

MINERAL STATUS OF GRAZING PHILIPPINE GOATS

I. THE NUTRITION OF CALCIUM, MAGNESIUM AND PHOSPHORUS OF GOATS IN LUZON ISLAND

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Summary

Nutritional status of macro minerals (Ca, Mg and P) in goats grazed on the native pasture was investigated for 2 years in Luzon Island, Republic of the Philippines. Three regions in Luzon Island (Los Banos; Southern area, Munoz, Nueva Ecija; Central area and Baguio; Northern area) were objected to collect the samples of forages and blood of goats on the pasture. The average values in Ca, Mg and P contents of all the forage samples were 0.29-1.32, 0.13-0.56 and 0.15-0.45% of dry matter, respectively, and these figures almost exceeded the required dietary levels for sheep. There was no obvious changes in mineral content of forages between the seasons of rainy and dry, or among regions. In blood Ca level, more than a half of goats (57.9%) without supplement showed the level below the lower limit, and the low level was not improved even when they fed with some supplemental concentrates. The plasma levels of Mg and P were satisfactory, referring to the lower limit of normal level in goats. It is, therefore, necessary to decide the requirement and to establish a most suitable technique for supplying Ca to grazing goats in Luzon Island.

(Key Words: Grazed Goats, Plasma Ca, Mg and P, Dietary Ca, Mg and P, Luzon Island of the Philippines)

Introduction

The feeding of ruminant in tropical and sub-tropical areas mostly depends on the native grasses. In southeast Asia, some workers pointed the mineral deficiency in forages occurred in some regions in Thailand (Vijchulata, 1983) and Indonesia (Hayashi et al., 1986). Under these conditions, the grazing ruminants obviously appeared to be suffered mineral imbalances. Recently, Kumagai et al. (1990) have reported a nutritional status of macro minerals of cattle in Java, Indonesia, and pointed out that a low phosphorus concentration and a high calcium: phosphorus ratio in the diets (by-products and/or forages)

were likely to induce a low plasma concentration of inorganic phosphorus in cattle. There are, however, few available informations about mineral nutrition of goats in tropical and/or sub-tropical Asia. The relationship between mineral content of forages and mineral nutrition of goats is extremely limited. In this paper, the results obtained about the macro minerals (Ca, Mg and P) in the diets and the plasma of goats in Luzon Island (during past 2 years) are described. A brief result of this study was reported earlier (Shimizu et al., 1989).

Materials and Methods

Location and season for investigation

The regions in Luzon Island objected were 3 as follows; Los Banos (Southern area), Munoz, Nueva Ecija (Central area) and Baguio (Northern area). As indicated in table 1, the sampling of forages and the blood of goats were made in the 3 experimental stations as follows; University of the Philippines at Los Banos (UPLB), Central Luzon State University (CLSU) and Baguio Dairy Farm (BDF) (figure 1).

The climate of the Luzon is a tropical mon-

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Received January 18, 1991

Accepted February 28, 1992

TABLE 1. LOCATION AND SEASON FOR COLLECTING SAMPLES

Year	Region	Los Banos (UPLB) ¹	Munoz (CLSU) ²	Baguio (BDF) ³
1988		March	September	—
		November	November	—
1989		March	March ⁴	March ⁴
		September	September ⁴	September ⁴
		November	November	November ⁴

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² Central Luzon State University.

³ Baguio Dairy Farm.

⁴ The blood-sampled goats were supplemented with some concentrates.

