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Mineral status of forages and grazing goats in West Sumatera Indonesia : 2. Micro minerals

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Abstract

This study is a second part of a series of experiments conducted to evaluate mineral status of forages and grazing goats in West Sumatra, Indonesia. Forage species, harvesting locations and animals used were the same as reported in the previous study. The results showed that concentration of micro minerals in forages were significantly affected by species and season. Concentration of iron (Fe) and selenium (Se) in dry and rainy seasons was higher than the critical level suggested for deficiency of goats. Deficiency of forages copper (Cu) was found in both seasons; of which in dry season the deficiency was 54.6% for grass and 71.4% for legume, while in rainy season the deficiency was 84.6% for grass and 85.7% for legume. In overall, deficiency of zinc (Zn), molybdenum (Mo) and cobalt (Co) for grass was 15.4, 11.5 and 42.5%; while the deficiency in legume was 42.9, 42.9 and 50%, respectively. OIT on micro mineral status of grazing goats showed that in overall the incidence of Cu, Mo and Se deficiencies were 16.5, 17.0 and 33.0%, respectively. This finding suggested that supplementation of these elements are required for ruminants grazing in naive pasture of West Sumatra.

Key words: Micro mineral status, forages, goats, dry and rainy season.

Introduction

In animal industry, mineral deficiency or toxicity is one of the limiting factors to support production. Mineral status of the animals closely related with the amount of forage mineral consumed. Results of the experiments conducted in tropical countries showed that incident of mineral deficiency or toxicity commonly occurred in grazing ruminants with forage as a main feed. Study of McDowell *et al.*¹ on grazing cattle in South America showed that Na, K, Ca, P, Mg, Zn, Cu, Co and I are minerals frequently deficient, while Fe and Se are minerals frequently toxic. Deficiencies of Cu, Co and Se have been also reported for grazing sheep in Australia and New Zealand.² Espinoza *et al.*³ reported that the forages grown in warm areas of Florida are deficient in minerals Co, Cu, Fe, Zn and Se, while study of Fujihara *et al.*⁴ showed goats grazed in Central Luzon, Philippines were deficient in Cu and Se.

Results of the study in Indonesia showed that concentrations of Cu and Zn in forages and grazing cattle in Java Island were lower than the critical levels.⁵ Deficiencies of Ca, P, Cu, Zn and Se in forages and grazing cattle also have been reported by Prabowo *et al.*^{6,7} in South Sulawesi. In North Sumatra, Hayashi *et al.*⁹ reported that Ca, P, Mg and K were deficient minerals in the forages. According to Underwood and Suttle¹⁰ several factors affect mineral contents of forages including species, soil fertility, climates and plant maturity. In dry season, mineral concentrations of tropical forages generally decrease which associated by mineral deficiency in animals grazed in the area. A high fiber and lignin content of tropical forages could reduce minerals availability for ruminants. Objective of the present study was to evaluate micro mineral concentration of several commonly forages and micro

mineral status of grazing goats in West Sumatra during dry and rainy seasons

Materials and Methods

Investigation area: This study was conducted in five regions of West Sumatra province, namely Padang, Solok, Tanah Datar, Pariaman and Sawahlunto Sijunjung. The province is located in tropical and monsoon region, lies between 0°54'N to 3°30'S and 98°36' to 101°53'E. There are two seasons during the year, dry season from February to September and rainy season from November to March. The temperature is nearly constant, differing only a few degrees among the dry and rainy seasons with daily temperature ranges from 23 to 31°C. The mean of monthly rainfall in dry and wet seasons is 195 and 233 mm respectively, with the annual rainfall being 2570 mm.

