# Effects of Intraruminal Soluble Glass Bolus on Blood Selenium and Plasma Mineral Level of Grazing Does under Backyard Conditions in Selected Areas in Nueva Ecija, Philippines

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**ABSTRACT :** Soluble glass bolus with selenium (Se), copper (Cu) and cobalt (Co) was administered intraruminally to Philippine grazing does fed under backyard farming conditions to determine its effect on blood mineral status. Forty-five does were dosed with SGB intraruminally every 6 months, whereas 15 were without SGB during this experimental period of 10 months. Blood of does in both treatment groups were collected every other month and blood Se, plasma Cu, Ca, P and Mg were determined in this study. All does did not show clinical Se, Cu, Ca, P or Mg deficiency during this experimental period. Selenium concentration of treated does increased ($p<0.01$) after beginning of this experiment, whereas the level of control does decreased slowly ($p<0.01$). Two months after SGB administration, all treated does had higher blood Se than the lower limit of 20 μg/l suggested by NRC (1981), whereas some control does had lower blood Se concentration than the lower limit of 20 μg/l. On the other hand, plasma Cu concentration of treated does started to increase more remarkably than control does 4 months after this experiment had started although the difference was insignificant. There were no significant differences between plasma Ca, P or Mg concentration of does in both treatment groups. Soluble glass bolus had no harmful effects on plasma macro mineral concentrations of grazing does. This study showed that SGB was available as mineral supplement to improve imbalances of selected mineral of grazing goats in the traditional backyard conditions in Luzon Island, Philippines. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 2 : 189-197)***

**Key Words :** Backyard Farming, Goat, Minerals, Philippines, Soluble Glass Bolus

## INTRODUCTION

Goats in the Philippines are traditionally raised in the backyard condition. They subsist mainly on available feed resources such as fibrous crop residues, agro-industrial by products, natural vegetation and communal pasture areas in the farm. Availability of these feed is one of the major constraints in production. According to McDowell (1985), tropical forages contain lesser amounts of minerals during the dry season, thus, it is most likely to suffer mineral inadequacies during this time. Conversely, the heavy rainfall in the wet season induces mineral losses through leaching from the soil. Therefore, mineral absorption of these plants is low due to acidity of the soil although mineral contents of the soil are adequate (Minson, 1990). As a result, herbivores in most tropical regions exhibit various degrees of mineral deficiencies and imbalances (McDowell, 1985).

A study conducted by Fujihara et al. (1992b) revealed the monthly variability of blood and plasma mineral concentration of mature grazing goats in the Island of Luzon, Republic of the Philippines. This was confirmed in subsequent studies by Serra et al. (1996) and Orden et al. (2000). Moreover, they pointed out the effectivity of soluble glass bolus (SGB) in supplying micro elements, particularly Se with concentrates was found to be below the critical level of 0.25 μmol/l (Fujihara et al., 1992b). Orden et al. (2000) reported that intraruminal administration of SGB including selenium (Se), copper (Cu) and cobalt (Co) had positive effects on improving plasma micro mineral status of grazing goats in the experimental farm of Central Luzon State University (CLSU). It is however difficult to conduct experiments under the backyard farming conditions instead of research institutions.

Mineral content of SGB is not intensively studied in tropical regions although reports have been advocating the use of Se supplement (Hidiroglou et al., 1987; Kendall et al., 2001). In spite of the encouraging results regarding the effects of SGB in improving mineral status of goats, there is a need to test its applicability under backyard condition where 99 % of goats in the Philippines are found.

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The objective of this study was to determine the effect of SGB on blood and plasma mineral concentration of grazing does under backyard conditions in the Luzon Island, Philippines.

## MATERIALS AND METHODS

### Location

The agroclimatic condition of the experimental site is classified as tropical monsoon type, consisting of two distinct seasons, *i.e.*, dry (November to April) and rainy (May to October) with mean annual temperature of 27.5°C and average rainfall of > 2,000 mm (Figure 1).

The study was conducted in three different farms within the vicinity of CLSU, Science city of Muñoz, Nueva Ecija, Philippines. Basically the farms were characterized as rice based, although one of the farm maintained mango trees as one of its major components. Each farm maintained an average of 30 does and relied on the existing vegetation within the farm. Growth and availability of forage crop depend on rainfall due to the absence of irrigation system. The animals grazed in these areas round the year without any concentrate supplementation. Occasionally, leguminous fodder trees such as Ipil-ipil (*Leucaena leucocephala*) and Kakawate (*Gliricidia sepium*) were provided to the animals especially during lean summer months.

### Animals

Twenty does were selected in each farm, fifteen were dosed with SGB (treated) and five without SGB (control). The treated animals received two boluses during the whole experimental period which were given in six months interval. The first bolus was introduced in March 1999, during the start of the study, and the second one on October of 1999.