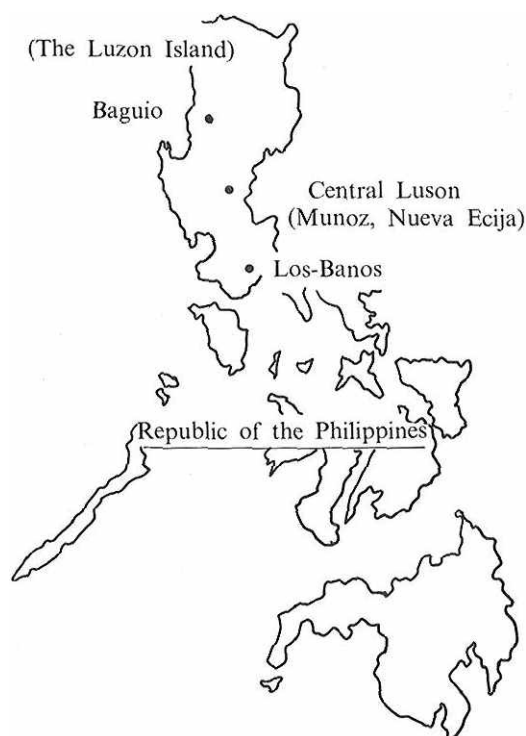


Figure 1. Location for collecting samples in Luzon Island, Republic of the Philippines.

soon type, i. e., it consists of two typical seasons of dry season (October-June) and rainy season (July-September). Thus, the most of grasses on pasture in flat areas usually wither on late of the dry season, if there are no irrigation systems. Baguio, however, adopted in this study is located on a mountainous area (about 1,000 m above sea level) being relatively low temperature and

high rainfall throughout year, therefore, the grass growth on pasture are much better than the other two places even in dry season.

Conditions of the pastures and animals

The pastures investigated in this study were the reformed but relatively aged ones in all the 3 regions. The dominant species of forages grazed by goats were Star-grass, Cogon and Napier grass, though there were some other species as minors. The most of pasture in the Luzon generally appeared to be no supply of any fertilizer for a long time.

The goats used in the present study had been basically grazed on the pasture in all seasons by tethering or free within a yard. Some of goats have been fed occasionally a small amount of concentrates such as rice bran, ground corn and/or their mixture as indicated in table 1. They were given sometimes salt or other minerals throughout the year.

Sampling of blood and forages, and analytical method

In this study, 122 healthy adult goats were sampled 10 ml of heparinized blood through the jugular vein. The forage samples were collected by a hand-picking method whenever the goats were blood-sampled on the pasture.

After wet digestion with nitric acid and perchloric acid, Ca, Mg and P in blood plasma were analysed using an Inductively Coupled plasma Emission Spectroscopy (ICPS-2000, Shimadzu Co. Kyoto, Japan), and the same method was adopted for analysis of Ca, Mg and P in forage samples

after drying (70°C, 48 hrs) and grinding them.

Results and Discussion

The contents of Ca, Mg and P in the major species of forages grazed by goats and concentrates as supplemented feed are shown in table 2. The Ca contents of forages examined in this study were with a wide range from 0.29 to 1.32% of a dry matter basis, the those of concentrates were in a range from 1.23 to 1.32%. The Ca contents of forage samples collected in 3 regions of Luzon Island were included in the range of 0.20-0.80%/DM required for sheep in NRC standard (1984). The figures with forages shown in table 2 were almost similar to that reported by Kumagai et al. (1990), in which the Ca content was investigated with some native grasses in Java, Indonesia. Hayashi et al. (1985) also reported that the Ca content of 44 forages (samples collected from pastures around Medan, Indonesia) was $0.37 \pm 0.35\%$. The other data obtained in Thailand (Vijchulata et al., 1983) has also shown that the Ca contents in forages from central Thailand were in a range from 0.18 to 1.49%.

The Mg content in all the forage samples ranged from 0.13 to 0.56% on a dry matter basis. The Mg content of Napier grass tended to be slightly lower than those in other forages. The range in Mg content of forages in this study was

very comparable to that reported by Kumagai et al. (1990). Hayashi et al. (1985) observed, however, that the Mg content of forages from grassland around Medan, Indonesia was less than 0.1% in more than a half of 44 samples. They suggested that the low content would relate to severe Mg deficiency in blood of large ruminants. The Mg contents of forages in regions objected in this study obviously meet a demand which is required in forage for sheep (0.12-0.18% DM) according to NRC standard (1984).

