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Haemato-biochemical and mineral status of crossbred cattle from various agro-climatic zones of North-West Himalayan region of Jammu division

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ABSTRACT

A baseline survey was conducted to know the status of haemato-biochemical and mineral parameters in crossbred cattle from 3 different agro-climatic zones of Jammu division. Blood samples (301) from cattle of various age groups were collected and analyzed. The average values of Hb, PCV, glucose, TPP, albumin, PUN, Ca, Pi, Mg, Na, K, Fe, Cu and Zn were 8.60 g/dl, 28.82%, 63.97 mg/dl, 6.78 g/dl, 3.16 g/dl, 9.45 mg/dl, 8.64 mg/dl, 4.88 mg/dl, 2.35 mg/dl, 145.63 mEq/I and 4.48 mEq/I, 65.40 µmol/l, 10.89 µmol/l and 31.25 µmol/l, respectively. Based on Hb and PCV level, anaemia was recorded in 28.12 and 18.75% animals, respectively. Overall the plasma analysis revealed deficiency of Ca, Pi, Mg, Na, K, Cu, Zn, Fe among 41.49, 34.27, 3.50, 25.84, 22.09, 48.72, 4.83 and 4.40% cattle population, respectively. Thus, study concludes that area specific mineral mixtures need to be framed and supplemented for enhancing the productive and reproductive potential of crossbred cattle.

Key words: Calcium, Copper, Crossbred cattle, Magnesium, Phosphorous, Potassium, Sodium, Zinc

Crossbreeding programme of cattle was successfully undertaken in the North-West Himalayan state of Jammu and Kashmir, however, genetic potential could not be exploited vis-a-vis productivity. Livestock reared in these areas are generally fed variable quantity of low quality feed resources which are characteristically low in fermentable nitrogen, mineral, and readily available carbohydrate. These deficiencies result in low animal growth, poor reproduction, long calving interval, and unthrifty condition. Therefore, a baseline survey to establish regional values could help in realistic evaluation of management practice, nutrition and diagnosis of health conditions. With this view in mind, a baseline survey was conducted to assess haemato-biochemical and mineral status of crossbred cattle from all districts of Jammu division.

MATERIALS AND METHODS

A baseline survey was conducted among crossbred cattle reared under various management system under different agro-climatic zones of Jammu division involving 6 districts i.e., Jammu and Kathua (sub-tropical zone), Udhampur (intermediate zone), Rajouri, Poonch and Doda (temperate zone) having mean height 300–4,000 m above MSL. Blood samples (301) from crossbred cattle of 60 villages covering 23 blocks and 257 households were collected. Based on age, animals were categorized into group-A, B and C comprising <3, 3–6 and >6 years age, respectively.

Sample collection: Blood samples were collected in disodium EDTA for determining Hb and PCV. A small quantity of blood was also collected in sodium fluoride for glucose estimation. For biochemical and mineral estimations, blood samples were collected in heparinized mineral free glass vials.

Plasma analysis: Total plasma proteins (TPP), glucose, albumin, plasma urea nitrogen (PUN employing urease method) and Ca were analysed using kits. Estimation of Mg (kit), Pi (Taussky and Shorr 1953), Na and K (flame photometer) was carried out. Each plasma sample (3 ml) was analysed for trace mineral analysis by digesting in distilled concentrated nitric acid AR (15 ml) and perchloric acid, Merck (3 ml) followed by one cycle of hydrogen peroxide AR (3.0 ml of 30%). The concentrations of micro-elements, viz. Cu, Fe and Zn were measured by atomic absorption spectrophotometer. Data were analyzed as a randomized complete block (run) design using SAS.

RESULTS AND DISCUSSION

Overall mean values of haematological indices Hb and PCV among crossbred cattle were within the normal range of 8.0–15.0 g/dl and 24–46%, respectively, as quoted by Feldman *et al.* (2000) (Table 1). As per the available literature, wide variations exist in normal values of these parameters which could mainly be due to physiological factors such as water balance, season, ambient temperature,

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muscular activity, altitude, quality of diet, animal excitement and time of sampling (Feldman *et al.* 2000), state of hydration, age, emotional state, lactation, form of restraint, parasitic burden and breed difference. Udhampur district animals showed higher level of Hb followed by Jammu, Rajouri, Doda, Kathua and Poonch districts. Whereas, PCV values for the animals from Doda district were higher followed by Rajouri, Jammu, Udhampur, Poonch and Kathua district. The highest prevalence of anaemia based on Hb and PCV was observed among cattle from Kathua district followed by Poonch, Doda, Rajouri, Jammu and Udhampur (Table 1). Age-wise, 3–6 years animal group had higher levels of Hb and PCV compared with group A and group C. The discrepancy between the prevalence of anaemia on Hb and PCV could be due to altered erythrocytic indices (MCV, MCHC). Feldman *et al.* (2000) commented that among various indices, PCV is a quick but not very reliable under the situation when erythrocyte morphology is altered. The reason attributed to this widely prevalent anaemia could be poor availability of minerals, proteins and energy from rations.