The bolus (COSECURE, Telsol Ltd., U. K.), which weighed about 16 grams, provided the goats with nutritionally essential minerals. This was a combination of

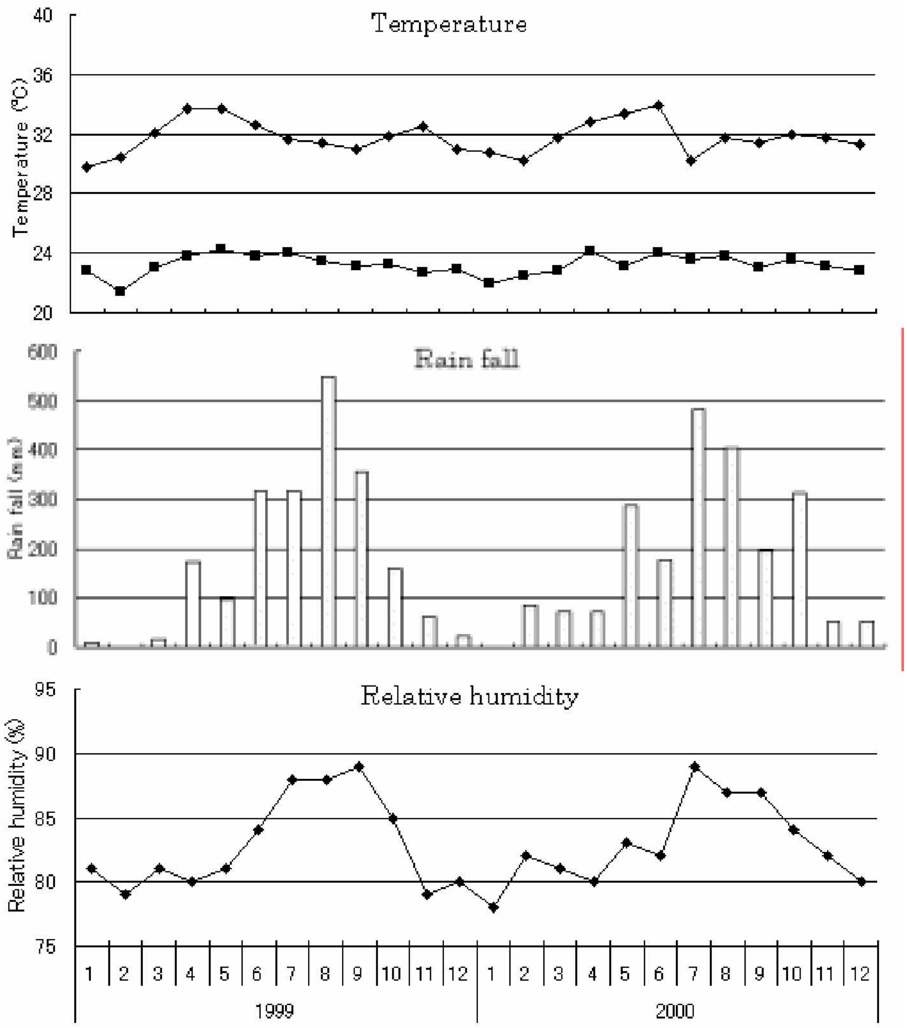


**Figure 1.** Climatic variations at Central Luzon State University, Science city of Muñoz, Nueva Ecija, Philippines.

0.15% w/w Se as $Na_2SeO_4$, 13.4% w/w Cu and 0.5% w/w Co. The bolus released 0.13 mg Se/d, 11.91 mg Cu/d and 0.44 mg Co/d over six months.

**Forage sampling**

Forage samples were collected bi-monthly using hand-plucking method. The dominant forage species found within the experimental areas were; Paragrass (*Brachiaria mutica*), Kabit-kabit (*Eleusine indica*), Guinea grass (*Panicum maximum*), Aguiñgai (*Rottboellia exaltata*), Rice (*Oryza sativa*), AlabangX (*Dichanthium aristatum*), Cogon grass (*Imperata cylindrica*), Bermuda grass (*Cynodon dactylon*), Vetiver (*Vetiveria zizanioides*), Napier grass (*Pennisetum purpureum*), Malitkalabaw (*Paspalum distichum*), Calopogonium (*Calopogonium mucunoides*), Centrosema (*Centrosema pubescens*), Kakawate (*Gliricidia sepium*) and Ipil-ipil (*Leucaena leucocephala*) (Table 1 and 2). Collected samples were dried at 70°C for 48 h before grinding. All samples were properly packed in plastic container, stocked and shipped to Japan for mineral analysis.

