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Growth performance and mineral status on goats (*Caprahircus*linn.) supplemented with zinc proteinate and selenium yeast

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Abstract *- The aim of this study was to determine the effects of dietary supplementation of Zn proteinate and Se yeast on growth performance and mineral status in local goats.Twenty two (22) doelings weighing 7.86 ± 2.12 kg were grouped into 6 weight classes in a feeding trial to determine the effects of dietary zinc proteinate and selenium yeast on mineral status and growth performance. The Zn-supplemented groups received 200 mg additional Zn daily from chelated Zn proteinate, an insoluble powder containing 15% elemental Zn. Se-supplemented groups received 3 mg Se from Se yeast consisting mainly of selenomethionine (63%). The four (4) dietary treatments were as follows: T1 : 0 mg Zn + 0 mg Se; T2: 0 mg Zn + 3 mg Se; T3 : 200 mg Zn + 0 mg Se. T4: 200 mg Zn/head + 3 mg Se/head. The experiment was conducted in a 2 x 2 factorial design in RCBD. Napier grass used in the trial contained 89.03 ppm Zn, while the mixture of corn-soybean oil meal had Zn content 49.73 ppm. Supplementation of Zn and Se in the diets composed of 60% Napier and 40% soya-corn mix had no effect on dry matter intake, body weight gain, and feed efficiency. Giving 200 mg Zn/head tends to increase (P<0.05) the Zn concentration in the blood of doelings among the levels of Se. Percent digestibility of Zn decreased with Zn supplementation at 200 mg. Percent apparent digestibility of Zn tends to be higher in animals without mineral supplementation. Results indicate that Zn and Se supplementation did not affect growth performance. Zn supplementation increased blood Zn concentration, but did not affect digestibility of Zn.*

Key words*- goats; minerals; digestibility; growth; performance*
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Introduction

In order to increase the animal productivity, people are trying to develop new technology to manipulate feed formulation such as silage, amofer technology, fermentation and ammonization to improve feed quality [1; 2; 3; 4]. Nutrient manipulation such protein-energy ratio was studied related to feed quality [5]. Among those technology regarding feed quality, farmer tend to be underestimate the availability of mineral among the available nutrients in the feed, since the needs of the animals are in small amount.Mineral nutrition of ruminant is a chronic problem since most forage plants contain varying levels of micro-minerals. To maintain the balance of minerals, the animals are given mixture of minerals to prevent deficiency that can cause certain diseases and maintain optimum productivity [6]. Underwood and Suttle[7] stated that minerals have the functions of the body's metabolic processes, among these are: structure, physiological, catalysts and regulator. Mineral requirements of goats are not fully understood or investigated, and established requirements are extrapolated largely from information from cattle and sheep [8].

Zn and Se are critical trace minerals for production and reproduction in farm animals. These minerals are absorbed and used to enhance performance, improve immunity, health and reproduction. While Se initially has been known as toxic element to some plants and animals, it is now recognized as one of the elements needed by the animal for growth and fertility[9]. The primary function of Se is in the synthesis of glutathione peroxsidose that helps deactivate oxygen radicals such hydrogen peroxide and prevents them from causing cellular damage [10]. Zn contributes to the growth and division of cells, antioxidants, sexual development, immune cell, dark adaptation, taste, and appetite [11].

Zinc is actively involved in enzyme function, most notably in metalloenzymes. The use of Zn as a supplementation is widely used in dairy cattle, in order to observe the effect of supplementation on milk quality parameters such as milk production, milk fat, milk protein and somatic cell count as well as studies conducted by Stanton *et al.*[12], Uchida *et al*. [13], Griffiths *et al*.[14].

For a long time, goat mineral nutrition has been considered as halfway between those of cattle and sheep [15]. There is limited research information about trace mineral in goats compared with other ruminants such sheep and cattle [16], hence, this study. Therefore, objectives of this study were to determine the effects of dietary supplementation of Zn proteinate and Se yeast on growth performance and mineral status in local goats.