To assess the status of dietary energy and protein (Radostits *et al.* 2000), plasma biochemical profile was assessed. Mean glucose concentration in cattle was was within the normal range quoted by Kaneko *et al.* (1999). The highest level of glucose was observed in Doda followed by Rajouri, Poonch, Jammu, Kathua and Udhampur districts. Overall, 20.48% animals were deficient in energy (Table 1). Group C animals were having higher prevalence of hypoglycermia with least among Group A.

Average TPP and albumin levels of crossbred cattle were within normal range of 5.7–8.1 g/dl and 2.1–3.6 g/dl as quoted by Radostits *et al.* (2000). Considering the critical limit of 5.7 g/dl, 32.25% animals were having hypoproteinemia with higher prevalence rate of 58.33, 54.35 and 48.38% among animal from Kathua, Jammu and Udhampur districts, respectively (Table 1). The cattle from subtropical and intermediate zones were having significantly lower levels of protein compared with temperate areas of Poonch, Rajouri and Doda districts. Age-wise non-significant rise in level of plasma protein was observed. Kaneko *et al*. (1999) reported that with advancing age, the plasma proteins levels increase due to a small decrease in albumin and a progressive increase in globulins. Higher prevalence of hypoproteinemia among younger group animals (group A, B) was recorded. The higher levels of albumin were observed among cattle from Kathua, Rajouri, Doda, Jammu, Poonch with lowest among Udhampur district. Age related non-significant rise in the level of globulins was observed. Mean PUN level was within normal range of 6–27 mg/dl (Radostits *et al.* 2000). The highest levels of PUN was observed in Udhampur followed by Doda, Jammu, Poonch, Rajouri and Kathua districts and group C followed by group A and group B. Overall, 32.46% animals were having low levels of PUN thus indicating the protein deficiency is widely prevalent among cattle.

Calcium: Mean plasma Ca level was within normal range of 9.7–12.4 mg/dl (Radostits *et al.* 2000). Singh *et al.* (2005) reported similar range of Ca in plasma/serum of cattle from Punjab. Animals from Doda, Rajouri and Poonch districts had significantly ($P<0.05$) higher levels of Ca than Jammu, Kathua and Udhampur districts. This could be due to difference in agro climatic zones as soils of hilly areas are generally rich in Ca. The differences observed could be due to variation in dietary level, physiological state, age, season of sampling, analytical technique etc. Age-wise, non-significant variation was recorded although group-A showed higher levels. Chhabra (2006) also recorded that plasma Ca level were independent of age. The overall prevalence of hypocalcaemia was 41.49% and district-wise it is given in Table 1. Various workers have reported varying percentage prevalence of hypocalcemia in crossbred cattle from other parts of country (Singh *et al.* 2005, Siddique 2011, Ozukum 2011). Our results revealed that occult hypocalcaemia is widely prevalent and therefore, extra supplementation of Ca needs to be done in all the age groups. Health records also indicate that subclinical hypocalcaemia could also be the reason for widespread prevalence of debility, generalized weakness and retention of placenta.

Phosphorus: The average value of inorganic phosphorous (Pi) was 4.88 mg/dl (range 3.88–5.59 mg/dl) below normal range of 5.6-6.5 mg/dl quoted by Radostits *et al.* (2000). Singh *et al.* (2005) and Siddique (2011) reported significantly higher level of Pi in crossbred cows from Punjab. Differences observed in the level of Pi in various studies could be due to difference in their diet level, breed, season and certain factors like sample preparation as haemolysis, temperature, duration of sample collection and plasma preparation time (McDowell 2003). Age related fall in the level of Pi was observed (Table l). The decline in plasma Pi beyond 6 years of age in animals could be due to lactational loss, higher salt determining solubility of osteocalcium phosphate content of young bone than that of hydroxyl apatite of adult bone and also because of declining gastrointestinal absorption (Payne 1989), reduction of exchangeable pool between bone and extra-cellular fluid. District wise analysis of the phosphorus level revealed that subclinical hypophosphataemia is widely prevalent in almost all the districts surveyed with highest incidence in hilly temperate Doda and Poonch compared with Udhampur and plains of subtropical zone Jammu and Kathua and Rajouri districts. Singh *et al.* (2012) reported widespread Pi deficiency among buffaloes of hilly areas of Jammu division. Age wise analysis revealed that highest incidence of subclinical hypophosphataemia (50%) among animals of age >6 years (Table 1). Our results revealed that phosphorus deficiency is widely prevalent and could be one of the cause of commonly prevalent non-specific clinical signs of ill-thrift, debility, poor feed conversion, infertility and repeat breeding in animals.