Collection of forage and blood samples: The forage evaluated consisted 13 species of grass (*Axonopus compressus*, *Pennisetum purpurifolium*, *Pennisetum purpureum*, *Setaria sphacelata*, *Cynodon dactylon*, *Panicum maximum*, *Paspalum notatum*, *Paspalum dilatatum*, *Brachiaria decumbens*, *Euchlaena mexicana*, *Andropogon gayanus*, *Haemodorum hexandra* and *Cynodon dactylon*) and 7 species of legumes (*Leucaena leucocephala*, *Gliricidia maculata*, *Calopogonium mucunoides*, *Centrosella pubescens* and *Mimosa pudica*). The forage samples were collected during dry and rainy seasons. Immediately after harvesting, representative samples were oven-dried at 60°C for 24 hours, ground in a Wiley mill through 1-mm screen and kept for further analyses. Blood samples were collected through jugular

Com about 30 goats at each season and region. Micro oncelltrations (Cu, Zn, Mn, Fe, Mo, Co and Se) in the nd blood plasma were analyzed by Inductively Coupled mission Sp...el,omlecr(!CPS-21)(), Shimadzu, Japan). The ferences of mineral concentration in forages and blood between the dry and rainy season were determined using t-test¹¹.

Results and Discussion

wn in Table 1, concentrnarion of micro minerals of grass among species and season. The concentration of Cu, Zn, Co were lower than requirement of sheep and goat (critical while concentration of Mn, Fe and Se were above the critical

suggested by McDowell¹¹. In rainy season, concentrauon varied from 2.3 to 11.9 mg/kg, while in dry season the entration ranged from 3.3 to 14.4 mg/kg. The lowest entration of Cu was obtained in *I. hexandra* and the highcs: found for *P. ...* both in dry and rainy seasons. Grass iency of Cu in both dry and rainy seasons was 84.6%. Though oncentration did not differ among the season, deficiency of element in dry season was significantly higher (p<0.05) pared to rainy season (23.1 vs 7.7%). The concentration of Cu he present study was similar with the result of Hayashi *et al.*⁹

who obtained Cu content of grass in North Sumatra being 8.99 ± 4.6 mg/kg, but it was relatively lower than result of Kumagai *et al.* and Prabowo *et al.*. According to Kumagai *et al.*, Cu concentration of forages in Java Island during rainy season varied from 3.9 to 36.1 mg/kg and from 4.3 to 8.2 mg/kg d!Jinz dry 5C350n. Study of Prabowo *et al.* in South Sulawesi, Indonesia, found that Cu concentration of grass was 8.7–15.9 mg/kg in dry season and

9.9– 22.9 mg/kg in rainy season; while deficiency of Cu was 33.3% in dry season and 30% in rainy season.

There was a great variation of Zn concentration of grass, ranging from 32.2 to 100.0 mg/kg in rainy season and from 29.0 to 113.0 mg/kg in dry season. The wide variation of Zn content in grass has been reponed by Hayashi *et al.* in North Sumatra (9.5–462.5 mg/kg) and in Jan Island by Kumagai *et al.* who found that Zn concentrauon varied from 10.9 to 56.5 mg/kg in dry season and from 20.6 to 69.5 mg/kg in rainy season. Study of Prabowo *et al.* showed that mean Zn concentrauon of forages in three regions of South Sulawesi during dry season was 30–48 mg/kg, decreased during rainy season to 25–38 mg/kg with percentage deficiency being 31.7% in dry season and 51.7% in rainy season. The other experiment of the tropical forages showed that Zn concentration in Thailand during dry and rainy season was 34.5–55.7 mg/kg and 40.2–51.8 mg/kg, respectively¹¹. In Phihippine Fujihara *et al.* reported that Zn concentration of forages w!s 2SA.../ 1 mg kg.

Conceruauon of Mo, Co and Se were greatly affected by season and forage species. In rainy season, mean concnraion of Mo and Co were 1.03 and 0.25 mg kg, respectively. These values were significantly k)\\er (p<0.05) than concentration of Mo and Co in dry season (1.25 and 0.51 mg/kg). It was noted that 30.0% of grass were deficient in Mo during dry season, while during rainy season 23.1% of grass was deficient in Co and 53.8% deficient in Mo. However, the result was in the range of the data reported by Prabowo *et al.* that Co concnraion of the forages grown in South Sulawesi at dry season

