0.30
Range		0.37-0.60	0.29-0.52	16.06-31.05	23.10-42.00	140.08-178.94	35.01-60.99
Critical level*		<0.30	<0.25	<30.0	<8.0	<50.0	<40.0

$\pm$ Standard error of mean *As per McDowell (1993) [10]

Farmers of the zone were also using maize fodder and bajra fodder as source of green. Mineral composition of maize fodder and bajra fodder has been depicted in Table 2 and Table 3, respectively. The Ca content in maize fodder ranged from 0.35% to 0.49% while in case of bajra fodder it was 0.19% to 0.36%. maize fodder had an average Ca value of 0.43% and it was 0.32% in case of bajra fodder. Thus, maize fodder and bajra fodder had adequate Ca and mean Ca was above critical level i.e., 0.30%. The concentration of P (%) in maize fodder ranged from 0.12% to 0.20% and had an average value of 0.16% while in case of bajra fodder it ranged from 0.06 to 0.23 and had an average value of 0.12%. Here maize fodder and bajra fodder both were

providing less of P than critical level i.e., 0.25%. The average values of Zn concentration in maize fodder and bajra fodder were 23.08 and 26.84 ppm which shows that both the sources were providing lower content of Zn than critical level i.e., 30 ppm for Zn. The average values of Cu concentration in maize fodder and bajra fodder were 10.32 and 2.99 ppm respectively. Considering 8ppm as critical limit, all the samples of maize fodder and bajra were deficient in Cu in the zone. The average values of Fe concentration in maize fodder and bajra fodder were 240.88 and 124.38 ppm respectively. Considering 50 ppm as critical limit, none of the samples were deficient in the zone.

Table 2: Mineral Composition of maize fodder in different districts of paddy-wheat growing zone

	N	Ca(%)	P(%)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Mn(ppm)
Ambala	28	0.43 $\pm$ 0.01	0.15 $\pm$ 0.01	0.19 $\pm$ 0.01	10.90 $\pm$ 0.47	237.44 $\pm$ 4.44	53.82 $\pm$ 0.64
Karnal	26	0.44 $\pm$ 0.01	0.17 $\pm$ 0.01	0.18 $\pm$ 0.01	09.26 $\pm$ 0.40	241.67 $\pm$ 4.56	52.95 $\pm$ 0.63
Kaithal	22	0.43 $\pm$ 0.01	0.16 $\pm$ 0.01	0.16 $\pm$ 0.01	10.51 $\pm$ 0.46	243.04 $\pm$ 4.80	48.13 $\pm$ 0.69
Yamunanagar	33	0.42 $\pm$ 0.01	0.16 $\pm$ 0.00	0.17 $\pm$ 0.00	09.84 $\pm$ 0.35	239.82 $\pm$ 3.98	54.22 $\pm$ 0.53
Sonipat	10	0.45 $\pm$ 0.01	0.16 $\pm$ 0.01	0.16 $\pm$ 0.01	10.75 $\pm$ 0.90	235.84 $\pm$ 6.32	49.79 $\pm$ 0.72
Panipat	13	0.43 $\pm$ 0.01	0.17 $\pm$ 0.01	0.17 $\pm$ 0.01	09.92 $\pm$ 0.71	244.43 $\pm$ 4.11	52.72 $\pm$ 0.90
Kurukshetra	25	0.42 $\pm$ 0.01	0.16 $\pm$ 0.00	0.18 $\pm$ 0.00	10.38 $\pm$ 0.44	239.48 $\pm$ 4.73	52.71 $\pm$ 0.64
Panchkula	13	0.43 $\pm$ 0.01	0.16 $\pm$ 0.01	0.16 $\pm$ 0.01	11.01 $\pm$ 0.43	248.75 $\pm$ 5.06	51.49 $\pm$ 0.80
Mean	170	0.43 $\pm$ 0.00	0.16 $\pm$ 0.00	0.17 $\pm$ 0.00	10.32 $\pm$ 0.17	240.88 $\pm$ 1.68	51.97 $\pm$ 0.24
Range		0.35-0.49	0.12-0.2	31.03-41.92	7.02-15	204.03-277.23	48.1-58.79
Critical level*		<0.30	<0.25	<30.0	<8.0	<50.0	<40.0