Magnesium: Mean plasma Mg level was observed to be 2.35 mg/dl (range of 2.18–2.66 mg/dl) comparable with normal range of 1.8–2.3 mg/dl (Radostits *et al.* 2000). Singh

Table 1. Haemato-biochemical and mineral status of cross bred cattle (mean±SE)

Age-group	Jammu	Kathua	Udhampur	Rajouri	Doda	Poonch	Total
			Hb (*Low: 6.0-7.9 g/dl, Very Low:<6g/dl*)				
Group-A	8.81±0.27	7.97±0.97	8.88±0.52	8.86±0.37	8.79±0.32	7.84±0.41	8.53±0.95^{A}
(n=73)	(L: 26.92)	(L:42.85;VL: 14.28)	(L:25)	(L: 30.76)	(L: 21.42)	(L:60)	(L:30.13; VL: 1.36)
Group-B	9.34 ±0.20	8.63±0.33	9.12±0.25	9.10±0.3	8.70±0.31	7.88±0.42	8.80±0.60^{A}
(n=119)	(L: 9.30)	(L: 37.50)	(L: 14.28)	(L: 21.42)	(L: 11.53; VL: 7.69)	(L: 33)	(L:16.80; VL: 1.68)
Group-C	9.59±0.32	8.44±0.41	9.11±0.27	8.52±0.01	8.19±0.21	8.00±0.65	8.48±0.62^{A}
(n=97)	(L: 30.43)	(L: 46.15)	(L: 9.09)	(L:50.00)	(L: 42.85; VL: 2.85)	(VL: 33.33)	(L:34.37;VL:3.12)
Total	8.92±0.26^{ab})	8.35±0.57^{a}	9.04±0.35^{ab}	8.83±0.25^{a}	8.56± 0.28^{a}	7.90±0.49^{b}	8.60±0.72
(n=289)	(L: 19.56)	(L:41.66; VL: 2.77)	(L: 15.15)	(L:31.42)	(L:28.00; VL: 4.00)	(L: 29.41;VL: 11.76)	(L:26.04; VL:2.08)
			PCV (*Marginal: 24%, Low: <24%*)				
Group-A	28.00±0.99	25.28±2.71	28.37±1.83	29.00±1.83	31.85±1.24	26.40±1.72	28.15±1.72^{A}
(n=73)	(M: 3.84; L: 23.07)	(L: 28.57)	(M: 12.50 L:25.00)	(M: 15.38; L: 15.38)	(L:7.14)	(M: 20.00; L: 20.00)	(M: 6.84; L: 19.17)
Group-B	29.53±0.56	27.12 ±1.04	28.21±0.89	30.28±1.36	31.00±0.82	25.66± 2.01	28.63±1.13^{A}
(n=119)	(M: 2.32; L: 6.97)	(M: 6.25; L:25.00)	(L:7.14)	(L:7.14)	(M: 3.84; L: 3.84)	(M: 16.66; L:16.66)	(M: 3.36; L: 9.24)
Group-C	27.25±0.82	26.69±1.33	27.90±0.90	29.87±0.03	29.25±0.89	27.83±2.40	28.13±1.06^{A}
(n=97)	(M: 4.34; L: 13.04)	(M: 30.76; L: 23.07)	(M: 27.27)	(L: 12.50)	(M: 2.85; L: 5.71)	(L: 33.33)	(M: 9.37; L: 11.45)