**Blood sampling**

Bi-monthly blood sampling was conducted during the course of the experiment. About 10 ml blood was drawn through the jugular vein of each animal using heparinized vacuum test tube. From which, one ml of whole blood was taken and the remaining portion was centrifuged 3,000 rpm for 20 min. to separate plasma from courpo cells. There after, one ml plasma was taken. The one ml whole blood and plasma samples were dried slowly over a hot plate at a temperature of 150°C for 6 h. After drying, all samples were properly packed, stored and shipped to Japan for mineral determination.

**Wet ashing and mineral analysis**

*Forage samples* : Forage samples were digested with nitric acid using a microwave oven (MDS-2000, CEM Co., U. S. A.). The setting for the microwave oven was as follows: Step 1: 40 bar, 5 min.; Step 2: 80 bar, 5 min.; Step 3: 120 bar, 5 min.; Step 4: 160 bar, 10 min. After cooling, the samples were diluted with deionized distilled water to a final volume of 50 ml. Thereafter, Se was analyzed through the fluorometric detection of the 2, 3-diaminonaphthalene (DAN) following the procedure of Watkinson (1966). The spectrofluoro photometer used was RF-1500 (Shimadzu Co., Japan) with 377 nm excitation and 520 nm emission. On the other hand, Cu, Ca, P and Mg were analyzed using an Inductively Coupled Plasma Atomic Emission Spectrometer (SPS 7700, Seiko Instruments Inc., Japan).

*Blood samples* : Whole blood and plasma samples were subjected to wet ashing with nitric acid and perchloric acid (3:1 v/v) prior to mineral determination. Selenium concentration was determined from the whole blood samples by DAN method (Watkinson, 1966). Copper, Ca, P and Mg concentration was determined by Inductively Coupled Plasma Emission Spectrometer (ICPS-2000, Shimadzu Co., Japan). All the glasswares used during the mineral analysis were acid washed with nitric acid to avoid any contamination.

**Table 1.** Selenium (Se) and Cu contents in forages in rainy and dry season

| Common name | Scientific name | Se (μg/kg DM) | | Cu (mg/kg DM) | |
|---|---|---|---|---|---|
| | | 100.0* | | 5.0 | |
| Grass | | Rainy | Dry | Rainy | Dry |
| Paragrass | *Brachiaria mutica* | 26.22 | 26.20 | 8.35 | 9.13 |
| Kabit-kabit | *Eleusine indica* | 20.02 | 14.09 | 8.55 | 6.09 |
| Guinea grass | *Panicum maximum* | 27.17 | 33.49 | 5.98 | 7.83 |
| Aguiñgai | *Rottboellia exaltata* | 23.77 | 14.95 | - | 6.80 |
| Rice | *Oryza sativa* | 19.32 | 23.83 | 8.06 | 7.35 |
| AlabangX | *Dichanthium aristatum* | - | 18.52 | - | 9.03 |
| Cogon grass | *Imperata cylindrica* | - | 20.85 | - | 8.30 |
| Bermuda grass | *Cynodon dactylon* | 23.96 | - | 6.76 | - |
| Vetiver | *Vetiveria zizanioides* | 21.04 | - | 6.94 | - |
| Napier grass | *Pennisetum purpureum* | 26.05 | - | 9.66 | - |
| Malitkalabaw | *Paspalum distichum* | 36.39 | - | 9.28 | - |
| Mean | | 24.88 | 21.70 | 7.95 | 7.79 |
| SEM | | 1.40 | | 0.49 | |
| Legume | | | | | |
| Calopogonium | *Calopogonium muconoides* | 29.70 | 28.91 | 9.95 | 8.98 |
| Centrosema | *Centrosema pubescens* | 24.80 | - | 9.03 | - |
| Kakawate | *Gliricidia sepium* | 26.68 | - | 3.99 | - |
| Ipil-ipil | *Leucaena leucocephala* | 24.13 | - | 12.15 | - |
| Mean | | 26.33 | 28.91 | 8.78 | 8.98 |
| SEM | | 2.16 | | 0.69 | |

* Critical level recommended by NRC (1985).