The P content of forages in the present study ranged from 0.1 to 0.46% on dry matter basis, and the average values in all the grasses were similar. The values in all the species were calculated to be $0.34 \pm 0.04\%$ (mean \pm S.E.), and this was higher than those ($0.23 + 0.11\%$) reported by Hayashi et al. (1985); and with those ($0.21 \pm 0.08\%$) by reported by Kumagai (1990) as observed in Medan and Java, Indonesia. According to NRC (1984), the P requirement in forage for sheep is 0.16-0.38% of dry matter, and thus, the P content of forages examined in this study seemed clearly to satisfy P requirement for goats. As described above, the values indicated in table 2 were compared with that for cattle or sheep to discuss their requirements for goats, because no standard for goats was available. It seems, however, to be similar to those of cattle and/or sheep in principle when the values are indicated by a range.

TABLE 2. MINERAL CONTENTS OF MAJOR SPECIES OF FORAGES GRAZED BY GOATS, AND OF CONCENTRATES (% OF DRY MATTER)

Forage species	No. of samples	Calcium	Magnesium	Phosphorus
Star grass (<i>Cynodon plectstachyum</i>)	8	0.55 ± 0.05^1 (0.34 - 0.75) ²	0.25 ± 0.02 (0.18 - 0.33)	0.38 ± 0.02 (0.33 - 0.46)
Cogon grass (<i>Imperata cylindrica</i>)	4	0.55 ± 0.05 (0.44 - 0.67)	0.26 ± 0.03 (0.17 - 0.31)	0.31 ± 0.07 (0.10 - 0.41)
Napier grass (<i>Pennisetum purpureum</i>)	2	0.34 ± 0.05 (0.29 - 0.39)	0.18 ± 0.01 (0.17 - 0.56)	0.35 ± 0.04 (0.31 - 0.39)
Mixed samples	16	0.71 ± 0.08 (0.33 - 1.32)	0.31 ± 0.13 (0.13 - 0.56)	0.30 ± 0.03 (0.15 - 0.44)
Concentrates	3	1.30 ± 0.05 (1.23 - 1.35)	0.33 ± 0.07 (0.25 - 0.39)	0.85 ± 0.32 (0.53 - 1.16)

¹ Mean \pm S.E. of number of samples.

² The figures in parenthesis are range of values.

According to Wise et al. (1963), dietary Ca : P ratios below 1 : 1 and above 7 : 1 obviously reduced the growth and feed efficiency in growing cattle. Young et al. (1966) also reported with sheep that the availability of P was lowered by a diet deficient in P with a wide Ca : P ratio had no apparent effect on P absorption when P intake was adequate. In the present study, the Ca : P ratio (in forage) was calculated to be 16 : 1 (table 2), and this value obviously showed an adequate value of Wise et al. (1963) described above.

The seasonal changes in Ca, Mg and P contents of forages in 3 regions of Luzon Island are shown in table 3. The Ca content in forages were almost the same but tended to be higher in dry season than in rainy season in all the regions. Kumagai et al. (1990), however, reported that the Ca content of forages in rainy season was significantly ($p < 0.01$) higher than that in dry season in Java. The Mg content in forages tended to be lower in rainy season than in dry season at Los Banos and Munoz. In Baguio, contrarily the Mg content in forages was slightly higher in rainy season than in dry season. Kumagai et al. (1990) also showed a similar results which a relatively high Mg content of forages in rainy season in two places. But another place, the Mg content of forages was similar in both rainy and dry season in Java. The P content

of forages tended to be higher in rainy season than in dry season at regions of Los Banos and Baguio. It was almost the same in both rainy and dry seasons in Munoz. The data of Java (Kumagai et al., 1990) also showed a similar trend that the content of P in forages tended to be higher in rainy season than in dry season (in the two places), although it was similar in rainy and dry seasons (in another place).