Materials and Methods

A. Animals and Experimental Design

Twenty-two (22) 5-7 month old female goats or doelings were used. The body weight ranged from 5 to 10 kg with an average body weight of 7.86 ± 2.12 kg (CV = 26.81%). The doelings were blocked by body weight and randomly assigned in to 4 dietary treatments. Prior to the start of the experiment, the doelingswere treated with antiparasitic, anthelmintic and antibiotic to control external and internal parasite. Likewise, the animals were also injected with vitamin A, D and E. Animals were maintained under uniform management condition. The housing was well ventilated with adequate facilities for individual feeding. Animals were allowed one week adjusment period and 1 week preliminary stage.

Table 1. Dietary composition of the basal diet (%) and its chemical composition

Ingredient	Composition (%)*	
Napier	60	
Soybean oil meal	5	
Yellow corn	35	
Chemical composition	Concentrate feed[1]	Napier grass[1]
Organic matter	94.96	82.27
Crude protein	15.31	14.78
Ash	5.04	17.73
Energy (Kcal/kg)	4230	3762
Zn[2] (ppm)	49.73	89.03
Se (µ/kg)		17.80[3]

* Based on dry matter basis
[1] Reported result from Animal Nutrition Laboratory; Animaland Dairy Science Cluster, UPLB
[2] Reported result from Chemistry Science Laboratory; UPLB
[3] Reported result from Fujihara*et al*., 1992

The feed was composed of corn and soy bean oil meal (SBOM) (Table 1), while Napier grass was the source of roughage. The diet was given at roughage:concentrate ratio at 60:40 based on DM requirement. The diet was formulated to be adequate in protein and energy for the class of goats. The doelings were fed in the morning at 8:00 and 14:00 hours. *Ad libitum* access to water was maintained throughout the study. Doelings were fed individually to meet the nutrient requirements of animals for maintenance and growth at 4.4% of body weight based on dry matter basis [17] for 84 days.

Zn proteinate and Se yeast/methionine were added to the concentrate. Zn proteinate was added at 0 mg and 200 mg/day/head, while Se at 0 mg and 3 mg/day/head. A 2 x 2 factorial design was used, where Factor 1 was Zn (with Zn and without Zn) and Factor 2 was Se (with Se and without Se). Treatment combinantions were as follows: T1 : Without Zn and Se; T2 : With Se and without Zn; T3 : With Zn and without Se; and T4 : With Zn and Se. The Zn-supplemented groups received 200 mg additional Zn daily from chelated Zn proteinate (Alltech), which is an insoluble powder containing 15% elemental Zn. Se-supplemented groups received 3 mg additional Se from Se yeast which contains 97-99% organic Se consisting mainly of selenomethionine (63%) and low molecular weight selenocomponent (34-36%).

B. Data Collection

The concentrate mixture and Napier grass were analyzed for proximate components and also for Zn and Se contents.

C. Feeding trial

The doelings were weighed at day 0 to obtain the initial body weight. Feed offered was recorded daily for each animal and feed refusal was weighed the next morning before feeding to calculate the feed intake. Feeding trial lasted for 84 days. The dry matter intake was calculated by substracting the total weight of feed refused multiplied by percent of dry matter from the total of feed offered multiplied by percent of dry matter of feed. During the feeding period, the animals were weighed every 2 weeks and the amount of feed offered was adjusted after each weighing. At the end of the experiment, the final body weight of the doelings was taken. Data on live weight gain, feed intake, and feed efficieny were gathered.

D. Mineral Blood Concentration

Blood samples were collected twice, at day 0 of the experiment and then at day 77 of the experimental period. The collection of 10 ml whole blood was via jugular venipuncture using stainless steel needles. The collected blood samples were placed into 50 ml crucible. The crucibles were immediately transported to the laboratory for weight determination followed by oven drying 70^{o}C for 2 days. Dry matter content was determined by drying the blood in to oven 105^{o}C overnight and ashed at a furnace temperature of 550^{o}C. Subsequently, the blood ash was dissolved in HCl (1+3) and 5 drops of HNO_3 and evaporated to about 5 ml, and diluted to 50 ml volumetric flash with distilled water then filtered before reading for Zn and Se contents using atomic absorption spectrophotometry (AAS) and inductively coupled plasma (ICP), repectively.