**Table 2.** Calcium (Ca), P and Mg contents in forages in rainy and dry season (g/kg DM)

| Common name | Scientific name | Ca | | P | | Mg | | Ca: P | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3.0* | | 2.5 | | 2.0 | | 1: 1- 2: 1** | |
| Grass | | Rainy | Dry | Rainy | Dry | Rainy | Dry | Rainy | Dry |
| Paragrass | *Brachiaria mutica* | 3.50 | 4.60 | 2.91 | 3.60 | 3.71 | 3.92 | 1.2:1 | 1.3:1 |
| Kabit-kabit | *Eleusine indica* | 4.64 | 3.32 | 3.93 | 3.72 | 1.92 | 2.55 | 1.2:1 | 0.9:1 |
| Guinea grass | *Panicum maximum* | 3.31 | 4.20 | 1.70 | 2.90 | 2.86 | 2.48 | 1.9:1 | 1.4:1 |
| Aguiñgai | *Rottboellia exaltata* | 3.17 | 3.32 | 3.12 | 1.85 | 3.03 | 2.32 | 1.0:1 | 1.8:1 |
| Rice | *Oryza sativa* | 3.14 | 2.70 | 1.85 | 1.80 | 1.83 | 1.70 | 1.7:1 | 1.5:1 |
| AlabangX | *Dichanthium aristatum* | - | 3.04 | - | 2.39 | - | 2.43 | | 1.3:1 |
| Cogon grass | *Imperata cylindrica* | - | 3.13 | - | 1.12 | - | 2.25 | | 2.8:1 |
| Bermuda grass | *Cynodon dactylon* | 4.30 | - | 2.29 | - | 1.35 | - | 1.9:1 | |
| Vetiver | *Vetiveria zizanioides* | 3.19 | - | 1.08 | - | 2.31 | - | 3.0:1 | |
| Napier grass | *Pennisetum purpureum* | 3.11 | - | 3.66 | - | 1.70 | - | 0.8:1 | |
| Malitkalabaw | *Paspalum distichum* | 3.51 | - | 1.74 | - | 2.60 | - | 2.0:1 | |
| Mean | | 3.54 | 3.47 | 2.48 | 2.48 | 2.37 | 2.52 | 1.6:1 | 1.6:1 |
| SEM | | 0.01 | | 0.01 | | 0.02 | | | |
| Legume | | | | | | | | | |
| Calopogonium | *Calopogonium muconoides* | 7.00 | 7.22 | 3.20 | 1.94 | 2.66 | 3.08 | 2.2:1 | 3.7:1 |
| Centrosema | *Centrosema pubescens* | 10.79 | - | 1.83 | - | 2.41 | - | 5.9:1 | |
| Kakawate | *Gliricidia sepium* | 15.14 | - | 2.02 | - | 3.87 | - | 7.5:1 | |
| Ipil-ipil | *Leucaena leucocephala* | 10.57 | - | 1.86 | - | 3.66 | - | 5.7:1 | |
| Mean | | 10.88 | 7.22 | 2.23 | 1.94 | 3.15 | 3.08 | 5.3:1 | 3.7:1 |
| SEM | | 0.13 | | 0.51 | | 0.51 | | | |

* Critical level recommended by McDowell (1985).
** Desired ratio (Maynard et al., 1979).

**Statistical analysis**

Mean values of mineral content among the season for grass and leguminous species, and between grass and leguminous species during a year were compared by Student t-test (Steel and Torrie, 1980). The difference of mean value of blood Se and plasma mineral concentrations among the treatment at each month, and between the first sampling month and other month in each group were detected using the same method (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

**Forage selenium and copper contents**

The mean Se and Cu contents of dominant forage species within the experimental area are presented in Table 1.

Average Se content of grasses during rainy and dry season was 24.88 µg/kg DM and 21.70 µg/kg DM (p>0.01), respectively. On the other hand, leguminous species contributed 26.33 and 28.91 µg/kg DM during rainy and dry season, respectively (p>0.01). In spite of the numerically higher Se concentration observed among legumes (p>0.01), these values were below the NRC (1985) recommendation of 100 µg/kg DM for goats and sheep. Result supports the previous observations (Fujihara et al., 1992b; McDowell, 1985; Minson, 1990) that forage grazed by goats contained critically low level of Se.

Unlike Se, the Cu concentration of the dominant pasture species was higher than 5.0 mg/kg DM required for goats and sheep (NRC, 1985). The Cu content of grasses showed less variability, with mean values of 7.95 and 7.79 mg/kg DM during rainy and dry season, respectively (p>0.01). Legumes had higher Cu content, 8.78 mg/kg DM during rainy season and 8.98 mg/kg DM in dry season (p>0.01), compared with grasses (p>0.01).

**Forage calcium, phosphorus and magnesium contents**

The mean Ca, P and Mg contents of dominant forage species within the experimental area are shown in Table 2.

Average Ca content of grasses during rainy season was 3.54 g/kg DM and 3.47 g/kg DM in dry season (p>0.01). On the other hand, leguminous species contributed 10.88 and 7.22 g/kg DM during rainy and dry season (p>0.01), respectively. According to Fujihara et al. (1992a), average Ca content of some selected grasses in Luzon Island was 7.1 g/kg DM. Average Ca level of forage species was above the critical level of 3.0 g/kg DM for ruminants recommended by McDowell (1985) although average Ca contents of grass species in this study was below the grass Ca content reported by Fujihara et al. (1992a). Therefore Ca intake of does was supposed to be adequate during some season when does were grazing adequate amounts of forage species. Conversely, the maximum tolerable level of Ca is 20 g/kg of diet dry matter for sheep (NRC, 1985). Calcium contents in all of forage species were lower than the highest limit in this study.