The concentrations of Ca, Mg and P in blood plasma of goats grazed with or without supplements and their seasonal changes in 3 regions of Luzon Island were presented in table 4. The plasma Ca level in Los Banos tended to be higher in dry season than in rainy season, and in Munoz, the plasma Ca concentration in dry season was about 20 mg/l higher than that in rainy season, though the goats received no supplementary concentrates. On the other hand, in the group of goats with some supplements, the plasma Ca level in Munoz tended to be higher in rainy season than in dry season, though there was no difference in plasma Ca level in Baguio. Plasma Ca levels obtained in this study were a little bit lower than those of cattle in Java as observed by Kumagai et al. (1990). According to Kaneko (1980), a normal value on average in plasma Ca level of goats was 10.3 ± 0.7 mg/100 ml, with a normal range was 8.9 - 11.7 mg/100 ml.

TABLE 3. SEASONAL CHANGES IN MINERAL CONTENTS OF FORAGES IN 3 REGIONS (% OF DRY MATTER)

Region	Season	No. of samples	Calcium	Magnesium	Phosphorus
Los Banos	Rainy	4	0.55 ± 0.15^1 (0.29 - 0.80) ²	0.20 ± 0.03 (0.17 - 0.25)	0.38 ± 0.04 (0.31 - 0.44)
	Dry	8	0.61 ± 0.10 (0.43 - 0.93)	0.31 ± 0.05 (0.12 - 0.53)	0.30 ± 0.03 (0.19 - 0.42)
Munoz	Rainy	4	0.52 ± 0.09 (0.33 - 0.75)	0.19 ± 0.02 (0.13 - 0.23)	0.35 ± 0.05 (0.20 - 0.40)
	Dry	6	0.66 ± 0.12 (0.34 - 1.19)	0.31 ± 0.05 (0.28 - 0.33)	0.34 ± 0.04 (0.20 - 0.40)
Baguio	Rainy	4	0.59 ± 0.17 (0.45 - 1.09)	0.31 ± 0.09 (0.17 - 0.56)	0.34 ± 0.07 (0.15 - 0.45)
	Dry	4	0.79 ± 0.18 (0.54 - 1.32)	0.27 ± 0.05 (0.17 - 0.40)	0.26 ± 0.06 (0.10 - 0.39)

¹ Mean \pm S.E. of number of samples.

² The figures in parenthesis are range of values.

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TABLE 4. SEASONAL CHANGES IN MINERAL CONCENTRATIONS OF PLASMA OF GRAZING GOATS WITH OR WITHOUT SUPPLEMENTS (mg/l)

Region	Season	No. of goats	Without supplement			With supplement ¹		
			Calcium (90) ⁵	Magnesium (15)	Phosphorus (40)	Calcium (90)	Magnesium (15)	Phosphorus (40)
Los Banos	Rainy	8	91.2 ± 2.3 ² (82.8 - 103.7) ³ (62.5) ⁴	27.1 ± 1.1 (23.2 - 32.8) (0)	71.5 ± 4.7 (53.0 - 89.9) (0)	-	-	-
	Dry	29	94.8 ± 1.7 (78.5 - 127.8) (19.1)	28.4 ± 1.0 (21.2 - 43.6) (0)	81.3 ± 2.3 (57.6 - 107.0) (0)	-	-	-
Munoz	Rainy	16	75.6 ± 0.9 (69.3 - 83.4) (100)	23.9 ± 0.7 (19.3 - 29.1) (0)	87.1 ± 0.8 (13) ⁶ (65.9 - 109.8) (0)	101.2 ± 2.7 (80.7 - 120.5) (8)	25.6 ± 0.8 (20.2 - 28.8) (0)	84.2 ± 4.6 (59.5 - 106.7) (0)
	Dry	23	93.8 ± 3.4 (71.6 - 126.7) (50.0)	24.8 ± 0.6 (22.0 - 26.7) (0)	81.8 ± 2.6 (11) (72.0 - 92.1) (0)	93.9 ± 2.5 (77.8 - 126.8) (27)	26.5 ± 1.2 (20.4 - 33.7) (0)	78.6 ± 4.0 (57.0 - 109.3) (0)
Baguio	Rainy	9	-	-	-	90.8 ± 4.4 (76.3 - 113.2) (44)	23.7 ± 2.9 (21.2 - 33.1) (0)	82.7 ± 2.4 (73.2 - 93.2) (0)
	Dry	15	-	-	-	92.9 ± 2.6 (79.5 - 109.3) (29)	27.2 ± 1.3 (21.2 - 36.9) (0)	85.0 ± 4.6 (53.4 - 112.9) (0)