Total	28.26±0.79^{ab}	26.36±1.69 ^{a}	28.16±1.20^{ab}	29.72±1.07 ^{ab}	30.70±0.98^{ab}	26.63±2.04^{ab}	28.82±1.30
(n=289)	(M: 3.26; L: 13.04)	(M: 13.88; L: 25.00)	(M: 12.12; L: 9.09)	(M: 5.71; L: 11.42)	(M: 2.66; L: 5.33)	(M:11.76; L: 23.52)	(M: 6.25; L: 12.50)
			Glucose (Deficient level <45mg/dl)				
Group-A	61.53±3.50	54.57±1.80	57.78±5.26	65.55±13.80	80.67±2.45	65.33±2.76	64.23±4.98^{A}
(n=45)	(15.38)	Nil	(12.50)	(20.00)	(Nil)	(6.67)	(13.33)
Group-B	55.64±2.17	50.59 ±1.19	45.91±2.76	88.89±26.30	72.67±3.40	86.67±1.98	66.73±6.30 ^{A}
(n=74)	(19.04)	(6.67)	(38.46)	(Nil)	(Nil)	(Nil)	(18.92)
Group-C	49.87±2.37	47.15±1.59	51.10±1.98	65.74±1.1	82.89±9.08	69.00±5.26	60.96±4.1^{A}
(n=49)	(34.78)	(30.77)	(20.00)	(Nil)	(Nil)	(6.67)	(29.48)
Total	55.68±2.68^{a}	50.77±1.52 ^{b}	51.59±3.3 ^{a}	73.39±13.37^{b}	78.74±4.98^{b}	73.33±3.3^{b}	63.97±5.12
(n=168)	(21.98)	(14.70)	(25.81)	(10.00)	(Nil)	(Nil)	(20.48)
			TPP (Deficient level <5.7g/dl)				
Group-A	5.63±0.29	5.39±0.19	5.39±0.16	7.48±0.21	7.95±0.27	6.13 ±0.26	6.33±0.23^{A}
(n=70)	(60.00)	(71.43)	(57.14)	(Nil)	(Nil)	(40.00)	(37.14)
Group-B	6.36±0.32	5.66±0.15	5.36±0.18	7.53±0.30	8.33±0.26	6.99±0.50	6.70±0.28 ^{A}
(n=116)	(53.49)	(62.50)	(57.14)	(Nil)	(7.69)	(Nil)	(37.06)
Group-C	5.96±0.27	5.90±0.19	5.84±0.13	7.73±0.00	8.74±0.23	6.95±0.39	6.85±0.20 ^{A}
(n=94)	(50.00)	(46.15)	(30.00)	(Nil)	(Nil)	(Nil)	(22.58)
Total	5.99±0.29^{a}	5.65±0.18^{a}	5.53±0.16^{a}	7.58±0.1^{ab}	8.34±0.25 ^{b}	6.69±0.38^{ab}	6.78±0.24
(n=280)	(54.35)	(58.33)	(48.38)	(Nil)	(2.70)	(11.76)	(32.25)
			Albumin (Deficient level <2.1g/dl)				
Group-A	3.05±0.15	3.51±0.32	2.39±0.21	3.41±0.05	3.34±0.17	2.70±0.15	3.06±0.17 ^{A}
(n=69)	(4.17)	(Nil)	(14.29)	(Nil)	(Nil)	(Nil)	(2.89)
Group-B	3.00±0.07	3.66±0.19	2.49±0.13	3.57±0.07	3.30±0.14	2.71±0.33	3.12±0.15 ^{A}