Table 3: Mineral Composition of bajra fodder in different districts of paddy-wheat growing zone

	N	Ca(%)	P(%)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Mn(ppm)
Kaithal	10	0.29±0.02	0.19±0.08	25.44±1.02	2.66±0.40	115.76±5.26	35.79±0.74
Sonipat	26	0.34±0.01	0.10±0.01	26.16±0.68	3.05±0.22	129.00±4.04	35.38±0.77
Panipat	8	0.34±0.01	0.10±0.01	28.92±1.63	3.25±0.43	120.14±7.17	38.30±1.12
Mean	44	0.32±0.01	0.12±0.02	26.84±0.54	2.99±0.18	124.38±3.04	36.12±0.55
Range		0.19-0.36	0.06-0.9	21.45-31.9	1.05-4.84	91.51-162.71	28.26-41.96
Critical level*		<0.30	<0.25	<30.0	<8.0	<50.0	<40.0

The average values of Mn concentration in maize fodder and bajra fodder were 51.97 and 36.12 ppm respectively. Considering 40 ppm as critical limit maize fodder was a good source of Mn and none of samples of the maize fodder was below critical level of Mn but in case of bajra fodder majority of samples (95%) were deficit in terms of Mn.

Farmers of the zone were also using sugarcane tops and grasses as source of green where cultivated fodder was not available in abundance. Mineral composition of sugarcane tops and grasses has been depicted in Table 4 and Table 5 respectively. The Ca content in sugarcane tops ranged from 0.61% to 0.79% while in case of grasses it was 0.57% to 0.81%. sugarcane tops and grasses both had average Ca value 0.70%. Thus, sugarcane tops and grasses had adequate Ca and mean Ca was above critical level i.e., 0.30%

The concentration of P (%) in sugarcane tops ranged from 0.25% to 0.41% and had an average value of 0.33% while in case of grasses it ranged from 0.11 to 0.29 and had an

average value of 0.20%. Here sugarcane tops provided sufficient P while grasses were providing less of P than critical level i.e., 0.25%. The average values of Zn concentration in sugarcane tops and grasses were 23.97 and 19.17 ppm which shows that both the sources were providing lower content of Zn than critical level i.e. 30 ppm for Zn. The average values of Cu concentration in sugarcane tops and grasses were 15.32 and 5.70 ppm respectively. Considering 8 ppm as critical limit, almost all the samples of sugarcane tops and grasses were deficient in Cu in the zone. The average values of Fe concentration in sugarcane tops and grasses were 183.93 and 124.38 ppm respectively. Considering 50 ppm as critical limit, none of the samples were deficient in the zone. The average values of Mn concentration in sugarcane tops and grasses were 45.94 and 37.80 ppm respectively. Considering 40 ppm as critical limit sugarcane tops was an average source of Mn but grasses were deficit in Mn concentration.

Table 4: Mineral composition of sugarcane tops in different districts of paddy-wheat growing zone

	N	Ca (%)	P(%)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Mn(ppm)
Ambala	15	0.72±0.01	0.32±0.01	23.04±0.43	16.33±0.38	182.00±3.73	46.56±1.02
Karnal	15	0.69±0.01	0.33±0.01	24.40±0.47	14.31±0.35	186.69±3.68	48.98±1.05
Kaithal	10	0.67±0.01	0.33±0.01	23.03±0.70	15.98±0.59	184.02±6.33	43.47±1.64
Yamunanagar	22	0.66±0.01	0.34±0.01	23.19±0.52	13.74±0.31	184.20±3.98	47.24±1.18
Panipat	5	0.73±0.02	0.33±0.03	24.80±0.84	14.72±0.64	188.76±6.16	43.42±3.45
Kurukshetra	13	0.70±0.01	0.33±0.01	25.39±0.43	16.84±0.35	181.62±3.46	46.00±0.99
Mean	80	0.70±0.00	0.33±0.00	23.97±0.22	15.32±0.16	183.93±1.71	45.94±0.51
Range		0.61-0.79	0.25-0.41	20.9-28.42	13.49-19.12	158.52-210.09	36.53-55.03
Critical level*		<0.30	<0.25	<30.0	<8.0	<50.0	<40.0