Average P content of grasses was the same (2.48 g/kg DM) during both seasons (p>0.01). Leguminous species contributed 2.23 and 1.94 g/kg DM during rainy and dry season (p>0.01), respectively. Phosphorus contents of forage species were below the critical level of 2.5 g/kg DM for ruminants recommended by McDowell (1985). Fujihara et al. (1992a) reported that P contents of some forage species in the Island of Luzon, Philippines, were higher than the lower limit. In this study, however, P contents of some forage species were below the critical level. According to McDowell (1985), in most livestock grazing areas of tropical countries, soils and plants are low in P. For grazing livestock, P deficiency is the most severe mineral limitation in tropical countries. Phosphorus deficiency is the most widespread and is of the higher economical importance of all the mineral deficiencies for grazing livestock (McDowell, 1985). Some forage species, in this study, contained more than the critical level of 2.5 g/kg DM recommended by McDowell (1985). To feed some of richer P forage species such as Paragrass (*Brachiaria mutica*) and Kabit-kabit (*Eleusine indica*) was supposed to be good for P status of grazing goats. Conversely, the maximum tolerable level of P is 6.0 g/kg of diet dry matter for sheep (NRC, 1985). In this study, P contents in all of forages were lower than the highest limit recommended by NRC (1985). These results agree with those reported by Fujihara et al. (1992a) and Serra et al. (1997) that forage P contents in Philippines were below the maximum tolerable level of 6.0 g/kg DM in NRC (1985).

Aside from the lower level of P contents in the forages, its ratio to Ca in the leguminous species exceeded the desirable Ca: P ratio of 1: 1 to 2: 1 (Maynard et al., 1979) due to higher contents of Ca in leguminous species. According to McDowell (1985), a Ca: P ratio of 1: 1 to 2: 1 is usually recommended if P intake is marginal or inadequate. The balance of the minerals is often upset when legumes with a Ca: P ratio of 6 to 10: 1 are fed, or likewise a wide ratio exists when only overly mature tropical forages, particularly those low in P, are available to grazing livestock during extended dry seasons. In this study, all of leguminous species and some of grass species had wide Ca: P ratio due to higher contents of Ca in these species. These results agree with those reported by Fujihara et al. (1992a) that some grass species tended to be wider in Ca: P ratio in the Luzon Island, Philippines. Therefore to feed the forage species containing narrower Ca: P ratio such as Paragrass (*Brachiaria mutica*), Guinea grass (*Panicum maximum*) and Rice (*Oryza sativa*), to goats will improve plasma mineral balance of grazing animals under backyard conditions.

Average Mg content of grasses during rainy season was 2.37 g/kg DM and 2.52 g/kg DM in dry season (p>0.01). Leguminous species contributed 3.15 and 3.08 g/kg DM during rainy and dry season (p>0.01), respectively. Almost (80.0%) of the dominant pasture species in this study contained higher Mg contents than the required 2.0 g/kg DM for ruminants (McDowell, 1985). This result agree with those reported by Fujihara et al. (1992a) and Serra et al. (1997) that mean forage Mg content were above the suggested level of 2.0 g/kg DM for ruminants by McDowell (1985). Fujihara et al. (1992a) also reported that Mg content of Napier grass (*Pennisetum purpureum*) tended to be lower than those in other grass species. Magnesium content of Bermuda grass (*Cynodon dactylon*), Rice (*Oryza sativa*) and Kabit-kabit (*Eleusine indica*) as well as Napier tended to be lower than those in other grass species in this study. Grass tetany can be a problem for grazing ruminants in tropical countries since forages are often low in Mg (McDowell, 1985). Dusting or spraying pastures with Mg compounds increases Mg of the forage, but the Mg is easily washed off by rain. Farmers did not use fertilizer during this experimental period in this study. However 72.2% of grass species and all of leguminous species were sufficient in Mg. Therefore to feed some of richer Mg forage species such as Paragrass (*Brachiaria mutica*) and Ipil-ipil (*Leucaena leucocephala*) was supposed to be better for Mg status of grazing animals under backyard conditions.

**Does whole blood selenium and plasma Cu status**

Whole blood Se and plasma Cu concentration of does in both treatment groups are presented in Table 3.