E. Statistical Analysis

The data collected were analyzed using analysis of variance (ANOVA) with 2 x 2 factorial in RCBD according to Gomez and Gomez [18]. Treatment mean differences were organized by Tukey's test with error level (α) 5% using MINITAB 14.

Results and Discussions

Diet Composition

cereal grains and other seeds tend to be lower than in the grass depending on the location with values ranging from 0.006 mg/kg DM to 3 mg/kg DM [19]. The Zn and Se content of drinking water were negligible and hence, were not accounted in the calculation of Zn and Se ntake. The corn-SBOM mix diet contained 73.306 ppm of Zn.

Feed Intake and Weight Gain

As shown in Table 2, both levels of Zn and Se supplementation have no significant effects on the final body weight, body weight gain, average daily gain, dry matter intake and feed efficiency among the treatment, nor was there any interaction effects between Zn supplementation and Se supplementation.

Effects of Zn and Se supplementation on average daily protein intake (ADPI) were not significantly different. There were no interaction effects between Zn supplementation and Se supplementation. The mean of average daily protein intakes (ADPI) with 0 and 200 mg of Zn proteinate were 51.24 and 55.63 g, respectively, and 53.84 and 53.03 g with 0 and 3 mg of Se.

The doelings supplemented with Zn proteinate and Se methionine did not show higher final body weight, faster average daily gain, higher feed intake and also better feed efficiency. A low level of feed efficiency was positively related to ADG, where the average growth of doelings were also very low. Nugoroho*et al.* [25], found the Philippines native goats has an average ADG of 13.92 g/d which is higher than this study on treatment with 0 mg of Zn supplementation resulted 6.60 g/day and lower than this study with 200 mg of Zn proteinate resulted 14.39 g/d. Similar observations were reported by Pal *et al*. [20] and Mandal*et al*. [26] where supplementation with organic source of Cu and Zn did not differ on final body weight, body weight gain, average daily gain, and feed efficiency. Other studies have shown that by supplementing Zn the ADG increases [27 and 28]. Compared with the marginal dietary level of 20-33 ppm Zn for goats as stated by NRC [23[, this level of Zn in present experiment was 30 ppm of Zn (15% of 200 mg of Zn). The control diet in this experiment which contained 73.306 ppm of Zn suggested that Zn concentration in the control diet was more than adequate, which could have minimized potential for responses in body weight change, average daily gain, feed intake and feed efficiency due to change in Zn status. Masters (1984) as cited by Puchala*et al.*[28] stated that the effect of dietary Zn supplementation, regardless of form, depends on the animal's nutrient status, particularly of minerals and protein. Increasing the dietary Zn concentration might increase some parameters on growth performance of animal, but it does not work on the dietary CP as the dietary CP level is held constant. Thus, the fixed dietary CP concentration in the present experiment may have masked effects of increasing dietary Zn may have on growth performance.

Napier contained 89.03 ppm of Zn, while Zn content of corn-SBOM was 49.72 ppm (Table 1). The Se content in

Animals with 200 mg of Zn proteinate have the same amount of feed intake compared to animals with 0 mg of Zn. No differences were observed in Zn and Se supplementation on the doelings in feed intake and protein intake in this experiment. Feed intake in this expereiment was set at 4.4% of body weight. The feeding regime should have unlimited opportunities for full expression of dietary treatment effects on feed intake [28]. The result of this study supports the findings of Garg*et al.*[29] that giving 200 mg Zn/kg of diet in the form of organic (Zn methionine) did not improve intake of dry matter, organic matter, crude protein, digestible CP and and nutrients digestibility, compared to the administration of inorganic Zn (ZnSO4) in the same amount on the lamb for 150 days. In the study of Jia*et al.*[27], digestibility of DM, crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) did not differ among treatments. Performance reponses to Zn supplementation of ruminant diet have been variable. Some of the studies on Zn treatment have shown different responses although the animals received the same amount from different sources. From these findings, it can be said that the type of animal, breed, stage of growth, feed, and environmental conditions also greatly affect the absorption and metabolism of trace minerals in the body. It is suggested that the basal diet with 73.306 mg Zn/kg DM can support normal growth in the doelings, and supplementation above that level has no further impact.