- ¹ The goats were supplemented with some concentrates.
- ² Mean ± S.E. of number of goats used.
- ³ The figures in parenthesis are range of values.
- ⁴ Percentage of blood samples less than the lower limit in plasma level.
- ⁵ The lower limit suggested by NRC (1984).
- ⁶ The number of goats used with supplement in Munoz.

Although plasma levels of Ca are not necessarily to indicate the nutritional status of Ca, because these levels are hormonally controlled. It is established that plasma Ca levels below 9 mg/100 ml indicate chronic low Ca intake and/or utilization (NRC, 1984). The average values of plasma Ca level, except the value of non-supplemented group in rainy season at Munoz, were within the range suggested by Kaneko (1980) as shown in table 3. However, as indicated in the range of without supplement, the values of some goats were obviously below the lower limit of the normal range described by NRC (1984). These results would show that a number of goats grazed in Luzon Island could not be in good nutritional status in Ca, although the Ca content in forages almost exceeded the requirement suggested

in NRC standard (1984). The causes of low plasma level of Ca in most of goats objected in the present study was not clear yet.

The plasma Mg levels of non-supplement group in Munoz were slightly lower than those in Los Banos. There were no obvious differences in plasma Mg levels between rainy and dry seasons in supplemented groups in Munoz, whereas the level in Baguio tended to be slightly higher in dry season than in rainy season. The plasma Mg levels shown in this study were clearly below the normal Mg level in goats, 32.0 ± 0.35 mg/l as suggested by Kaneko (1980). According to NRC (1984), however, the lower limit of normal Mg level is 15 mg/l of plasma, and thus, as indicated in parenthesis of table 4, all of the goats were not in under nutrition of Mg in both

groups regardless of supplementation of concentrates. Kumagai et al. (1990) reported that the plasma Mg level of cattle was significantly lower in rainy season than in dry season at 3 places in Java, and regarded it related in principle to a relatively low Mg content of forages.

The plasma P levels of goats without supplements in rainy and dry seasons were 71.5 and 81.3 mg/l in Los Banos and 87.1 and 81.8 mg/l in Munoz. In the supplement groups, the plasma P levels in rainy and dry seasons were 84.2 and 75.6 mg/l in Munoz and 87.7 and 85.0 mg/l in Baguio. There was no clear change of plasma P levels in both groups of with or without supplements or among regions. The average values in all regions, seasons and supplements exceeded the level as a normal value (65 mg/l) described by Kaneko (1980). But it was observed the 25 % of blood samples and 10% of blood samples in rainy and dry seasons showed P levels below the normal level in non-supplemented group in Los Banos. Similarly, in supplemented groups, 23% of samples in rainy season and 9% of samples in dry season in Munoz showed P levels below the level (Kaneko, 1980), and also in Baguio, 20% of blood samples in dry season showed low P values. In terms of plasma P level 40 mg/l has been shown as the lower limit according to NRC (1984), and thus, the P levels in all goats adopted in this study exceeded the critical level of plasma P.

From the results obtained in the present investigation, it can be concluded that some of grazed goats are in an under nutrition of Ca status in Luzon Island. Mineral deficiency, in general, can be prevent or overcome directly treating the animals through either the dietary means or minerals contained water supply, or indirectly, by applying an appropriate fertilizer to the soil of pastures (McDowell, 1985). But concentrates supplementation procedure could be unrealistic depend on the conditions of animal husbandry in the country. It is, therefore, necessary to decide and establish the most suitable

technique for supplying minerals to grazing ruminants in the Luzon, Philippines.

Acknowledgements

The authors wish to thank Japan Society for the Promotion of Science for funds supporting this research.

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