Initial blood selenium concentration of control and treated does were 52.0 and 53.1 μg/l at the start of the experiment. Selenium concentration of control does decreased slowly from May, early in the rainy season, to November because grazing time, forage intake and mineral intake from forages of grazing does appeared to get smaller due to heavy rainfall (97.3-547.5 mm) in this season. Conversely Se concentration of the treated does increased after beginning of this experimental period. All of treated does' blood Se concentrations were higher than the lower limit for goats, 20 μg/l in NRC (1981), from May to February, whereas 12.5% of control does' blood Se concentrations were lower than the level. Orden et al. (2000) reported that there were positive effects of SGB on blood Se concentrations of Philippine goats one month after supplementation. The initial Se level of grazing does in this study was higher than the level of 22.1 μg/l of treated goats in their study (Orden et al., 2000). After 10 months, whole blood Se concentration of treated does in three farms was 78.5 μg/l and was 1.48 fold higher (p<0.01) than initial level. According to Orden et al. (2000), the mean blood Se concentration of treated animals was 76.6 μg/l at the end of experiment and was 3 fold higher (p<0.01) than that of untreated animals. Underwood and suttle (1999) indicated

**Table 3.** Whole blood Se and plasma Cu concentration of does

| | | Mar. | May | Jul. | Sep. | Nov. | Jan. | Rainy | Dry |
|---|---|---|---|---|---|---|---|---|---|
| Blood Se (μg/l) | | | | | | | | | |
| 20.0[a] | Control | 52.0 | 41.5 | 38.2 | 31.0[b] | 22.7[b] | 30.2[b] | 37.1 | 34.1 |
| | Treated | 53.1 | 67.7 | 83.7[b] | 86.6[b] | 76.6[b] | 78.5[b] | 79.6[c] | 65.1 |
| | SEM | 3.50 | 4.24 | 5.48 | 6.55 | 5.34 | 6.41 | | |
| | Level of significance | ns | * | * | * | * | * | | |
| Plasma Cu (mg/l) | | | | | | | | | |
| 0.60 | Control | 0.62 | 0.57 | 0.57 | 0.57 | 0.63 | 0.63 | 0.57 | 0.63 |
| | Treated | 0.60 | 0.57 | 0.60 | 0.63 | 0.68 | 0.77 | 0.60[c] | 0.67 |
| | SEM | 0.03 | 0.01 | 0.01 | 0.01 | 0.04 | 0.05 | | |
| | Level of significance | ns | ns | ns | ns | ns | ns | | |

[a] The lower limit suggested by NRC (1981 and 1985).
[b] Significant difference compared to initial level ($p<0.01$).
[c] Significant difference compared to dry season ($p<0.01$).
ns: Not significant ($p>0.01$), * $p<0.01$.

that normal range of sheep blood Se concentration was 39.5-71.1 μg/l. Blood Se concentration of animals increased up to 78.5 μg/l due to the oral administration of intraruminal SGB in this study. These levels did not excess so remarkably compared to the maximum level of 71.1 μg/l of sheep indicated by Underwood and suttle (1999). Moreover all of these experimental animals did not show any Se toxicities such as Blind Staggers or Alkali disease. Therefore it was suggested that SGB was a good Se supplement for grazing does under the traditional backyard farming conditions.

According to McDowell (1992) and Underwood and Suttle (1999), ruminant Se deficiency could result to white muscle disease and reproductive disturbance. Although this study did not determine the ratio of clinical signs of Se deficiencies, it was feared that some of control does suffered from reproductive disturbance such as abortion, stillbirth and neo-natal mortality due to Se deficiency. Soluble glass bolus was found to be effective in maintaining an adequate Se supply to increase whole blood Se concentration of grazing does.

Mean plasma Cu concentration of control and treated does was 0.62 and 0.60 mg/l when this experiment started. Plasma Cu concentration of does of both treatment groups in three farms decreased ($p>0.01$) from March to May at the change of season from dry to rainy season. Thereafter these levels in both groups increased slowly ($p>0.01$). The increase rate of mean plasma Cu levels of treated does was a little higher than that of control does due to SGB administration although there was no significant difference among two groups at the same month ($p>0.01$). According to NRC (1985), the lowest limit of goat plasma Cu level was 0.6 mg/l. Underwood and Suttle (1999) also indicated that the normal range of plasma Cu concentration was 0.57-0.95 mg/l for ruminants. After 10 months, 50.0% of control does' blood Cu concentration were lower than the lower limit of 0.6 mg/l suggested by NRC (1985), whereas only 25.0% of treated does' blood Cu concentration were lower than the level.