(Contd...)

(Table 1...)

Age-group	Jammu	Kathua	Udhampur	Rajouri	Doda	Poonch	Total
(n=115)	(4.88)	(6.25)	(14.28)	(Nil)	(7.69)	(33.33)	(7.82)
Group-C	3.09±0.17	3.30±0.30	2.36±0.19	3.37±0.00	3.48±0.11	2.96±0.07	3.09±0.14 ^{A}
(n=95)	(4.35)	(15.38)	(20.00)	(Nil)	(Nil)	(Nil)	(5.32)
Total	3.05±0.13^{b}	3.49±0.27 ^{bc}	2.41±0.18 ^{a}	3.45±0.04^{bc}	3.37±0.14^{bc}	2.79±0.18^{ab}	3.16±0.15
(n=279)	(4.55)	(8.33)	(16.13)	(Nil)	(2.70)	(11.76)	(5.75)
				Globulin			
Group-A	2.50±0.33	1.88±0.28	3.00±0.28	4.06±0.21	4.61±0.36	3.42±0.28	3.24±1.74 ^{A}
(n=69)							
Group-B	3.25±0.34	1.99±0.25	2.86±0.21	3.98±0.32	5.02±0.28	4.28±0.45	3.56±0.31 ^{A}
(n=115)							
Group-C	2.82±0.24	2.50±0.37	3.47±0.25	4.26±0.00	5.26±0.26	3.99±0.40	3.77±0.25 ^{A}
(n=95)							
Total	2.85±0.30^{ab}	2.12±0.30^{a}	3.11±0.25^{ab}	4.10±0.18^{cd}	4.96±0.3^{d}	3.90±0.38^{cd}	3.61±0.77
(n=279)							
				PUN (Deficient level <6mg/dl)			
Group-A	10.59±1.43	5.02±1.35	12.21±1.81	5.96±1.16	12.65±2.66	9.93±0.95	9.39±1.56 ^{A}
(n=51)	(36.00)	(71.43)	(28.57)	(50.00)	(Nil)	(25.00)	(43.13)
Group-B	10.52±0.94	7.00±0.79	11.03±0.79	6.90±1.17	9.05±1.81	7.05±1.35	8.59±1.41 ^{A}
(n=85)	(30.23)	(37.50)	(7.14)	(33.33)		(37.50)	(28.23)
Group-C	10.68±1.18	7.51±0.95	14.77±2.66	8.89±0.02	12.30±0.79	8.02±0.79	10.36±1.06 ^{A}
(n=56)	(25.00)	(46.15)	(10.00)	(25.00)	(Nil)	(25.00)	(27.27)
Total	10.59±1.18^{ab}	6.51±1.03^{a}	12.67±1.75^{b}	7.25±0.78^{a}	11.00±1.75^{ab}	8.00±1.03 ^{a}	9.45±1.34
(n=192)	(30.43)	(47.22)	(16.13)	(37.50)	(Nil)	(31.50)	(32.46)
				Ca (Deficient level <8.4mg/dl)			
Group-A	8.18±0.55	9.44±0.58	7.54±0.85	9.55±0.26	9.89±0.69	7.85±0.64	8.74±0.59 ^{A}
(n=70)	(48.00)	(28.57)	(71.43)	(8.33)	(28.57)	(60.00)	(38.57)
Group-B	7.58±0.43	7.07±0.47	7.88±0.54	9.90±0.33	10.2±0.32	8.93±0.76	8.59±0.47 ^{A}
(n=117)	(62.79)	(75.00)	(64.29)	(Nil)	(15.38)	(33.33)	(46.16)
Group-C	7.96±0.56	7.94±0.65	7.54±0.71	9.58±0.00	10.03±0.37	7.85±0.35	8.48±0.44 ^{A}
(n=96)	(54.17)	(53.85)	(60.00)	(Nil)	(17.65)	(66.67)	(37.89)
Total	7.91±0.51^{a}	8.15±0.57^{a}	7.65±0.7^{a}	9.68±0.20^{bc}	10.04±0.46^{c}	8.21±0.58^{ab}	8.64±0.50
(n=283)	(56.52)	(58.33)	(64.52)	(3.12)	(18.91)	(52.94)	(41.49)
				Pi (Deficient level <4mg/dl)			
Group-A	6.03±0.33	4.68±0.58	5.18±0.42	6.32±0.39	4.10±0.45	5.43±0.90	5.29±0.51 ^{A}
(n=70)	(16.00)	(57.14)	(14.29)	(Nil)	(42.86)	(20.00)	(22.86)
Group-B	5.24±0.26	5.86±0.30	4.33±0.30	5.27±0.55	4.08±0.23	4.30±0.33	4.85±0.33 ^{A}
(n=117)	(25.58)	(Nil)	(35.71)	(25.00)	(42.30)	(50.00)	(28.20)
Group-C	5.48±0.36	5.79±0.63	3.69±0.35	4.57±0.01)	3.40±0.18	4.04±0.35	4.49±0.31 ^{A}
(n=97)	(24.00)	(23.07)	(60.00)	(37.50	(76.47)	(66.67)	(50.00)
Total	5.59±0.32^{b}	5.44±0.50 ^{b}	4.40±0.36^{a}	5.39±0.32^{b}	3.86±0.29^{a}	4.59±0.53^{ab}	4.88±0.38
(n=284)	(22.58)	(19.44)	(38.71)	(18.75)	(58.10)	(47.06)	(34.27)
				Mg (Deficient level <1.2mg/dl)			

(Contd...)

(Table 1...)