±Standard error of mean *As per McDowell (1993) ^[10]

Table 5: Mineral composition of grasses/weeds in different districts of paddy-wheat growing zone

	N	Ca (%)	P(%)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Mn(ppm)
Ambala	16	0.76±0.00	0.21±0.00	15.21±0.00	6.81±0.00	139.04±0.00	29.70±0.00
Karnal	27	0.70±0.01	0.21±0.01	18.84±0.87	5.66±0.27	166.59±9.20	37.61±1.31
Kaithal	23	0.69±0.02	0.19±0.01	18.71±0.84	5.68±0.32	173.61±10.60	38.44±1.48
Yamunanagar	10	0.75±0.00	0.20±0.00	23.12±0.00	7.98±0.00	92.65±0.00	44.49±0.00
Sonipat	26	0.71±0.01	0.19±0.01	19.06±0.80	5.39±0.29	189.87±8.10	38.37±1.18
Panipat	19	0.68±0.02	0.21±0.02	19.87±1.04	5.43±0.40	185.61±10.24	36.31±1.55
Kurukshetra	17	0.71±0.02	0.20±0.01	20.09±0.94	5.93±0.43	152.90±10.10	37.56±1.55
Panchkula	20	0.70±0.02	0.22±0.01	18.81±0.94	6.06±0.38	175.85±9.24	38.32±1.39
Mean	158	0.70±0.01	0.20±0.00	19.17±0.36	5.70±0.14	173.78±3.98	37.80±0.56
Range		0.57-0.81	0.11-0.29	12.24-26.17	3.18-8.27	91.35-249.41	26.22-48.69
Critical level*		<0.30	<0.25	<30.0	<8.0	<50.0	<40.0

±Standard error of mean *As per McDowell (1993) ^[10]

The mean Ca and P content of sorghum fodder were 0.47% and 0.40% respectively.

The mean Cu content of sorghum fodder was 33.19 ppm which is adequate in terms of daily dietary requirement. Lall *et al.*, (1994) ^[8] reported that Cu content was quite high in sorghum (10-16 mg/kg) compared to the requirement of this element in diet is 10 mg/kg. Bhandari *et al.*, (2013) ^[3] while surveying the Sabarkantha District of Gujarat reported that green roughages were good source of copper (12.31 ppm).

Garg *et al.*, (2008) ^[6] reported that the average value of Cu in green fodders is 9.68 ppm in Bharatpur district of Rajasthan. The values under the present investigation are also in the higher range as reported earlier.

In the present study, Zn level of Sorghum was 23.08 ppm. Dhore *et al.*, (2007) ^[5] reported that the average value of Zn in feed and fodders was less than 25.06 ppm in Western Agro Climatic Zone of Vidarbha. Garg *et al.*, (2008) ^[6] reported that the Zinc was acutely deficient in most of the

feedstuffs (average level < 26.30 ppm) in Bharatpur district of Rajasthan.

According to Lall *et al.*, (1994) ^[8], the Fe content in sorghum was about 200 mg/kg in Hisar district. Garg *et al.*, (2011) ^[6] while surveying the Amritsar, Ludhiana and Patiala districts of Punjab reported that the average Fe content was very high in green roughages (>500 ppm). The values under the present investigation are also in the higher range as reported earlier.

It was found that green fodder (maize, bajra, grasses and sugarcane tops) in the paddy-wheat growing zone were deficient in P, Zn, Cu and Mn content.

Garg *et al.*, (2008) ^[6] reported that the manganese contents were adequate in the diet of animals, with traditional feeding system in Bharatpur district. The values under the present investigation are also in line with the ranges reported earlier.

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