Orden et al. (2000) reported that there were positive effects of SGB on plasma Cu concentrations of Philippine goats two months after supplementation. They also indicated that the mean plasma Cu concentration of treated animals was 1.69 mg/l and higher ($p<0.05$) than untreated animals (1.37 mg/l) after one year, and both were higher than the lowest level of the normal range suggested by NRC (1985). After 10 months, in this study, mean plasma Cu concentration of control does in these three farms was 0.63 mg/l and 1.02 fold higher ($p>0.01$) than initial level. On the other hand, plasma Cu concentration of treated does in these three farms was 0.77 mg/l and 1.29 fold higher ($p>0.01$) than initial level. These levels were lower than those reported by Orden et al. (2000). The experimental does in this study were grazing under the backyard farming conditions whereas animals had been grazing in the pasture in the university (Orden et al., 2000). Although mean forage Cu content was above the NRC (1985) recommendation of 5.0 mg/kg DM for goats, Cu intake of grazing does in this study was not supposed to be so sufficient as expected. According to McDowell (1985 and 1992), other minerals such as Mo present in excessive amount have been found to adversely affect Cu utilization. Copper deficiency is a severe limitation to grazing ruminants and has been observed in many parts of the world. Plasma Cu concentration of grazing does increased up to utmost 0.77 mg/l unlike the results reported by Orden et al. (2000). However these plasma Cu levels of grazing does in both groups at the end of the experiment were higher than the lowest limit of 0.6 mg/l in NRC (1985). Results indicated that SGB was supposed to be effective in improving plasma Cu status of Philippine grazing does under the traditional backyard farming conditions although there were no significant effects of SGB administration on plasma Cu concentration of grazing does in this study.

**Does plasma calcium, phosphorus and magnesium status**

Plasma Ca, P and Mg concentration of does in both treatment groups are presented in Table 4. There were no effects of SGB on plasma Ca, P and Mg concentration of

**Table 4.** Plasma Ca, P and Mg concentration of does (mg/l)

| Ca | | Mar. | May | Jul | Sep | Nov | Jan | Rainy | Dry |
|---|---|---|---|---|---|---|---|---|---|
| 90.0[a] | Control | 86.7 | 91.2 | 87.1 | 86.9 | 85.1 | 85.2 | 88.1 | 85.7 |
| | Treated | 86.4 | 90.5 | 91.2 | 87.8 | 90.0 | 89.6 | 90.0 | 88.7 |
| | SEM | 1.51 | 1.20 | 1.54 | 1.04 | 1.28 | 1.90 | | |
| | Level of significance | ns | ns | ns | ns | ns | ns | | |
| P | | | | | | | | | |
| 40.0 | Control | 70.4 | 79.6 | 65.9 | 61.6[b] | 68.3 | 63.6 | 69.3 | 67.9 |
| | Treated | 74.0 | 74.3 | 63.9[b] | 62.2[b] | 71.8 | 64.3 | 66.9 | 71.0 |
| | SEM | 2.02 | 2.36 | 2.19 | 1.77 | 2.38 | 3.68 | | |
| | Level of significance | ns | ns | ns | ns | ns | ns | | |
| Mg | | | | | | | | | |
| 15.0 | Control | 23.9 | 25.3 | 22.9 | 25.2 | 24.5 | 24.6 | 24.4 | 24.2 |
| | Treated | 22.6 | 23.0 | 23.9 | 24.1 | 26.2[b] | 25.2[b] | 23.6 | 24.8 |
| | SEM | 0.46 | 0.48 | 0.42 | 0.45 | 0.45 | 0.63 | | |
| | Level of significance | ns | ns | ns | ns | ns | ns | | |

[a] The lower limit suggested by NRC (1985).
[b] Significant difference compared to initial level ($p<0.01$).
ns: Not significant ($p>0.01$).

grazing does under backyard conditions in this study ($p>0.01$).

Initial plasma Ca concentration of control and treated does was 86.7 and 86.4 mg/l, respectively when this experiment started. Plasma Ca concentration of does in both treatment groups were constant ($p>0.01$) during this experimental period. Animals did not show any clinical signs of Ca deficiency although they were not fed any mineral supplements throughout the year. Orden et al. (2000) reported that there were no effects of SGB on plasma Ca concentrations of Philippine goats in CLSU experimental farm during experimental period. In this study, there were also little effects of SGB on plasma Ca concentration of does grazing under backyard conditions ($p>0.01$).

NRC suggested that the plasma Ca concentration of goats under chronic low Ca intake was 90 mg/l (1985). 45.2% of treated does had higher plasma Ca concentration than the lower limit during this experimental period, whereas 35.8% of control does had higher plasma Ca level than the lower limit. Fujihara et al. (1992a) reported that many goats showed Ca level below the lower limit of 90 mg/l suggested by NRC (1985). This study showed a similar result, and it seemed to be necessary to supplement Ca to grazing goats.

Initial plasma P concentration of control and treated does was 70.4 and 74.0 mg/l, respectively, when this experiment started. Plasma P concentration of treated does did not change so far whereas plasma P level of control does changed more remarkably during this experimental period. But these changes did not show any significant differences.