Age-group	Jammu	Kathua	Udhampur	Rajouri	Doda	Poonch	Total
Group-A	1.89±0.18	2.52±0.38	2.30±0.37	2.36±0.16	2.67±0.17	2.13±0.19	2.31±0.24 [A]
(n=43)	(11.11)	(Nil)	(Nil)	(Nil)	(Nil)	(Nil)	(2.32)
Group-B	2.13±0.12	1.76±0.17	2.61±0.30	2.51±0.13	2.60±0.14	2.45±0.24	2.34±0.18 [A]
(n=72)	(7.69)	(16.66)	(Nil)	(Nil)	(Nil)	(Nil)	(5.55)
Group-C	2.51±0.13	2.26±0.26(9.09)	2.40±0.19	2.39±0.00(Nil)	2.63±0.17	2.41±0.19	2.43±0.16 [A]
(n=56)	(Nil)	(Nil)	(Nil)	(Nil)	(Nil)	(Nil)	(1.78)
Total	2.18±0.14[a]	2.18±0.27[a]	2.43±0.29 [a]	2.42±0.10 [a]	2.63±0.16 [a]	2.33±0.21 [a]	2.35±0.19
(n=171)	(6.66)	(10.71)	(Nil)	(Nil)	(Nil)	(Nil)	(3.50)
				Na (Deficient level <132µmol/l)			
Group-A	149.16±3.45	144.72±10.7	123.69±11.26	150.72±6.94	145.71±5.25	124.00±6.66	139.67±7.38 [A]
(n=68)	(15.38)	(28.57)	(33.33)	(22.22)	(14.29)	(80.00)	(23.88)
Group-B	152.06±3.11	121.46±4.84	160.87±4.32	141.30±5.3	149.04±3.1	116.50±6.89	140.21±4.59 [A]
(n=109)	(12.82)	(62.50)	(Nil)	(25.00)	(7.69)	(100)	(23.85)
Group-C	151.46±4.76	144.94±10.84	148.70±6.67	149.27±0.10	144.03±1.90	119.17±2.87	142.93±4.52 [A]
(n=92)	(17.39)	(50.00)	(30.00)	(50.00)	(14.71)	(100)	(29.67)
Total	150.90±3.77[b]	137.04±8.8[ab]	144.42± 7.42[b]	147.10±4.14[b]	146.26±4.6[b]	119.89±5.47[a]	145.63±5.49
(n=268)	(14.77)	(54.28)	(16.66)	(30.43)	(12.16)	(94.12)	(25.84)
				K (Deficient level <3.µmol/l)			
Group-A	4.72± 0.16	4.46 ± 0.34	4.39± 0.35	5.01± 0.20	4.56 ± 0.12	4.54 ± 0.28	4.65± 0.09[A]
(n=68)	(23.08)	(42.86)	(28.57)	(11.11)	(nil)	(nil)	(17.64)
Group-B	4.48± 0.13	3.97 ± 0.20	4.35± 0.16	5.02± 0.15	4.54 ± 0.15	4.20 ± 0.26	4.43± 0.07 [A]
(n=109)	(33.33)	(56.25)	(23.53)	(nil)	(3.84)	(16.67)	(25.68)
Group-C	4.33± 0.17	4.14 ± 0.16	4.05± 0.16	4.74 ± 0.004	4.59 ± 0.11	4.36 ± 0.12	4.40± 0.07 [A]
(n=92)	(34.78)	(45.45)	(40.0)	(16.67)	(2.94)	(nil)	(21.11)
Total	4.51± 0.08 [ab]	4.13± 0.13[a]	4.26± 0.12 [a]	4.94±0.13[b]	4.57± 0.07[ab]	4.36± 0.12 [a]	4.48± 0.04
(n=268)	(30.68)	(50.0)	(32.26)	(8.69)	(2.70)	(5.88)	(22.09)
				Fe (Deficient level <17.9 µmol/l)			
Group-A	74.56±8.05	88.64±18.80	50.61±8.44	51.77±5.62	53.84±6.03	22.63±4.24	63.32±8.53 [A]
(n=73)	(nil)	(nil)	(16.66)	(8.33)	(7.69)	(50.00)	(8.06)
Group-B	75.83±7.54	59.13±7.66	48.1±3.72	51.52±2.72	59.35±1.84	33.89±8.71	60.69±5.36 [A]
(n=119)	(5.40)	(7.69)	(nil)	(nil)	(nil)	(20.00)	(3.92)
Group-C	81.84±9.14	92.41±5.90	67.46±13.03	57.66±0.06	58.14±2.51	48.71±4.41	70.88±5.84 [A]
(n=97)	(nil)	(nil)	(nil)	(nil)	(3.03)	(20.00)	(2.32)
Total	75.64±8.24 [b]	76.83±4.12[b]	54.89± 8.40[ab]	42.52±2.8[a]	58.51±3.46[ab]	53.16±9.12 [ab]	65.40±6.58
(n=289)	(2.47)	(3.44)	(4.00)	(3.33)	(2.81)	(28.57)	(4.40)
				Cu (Marginal: 7.9-9.59 µmol/l, Low: <7.9 µmol/l)			
Group-A	12.61±1.65	6.17±1.12	7.05±0.96	1±0.82	11.81±1.43	8.99±0.6	10.58±1.10 [A]
(n=73)	(M:11.53; L: 46.15)	(M:14.28; L: 71.42)	(M:28.57; L:57.14)	(M:18.18; L: 27.27)	(L:15.38)	(M:40.00; L: 20.00)	(M:14.49; L: 39.13)
Group-B	12.53±1.23	5.14±0.71	8.28±0.56	9.61±1.21	13.61±1.07	10.79±0.79	10.92±0.93 [A]
(n=119)	(M:11.90; L: 42.85)	(M:6.66; L: 86.66)	(M:38.46; L: 38.46)	(M:10.00; L: 40.00)	(M:4.00; L: 4.00)	(L:16.66)	(M:11.71; L: 37.83)
Group-C	12.05±1.59	7.21±0.88	7.35±0.88	10.14±0.01	13.15±1.13	11.43±0.75	11.08±0.87 [A]
(n=97)	(M:16.66; L: 41.66)	(M:7.69; L: 69.23)	(M:10.00; L: 60.00)	(M:37.50; L: 12.50)	(M:8.82; L: 8.82)	(M: 16.66)	(M:13.68; L: 30.52)