varied from 0.34 to 0.42 mg/kg, while in rainy season the Co concentration ranged from 0.31 to 0.44 mg/kg. Furthermore, they reported that concentration of Mo in dry season ranged from 0.26 to 1.25 mg/kg and from 0.42 to 1.75 mg/kg in rainy season. The Mo concentration found in the present study was also comparable with the result of Kumagai *et al.* in Thailand that grass contained higher Mo in dry season compared to rainy season (2.09–3.39 mg/kg vs 0.89–1.66 mg/kg). Data on Java Island of Indonesia showed that concentration of Mo in dry season varied from 0.33–2.03 mg/kg and in rainy season ranged from 0.27–3.06 mg/kg¹¹. In rainy season, concentration of Se was significantly higher (p<0.05) than in dry season (0.68 vs 0.47 µg/kg), the values were above the requirement of Se for sheep and goats. The average Se concentration in the present study was relatively higher compared to the results of previous studies¹¹.

Table 2 shows concentration of micro minerals in legume forages. It is clear that except for Se, concentration of nuro minerals was lower in legumes

Table 1. Micro mineral concentration of grass in rainy and dry seasons (mg/kg DM).

Species	Season	Cu	Zn	Mn	Fe	Mo	Co	Se
Critical level#		11	33	40	50	0.5	0.2	0.2
Toxic level		25	750	1000	500	10	10	1
<i>P. compressus</i>	Rainy	11.3	45.6	77.3	417.0	0.78	0.16	0.73
	Dry	7.9	30.3	92.4	411.2	1.19	0.54	0.42
<i>P. purpuphoides</i>	Rainy	10.8	40.6	48.5	203.3	0.08	0.23	0.94
	Dry	8.7	29.0	83.2	331.8	0.67	0.02	0.51
<i>P. sphacelata</i>	Rainy	9.9	52.7	150.5	338.7	1.62	0.12	0.64
	Dry	10.5	37.2	96.2	125.5	0.91	0.32	0.57
<i>P. lectostachyus</i>	Rainy	8.2	80.1	49.0	267.3	1.25	0.53	1.04
	Dry	9.1	34.5	40.9	223.2	1.97	1.54	0.42
<i>P. purpureum</i>	Rainy	9.4	38.5	45.1	243.7	1.30	0.17	0.50
	Dry	7.4	42.1	105.5	101.1	1.76	0.33	0.30
<i>P. notatum</i>	Rainy	10.0	58.9	96.9	1591.7	0.60	0.42	0.46
	Dry	11.8	66.3	135.3	239.3	2.10	0.43	0.26
<i>P. maximum</i>	Rainy	11.9	38.6	132.0	453.4	0.16	0.05	0.70
	Dry	14.4	6.2	125.7	397.5	0.70	0.53	0.21
<i>P. decumbens</i>	Rainy	5.0	3.0	119.7	241.7	0.85	0.28	0.58
	Dry	6.3	36.1	119.6	211.9	1.74	0.73	0.27
<i>P. mexicana</i>	Rainy	6.8	36.5	41.2	373.2	0.54	0.14	0.60
	Dry	7.5	32.8	145.3	1438	0.60	nd	0.42
<i>P. gayallus</i>	Rainy	6.5	32.2	101.9	116.3	0.18	0.0-1	0.56
	Dry	6.9	11.1	67.4	214.4	0.50	0.12	0.30
<i>P. hexandra</i>	Rainy	2.3	100.0	80.6	284.0	3.58	0.11	0.71
	Dry	3.3	113.0	70.2	307.8	1.10	0.46	0.63
<i>P. dilatatum</i>	Rainy	9.2	47.0	55.6	341.4	1.07	0.32	0.51
	Dry	4.2	62.7	114.4	103.2	2.35	0.19	0.53
<i>P. dactylon</i>	Rainy	9.3	156.4	90.3	160.0	1.42	0.26	0.60
	Dry	7.8	113.2	83.7	118.4	0.48	0.46	0.90
Mean	Rainy	8.9	56.3	83.7	389.2	1.03	0.25	0.68
	Dry	8.2	57.8	93.1	295.3	1.2	0.51	0.47
Overall		8.6	57.1	88.9	312.3	1.14	0.38	0.58
Deficiency (%)	Rainy	81.6	7.7	00	00	23.1	53.8	0.0
	Dry	81.6	3.1	00	00	30.8	30.8	0.0
Overall		81.6	15.4	00	00	11.5	42.3	0.0