Plasma P concentration of control and treated does increased after the start of experiment ($p>0.01$). Thereafter plasma P concentration of grazing does in both treatment groups decreased ($p<0.01$) until September. There was a light rain during April (172.1 mm), late of the dry season, plants grew up and forage intake of goats was supposed to increase more than previous month. Phosphorus intake of grazing animals was supposed to increase and plasma P concentration of both treated does was slightly lower during rainy season than during dry season ($p>0.01$). There was a heavy rain from June to September (393.3 mm/month), during rainy season, it was considered that grazing time and forage intake of goats decreased although plants grew up quickly and remarkably. According to Minson (1990), the heavy rainfall induces mineral losses through leaching from the soil during rainy season. McDowell (1985) indicates that P content declines as the plant matures, whereas forage Ca content is less affected by advancing maturity. Therefore P intake of grazing does was supposed to be lower during rainy season than dry season in this study.

In NRC (1985) it was suggested that the lower limit of plasma P concentration of goats was 40 mg/l. Almost (98.4%) of does plasma P concentration in both treatment groups, in this study, were higher than the lower limit during this experimental period.

Initial plasma Mg concentration of control and treated does was 23.9 and 22.6 mg/l, respectively, when this experiment started. There were supposed to be only few available plants in the pastures at the late of dry season (March). It was therefore suggested that forage intake of grazing does was limiting and plasma Mg levels of does was low. NRC suggested that the lower limit of plasma Mg concentration of goats was 15 mg/l (1985). Plasma Mg concentration in both treatment groups during this experimental period was higher than the lower limit. Mean plasma Mg concentration of grazing does in treated group increased slowly ($p>0.01$) whereas the level of control does tended to change up and down ($p>0.01$) from March to

September, *i.e.*, from late of dry season to late of rainy season. There was a light rain (97.3 mm) at the onset of rainy season (May), and it is considered that plants grew up and animals were able to find available forages. Plasma Mg levels of grazing does increased a little during this month. However there was a heavy rain (97.3- 547.5 mm) as rainy season advanced. It is considered that the decrease of does' grazing time due to the heavy rain resulted to decrease plasma Mg concentration of animals. Does' plasma Mg concentration in control and treated group was higher ($p>0.01$ and $<0.01$) than initial levels when this experiment finished at the middle of dry season. It was considered that there were still some available forages and animals had much time to graze in the pastures.

Does' plasma Mg concentration was not affected by SGB administration but by the change of season. The insignificant effect of SGB on plasma Mg concentrations supports the conclusion of Batra and Hidiroglou (1993) that intraruminal administration of 30 g Se pellets did not influence plasma level of Mg in dairy cattle. Soluble glass bolus had no harmful effect on plasma Mg concentration of grazing does in this study.

## CONCLUSION

The principal factors limiting performance of grazing animals are the low protein content of grasses, low energy intake due to the high fiber content of forages, and mineral deficiencies or imbalances (McDowell, 1985). Livestock producers in tropical countries do not always supplement grazing livestock with minerals. Grazing livestock depend largely upon forages to supply their mineral requirements. It is considered that mineral supplementation is necessary for grazing animals in addition to feeding adequate forage species. Generally, negligible concentrate supplementation, available fibrous crop residues and vegetation are available to Philippine goats under backyard condition. Occasionally, feed supplements, household scraps, small quantities of grains or grain by-products are given (PCARRD, 1985).

There were positive effects of intraruminal SGB on grazing does blood Se and plasma Cu status in this study although there was no significant difference between does' plasma Cu levels in both treatment groups. According to Serra et al. (1996), SGB can dissolve gradually in the rumen and its effect on improving blood Se status of goats continues up to five months after intraruminal administration. The effects of SGB appeared to continue over six months in this study. Therefore, farmers do not have to introduce SGB to goats so frequently. They do not need so much investment, time or labor for administering SGB. In this study, plasma Ca, P and Mg concentration of treated does was not affected by SGB administration. Farmers, therefore, can use SGB as mineral supplement to micro mineral deficient goats without any harmful effects on other mineral status of animals. Soluble glass bolus is available and suitable as mineral supplement to improve blood Se and plasma Cu mineral imbalances of grazing goats in the traditional backyard conditions in Luzon Island, Philippines.

According to McDowell (1985), some mineral deficiencies bring about reproductive disorders. Many reports indicated that mineral supplementation improved mineral status of mineral deficient animals (Abdelrahman and Kincaid, 1995; Hidiroglou et al., 1987; Kott et al., 1983; Langlands et al., 1991; White et al., 1989). In this study, oral administration of intraruminal SGB improved dose' whole blood Se and plasma Cu levels. There is a possibility that continuous intraruminal SGB administration will improve reproductive performance of grazing does fed on backyard farming conditions in Luzon Island, Philippines.

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