Blood Mineral Status

Zn Supplementation

Final Zn concentrations in the doeling's blood were not significantly different between treatments. The levels of both factors had also the same average and did not increase the Zn concentration in the blood. There was no significant interaction effects between the factors.The final Zn concentrations in blood among the levels of Zn supplementations were the same, as well as for Se supplementations. Supplementing Zn of as much as 30 mg (15% elemental Zn of 200 mg) could not increase Zn concentration in the blood, which is dietary Zn concentration (post treatment) held constant.

Table 2. Dry matter intake, protein intake, final body weight, body weight gain, average daily gain and feed efficiency ofdoelings supplemented with Zn and/or Se

No.	Zn	Se	DMI (g/day)	Protein intake (g of DM)	Final BW (kg)	BWG (kg)	ADG (g/day)	Feedefficiency (kg/kg)
1	0 mg	0 mg	334.57	50.12	8.52	0.43	5.16	1.59
2		3 mg	349.46	52.35	8.93	0.68	8.04	1.69
3	Mean		342.02	51.24	8.73	0.56	6.60	1.64
4	200	0 mg	384.39	57.55	9.67	1.40	16.67	4.19

No.	Zn	Se	DMI (g/day)	Protein intake (g of DM)	Final BW (kg)	BWG (kg)	ADG (g/day)	Feedefficiency (kg/kg)
5	mg	3 mg	358.62	53.70	8.68	1.02	12.10	3.13
6	Mean		371.51	55.63	9.18	1.21	14.39	3.66

The mean blood change concentrations of Zn among Zn levels as well as the level of Se supplementation were significantly different (P<0.05). Still, there was no interaction effect between Zn supplementation and Se supplementation.

Table 3. Zn concentration in blood of doelings supplemented with Zn and/or Se

No.	Zn	Se	Initial Zn (ppm)	Final Zn (ppm)	Change (ppm)
1	0 mg	0 mg	2.20^{a}	2.88	0.67^{b}
2		3 mg	3.48^{a}	1.92	-1.56^{a}
3	Mean		2.84^{y}	2.40	0.44^{y}
4	200 mg	0 mg	1.70^{a}	3.24	1.54^{b}
5		3 mg	1.94^{a}	2.70	0.76^{a}
6	Mean		1.82^{x}	2.97	1.15^{x}

Differentsuperscripts within columns denote significant differences (P<0.05)

Supplementing Zn proteinate at 200 mg level obviously increased (P<0.05) the total Zn intake by as much as 57.77 ppm compared to 25.39 ppm for 0 mg of Zn. However, the levels of Se supplementation have the same mean on Zn intake. The means of Zn intake with 0 and 3 mg of Se supplementation were 41.8 and 41.36 ppm, respectively. There were no significant interactions between Zn and Se supplementation.

Supplementing Zn resulted in significant differences (P<0.05) on fecal Zn among the levels. On the other hand, supplementing Se resulted in the same mean on Zn feces among the levels and there were no interaction effects between Zn supplementation and Se supplementation.

Zn digestibility of diets supplemented with Zn had different means (P<0.05). Supplementing Se, however, had the same mean on Zn digestibility among the levels as there were no interactions between Zn and Se supplementation.

Table 4. Total Zn intake, fecal Zn, apparent Zn digestibility ofdoelings supplemented with Zn and/or Se

No.	Zn	Se	Total Zn intake (mg)	Zn feces (mg)	Zn digested (mg)	Zn digestibility (%)
1	0 mg	0 mg	24.84^{a}	3.56^{a}	21.28	85.22^{a}
2		3 mg	25.95^{a}	2.64^{a}	23.31	89.82^{a}
3	Mean		25.39^{y}	3.10^{y}	22.30	87.52^{y}
4	200 mg	0 mg	58.76^{a}	37.17^{a}	21.60	38.16^{a}
5		3 mg	56.77^{a}	35.51^{a}	21.26	37.97^{a}
6	Mean		57.77^{x}	36.34^{x}	21.43	38.06^{x}