(Contd...)

(Concluded Table 1)

Age-group	Jammu	Kathua	Udhampur	Rajouri	Doda	Poonch	Total
Total (n=289)	12.43±1.49^{c} (M:13.04; L: 43.47)	6.11±0.90^{a} (M:8.57; L: 77.14)	7.68±0.8^{ab} (M:26.66; L: 50.00)	9.95±0.68^{bc} (M:20.68; L: 27.58)	13.06±1.21^{c} (M:5.55;L: 8.33)	10.48±0.12^{bc} (M:17.64; L: 11.76)	10.89±0.97 (M:13.09; L: 35.63)
Zn (Deficient level <12.2µmol/l)							
Group-A (n=45)	24.37±1.29 (nil)	18.90±2.53 (14.28)	22.99±2.68 (14.28)	28.52±1.56 (nil)	43.02±7.08 (nil)	29.77±5.34 (nil)	28.03±3.41^{A} (2.89)
Group-B (n=74)	24.72±1.77 (7.31)	14.07±1.01 (33.33)	27.71±1.44 (nil)	46.29±10.25 (nil)	43.95±4.02 (nil)	28.57±4.61 (nil)	30.33±3.85^{A} (7.33)
Group-C (n=49)	24.50±1.54 (nil)	18.8±2.31 (23.07)	30.42±5.32 (nil)	39.64±0.08 (nil)	48.98±4.38 (nil)	31.98±5.53 (nil)	34.76±3.19^{A} (3.29)
Total (n=168)	24.56±1.53^{ab} (3.37)	16.78±1.95^{a} (25.71)	27.50±3.15^{b} (3.44)	37.63±3.96^{c} (nil)	46.16±5.16^{c} (nil)	30.12±5.16^{ab} (nil)	31.25±3.48 (4.83)

Figures in the parenthesis indicate percentage of animals deficient. a, b, c superscript show significance (P<0.05) between districts. A, B superscript show significance (P<0.05) between groups within district.

et al. (2005) and Siddique (2011) reported higher levels of Mg in cows from Punjab. Sharma *et al.* (2005) reported significantly (P<0.05) lower levels of Mg in cattle from eastern Uttar Pradesh with prevalence of deficiency among 30–37% animals. District wise analysis of data revealed that animals from subtropical plains of Jammu and Kathua district were having lower level compared with hilly temperate belt of Poonch, Rajouri, Udhampur and Doda districts (Table 1). The overall incidence of hypomagnesamia was 3.50% with higher prevalence in Kathua followed by Jammu district. Non-significant difference in plasma Mg levels of cows belonging to different age groups were recorded which corroborates with reports of Ozukum (2011) and Siddique (2011).

Sodium: The overall average value of Na in plasma of cattle was 145.63 mmol/l (range 119.89–154.40 mmol/l) within the normal range (Radostits *et al.* 2000). District-wise analysis revealed that the crossbred cattle from Poonch district were having significantly (P<0.05) lower level of Na (119.64 mmol/l) compared with the values observed among cattle from Jammu, Udhampur and Doda districts (Table 1). The overall prevalence of hyponatremia was 25.84% with maximum prevalence from Poonch district (94.12%) followed by Kathua (54.28%). Sharma *et al.* (2005) recorded comparatively lesser prevalence of Na deficiency among cattle from eastem Uttar Pradesh and Delhi. Numerous factors like difference in demand and utilization for physiological needs, effect of environment, age, species, nature of feed, time of sampling, storage, analytical technique employed etc. as suggested by Underwood and Suttle (1999) influence the level of Na.