fa compared with grass. The changes of season significantly affected concentration of Zn, Fe, Co and Se and percentage deficiency of Cu, Zn, Mn, Mo and Co ($p < 0.05$). In the rainy season, the average concentration of Zn, Fe, Co and Se was 37.2, 255.2, 0.17 mg/kg and 1.0 $\mu\text{g}/\text{g}$, while in dry season the concentration was 27.3, 191.6, 0.27 mg/kg and 0.52 $\mu\text{g}/\text{g}$, respectively. There was no significant difference among the seasons for concentration of Cu, Mn and Mo, the average values being 7.4, 49.5 and 0.77 mg/kg. However, the deficiency of Cu, Zn, Mn, Mo and Co significantly differed among rainy and dry season. In dry season, percentage deficiency of Zn, Mn and Mo of legumes was 71.4, 28.6 and 57.1%; these values were higher compared to rainy season (42.9, 14.3 and 28.6%). Conversely, deficiency of Cu and Co in rainy season was higher compared to dry season (55.4 and 71.4% Vs 71.4 and 28.6%).

Table 3 shows micro mineral concentration of blood plasma goats grazed in several regions of West Sumatra. It can be set that plasma concentrations of Cu, Mo and Se of several goa were lower than the normal level of these elements in blood plasma of goats. Concentration of plasma Cu (1.1-4.1) season varied from 0.70 mg (Solok) to 0.997 mg/l (Pariaman) with the average value of 0.829 mg/l; this level was lower compared to plasma Cu concentration in rainy season that varied from 0.798 mg/l (Tarah Darar) to 1.329 mg/l (Solok) which the average of 0.996 mg/l. In dry season, the range of plasma Mo concentration was 0.084 mg (Sawahlunto) - 0.154 mg/l (Padang), the average value being 0.12 mg/l. These values were similar to those of rainy season which ranged from 0.076 mg/l (Padang) to 0.147 mg/l (Pariaman). Concentration of Se in rainy season varied from 16.9 $\mu\text{g}/\text{l}$ (Tarah

Table 2. Micro mineral concentration of legumes in rainy and dry seasons

Species	Season	Cu	Zn	Mn	Fe	Mo	Co	Se
Critical levels								
		41	33	40	50	0.5	0.2	0.2
Maximum level								
		25	750	1000	500	10	10	2.0
<i>L. leucocephala</i>	Rainy	10.2	34.5	42.4	239.9	0.18	0.13	1.33
	Dry	10.3	31.5	50.4	131.2	0.43	0.41	0.41
<i>G. nivalis</i>	Rainy	3.4	19.6	32.9	121.3	0.53	0.08	1.29
	Dry	11.2	20.4	48.9	330.3	0.42	0.26	0.52
<i>C. mucunoides</i>	Rainy	4.7	27.7	40.6	569.2	0.70	0.16	0.73
	Dry	7.1	25.3	49.0	405.8	1.12	0.32	0.80
<i>M. pudica</i>	Rainy	7.7	44.4	42.1	295.1	1.95	0.33	0.87
	Dry	8.5	35.9	73.5	139.1	0.32	0.26	0.46
<i>C. pubescens</i>	Rainy	14.5	39.7	49.0	282.8	0.36	0.21	0.75
	Dry	10.5	34.1	78.9	103.8	1.20	0.51	0.27
<i>M. imvisa</i>	Rainy	9.0	67.4	60.1	107.2	0.51	0.16	1.14
	Dry	5.7	22.3	38.4	96.3	1.64	0.01	0.20
<i>S. glandiflora</i>	Rainy	3.5	27.0	48.0	171.2	1.67	0.15	0.88
	Dry	3.1	21.5	38.1	155.0	0.27	0.12	0.95
Mean	Rainy	7.6	37.2 ^a	45.0	255.2 ^a	0.76	0.17 ^a	1.00 ^a
	Dry	8.1	27.3 ^b	53.9	191.6 ^b	0.77	0.27 ^b	0.52 ^b
	Overall	7.4	32.3	49.5	223.4	0.77	0.22	0.76
Deficiency (%)	Rainy	85.7 ^a	42.9 ^a	14.3 ^a	0.0	28.6 ^a	71.4 ^a	0.0
	Dry	71.4 ^b	71.4 ^b	28.6 ^b	0.0	57.1 ^b	28.6 ^b	0.0
	Overall	78.6	57.1	21.4	0.0	42.9	50.0	0.0

Se = $\mu\text{g}/\text{g}$ DM.
 The values hetero. hi, lt, cl are different.
 b. $p < 0.05$.