Potassium: The mean value of K in plasma samples of cattle was 4.48 mmol/l within the normal range of 3.9-5.8 mmol/l (Radostits *et al.* 2000). District wise analysis revealed that cattle from Rajouri had significantly (P<0.05) higher K level than Kathua, Udhampur and Poonch. Hypokalemia was observed in 22.09% animals with maximum prevalence in Kathua district (Table 1). Comparatively lesser prevalence of K deficiency among cattle from eastem Uttar Pradesh and Delhi was reported by Sharma *et al.* (2005).

Iron: Overall mean plasma iron concentration of crossbred cows was above the normal range (Table 1) of 17.9-35.8 µmol/l as quoted by Radostits *et al.* (2000). Significantly (P<0.05) higher levels (123.79 µmol/l) of Fe in cattle from mountainous areas of Punjab were reported by Singh *et al.* (2003) compared with significantly (P<0.05) lower levels (15.57–48.15 µmol/l) from plain areas by Randhawa *et al*. (2009). Kaneko *et al.* (1999) reported that elevated iron could be due to refractory anaemia, haemolytic iron overload and liver disease. Thus, it can be concluded that elevated level of iron observed in present study could be either due to widely prevalent anaemia among the animals (28.12%) or it could also be due to excessive level in the diet of animals as soil from hilly areas have higher levels of Fe content. District wise analysis revealed significantly higher average values of plasma Fe among

crossbred cattle of Kathua and Jammu districts (Table 1). Overall prevalence of Fe deficiency was 4.40% with highest number of animals from Poonch district. No consistent age-wise pattern in Fe level of cattle was observed and finding corroborates with Ozukum (2011).

Copper: Mean copper concentration (10.89 ± 0.36 µmol/l) was within the normal range 9.5-23.6 µmol/l quoted by McDowell (2003). Significant ($P<0.05$) difference in plasma Cu levels of cattle from Jammu and Doda districts was observed compared with Kathua and Udhampur districts (Table 1). Overall the animals from sub mountainous districts (Kathua and Udhampur) were having low level than hilly (Poonch, Rajouri and Doda) and plain districts (Jammu). Similar levels of Cu among cattle from various parts of neighboring state of Punjab were reported by Singh *et al.* (2003) and Chhabra (2006). Prevalence of hypocupraemia was recorded in 48.72% animals. Animals from Kathua and Udhampur districts were having higher prevalence of hypocupraemia compared with Jammu, Rajouri, Poonch and Doda districts (Table 1). Non-significant increase in levels of Cu with age was recorded with higher prevalence rate of deficiency among younger age group. The finding corroborates with report of Singh *et al.* (2003). Differences observed in the levels of Cu in various studies could be due to different geographical areas, difference in dietary Cu level, method of sample collection and analytical technique employed.

Zinc: Overall mean plasma Zn concentration was higher than the normal range of 12.2 to 18.2 µmol/l quoted by Radostits *et al.* (2000). Comparatively lower levels of Zn in cattle from Punjab were reported by Chhabra (2006) whereas Singh *et al*. (2003) recorded similar levels. The differences could be due to variations in diet, age, physiological status and agro-climatic conditions. Several other factors have also been reported to influence the Zn level in plasma like haemolysis, blood collection tubes with Zn stearate content in rubber stoppers and use of EDTA as anticoagulant. The temperate districts were having higher levels of Zn in plasma of cattle (Table 1). Overall prevalence of Zn deficiency was 4.83% with maximum cases from Kathua (25.71%). Age-wise highest incidence of zinc deficiency was 7.33% among 3–6 years age group.

Results suggested that livestock in the hilly areas suffers from anaemia as 28.12% of crossbred cattle were having low Hb level. Based on plasma analysis, it was observed that deficiency of Ca, Pi, Na and Cu exists among 41.49, 34.27, 25.84 and 48.72% of cattle, respectively. The Mg, Fe and Zn level of these animals is adequate. The districts having higher prevalence of Pi deficiency were having higher Ca level and vice- versa. Thus, study concludes that area specific mineral mixtures need to be framed and supplemented for enhancing the productive and reproductive potential of crossbred cattle.

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