Table 3. Concentration of micro mineral in blood plasma of goats at several regions in West Sumatra during rainy and dry seasons (mg/l).

Location	Season	Cu	Zn	Mn	Fe	Mo	Co	Se
Critical level								
		0.65	0.4	0.002	1.6	0.05	0.030	0.02
Padang	Rainy (30)	0.885	2.05	0.048	6.72	0.076	0.030	111.2
	Dry (41)	0.820	1.27	0.056	7.08	0.154	0.063	159.8
Pariaman	Rainy (15)	1.031	1.22	0.072	9.71	0.147	0.036	21.2
	Dry (12)	0.997	1.24	0.065	8.12	0.135	0.027	20.1
Solok	Rainy (14)	1.329	1.78	0.049	8.20	0.085	0.068	78.7
	Dry (12)	0.700	2.05	0.107	4.20	nd	0.027	63.4
Sawahlunto	Rainy (28)	0.936	1.06	0.036	4.64	0.093	0.039	35.7
	Dry (24)	0.897	0.95	0.027	5.01	0.084	0.035	30.2
Tarah Darar	Rainy (35)	0.798	0.98	0.052	6.21	0.124	0.062	16.9
	Dry (36)	0.730	0.93	0.041	6.06	0.137	0.053	16.7
Average	Rainy	0.996 ^a	1.44	0.051	7.10 ⁵	0.105	0.047	52.7 ^a
	Dry	0.829 ^a	1.29	0.059	8.09 ^a	0.127	0.041	58.0 ^a
	Overall	0.912	1.36	0.055	7.59	0.116	0.044	55.3
Deficiency (%)	Rainy	16.0	0	0	0	20.0	—	26.0
	Dry	17.0	0	0	0	14.0 ^b	—	40.0 ^a
	Overall	16.5	0	0	0	17.0	—	33.0

x, l, o, h
 h, < n o

for) to 1:1.2 µg/l (Padang), significantly lower compared to values in dry season from 16.7 µg/l (Pariaman) to 159.8 µg/l (Padang).

In overall, the amount of goats deficiency in Cu, Mo and Se during dry season was 17, 21 and 10%, while in rainy season the percentage deficiency was 16, 20 and 26 %, respectively. Study of Prabowo *et al.* found that the ranges of Cu, Zn and Se concentration of cattle blood in dry season was 0.61–0.76, 0.67–0.84 and 0.05–0.11 µg/ml; while in rainy season the concentration was 0.61–0.80 µg/ml for Cu, 0.90–1.15 µg/ml for Zn and 0.11–0.14 µg/ml for Se, respectively. They also reported that percentage of the animals deficiency in Cu, Zn and Se during dry season was 41, 20 and 3%, while in rainy season the percentage deficiency of Cu and Zn was 30 and 5%, respectively.

It can be seen that although Cu, Zn, Mo and Co concentrations of the forages were lower than the critical level, only Cu, Mo and Se were deficient in the experimental goats. This suggested that utilization of minerals by animal was affected by both concentration and bioavailability of the minerals.

Conclusions

Based on the above results, it could be concluded that the availability of copper (Cu), zinc (Zn), molybdenum (Mo) and cobalt (Co) was deficient in the forages; while Cu, Mo and selenium (Se) were the elements deficient in goats grazed in West Sumatra, Indonesia.

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**LEMBAR HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW
KARYA ILMIAH : JURNAL ILMIAH**

Judul Jurnal Ilmiah (Artikel) : Mineral Status of Forages and Grazing Goats in West Sumatra, Indonesia: 2. Micro minerals

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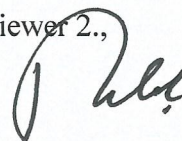
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