Different superscripts within columns denote significant differences (P<0.05)

The diet in the present experiment contained 73.30 ppm Zn. Overall, it appears that Zn content in the control diet in the present experiment was adequate. Several studies showed significant increased in plasma Zn concentration as effect of Zn supplementation. In the study of Jia*et al*. [27], plasma Zn concentrations increased (P<0.01) with Zn supplementation and were higher (P< 0.05) for the treatment groups supplemented with 30 and 45 mg Zn/kg DM. The study of Puchala*et al.*[28] revealed that supplementation of the diet with Zn-methionine treatments (1, 3, and 5 mg/day Zn-Met) increased (P <0:03) plasma Zn concentration (0.92 versus 0.72 mg/l for control).

Plasma Zn and Cu concentrations were significantly higher (P<0.05) in ewes that consumed Cu-Met + Zn-Meth [20]. In contrast, Ryan *et al.*[30] did not find any difference in the plasma Zn concentration in adult sheep that were daily supplemented with 75 and 150 mg of Zn either as Bioplex Zn (chelated Zn) or inorganic Zn (ZnSO).

Zn content in the basal diet seemed to have been able to provide Zn to meet the requirement of the doelings. Animals fed with 200 mg of Zn digested only small amounts as needed while the remainder was excreted through feces. These data are supported by the level of Zn content in the feces. Animals with 200 mg Zn supplementation showed high fecal Zn, while animals without Zn supplementation (0 mg) resulted to small amount of Zn in the feces. Percentage of apparent digestibility showed contrasting results. Animals fed with 200 mg of Zn showed less absorption, while animals without Zn supplementation had a higher digestibility. This indicates that animals utilize Zn received according to their requirements and the rest are excreted. Lőnerdal[31] said that by increasing the amount of Zn in a meal, fractional Zn absorption (%) will decrease, whereas the amount of Zn absorbed increases linearly at higher dietary levels, which would be consistent with a diffusion process. This study strengthens the findings of Miller [32] that percentage absorption of Zn from feed materials will decrease with increasing dietary Zn on ruminant. The observed apparent Zn absorption values also confirm the findings of Reid *et al.*[33] that the percentage of absorbed Zn decreases with increasing dietary Zn level.

Se Supplementation

Se concentration in the blood was conducted prior to the experiment to get the initial Zn concentration and later after 77 days feeding period. Based on the analysis, Se concentration in blood, both at the initial and final phases, could not be detected because the concentration of Se was very low. Se contained in the blood, fecal, feed and also forage was not detected due to the low amount and could not reach the limit detection of the instruments (AAS and ICP). Both dry and wet ashing methods were used to digest the samples, sample size was also increased and yet could not be detected. Although several methods can be used for selenium determination, the volatility and instability of certain forms of selenium and the non-homogeneity of sample

materials are the common challenges for all analytical procedures [19].

Low absorption of Se in ruminants is believed to result from reduction of dietary Se to insoluble forms such as elemental Se or selenides in the rumen environment [34]. Another factor that affects the absorption of Se is mineral antagonism. Association mineral with fibers in the feedstuff or mineral bond with undigested fiber constituents in the gastrointestinal tract may alter the bioavailability of some trace minerals in the ruminant. Rumen conditions with pH 6-6.8 produce a trace mineral that forms insoluble.

Conclusions

The supplementation of Zn and Se in the diets composed 60% forage and 40% corn-SBOM had no effect on BWG, ADG, feed efficiency, total intake of dry matter and also total intake of crude protein. Giving 200 mg/head of Zn tends to increase the Zn concentration in the blood of doelings, but was not significantly diferrent among the level of Se. Based on the analysis, Napier has a fairly high content of Zn. In addition, the mixture of SBOM-corn feed used has high Zn content. Zn content in the basal diet seems to be sufficient for the doelings. Because of the apparent digestibility of Zn treatment for almost all the same, hereinafter excess minerals are excreted in feces. Percent digestibility of Zn decreased with Zn supplementation of 200 mg/head and otherwise, percent of apparent digestibility of Zn to be higher in animals with 0 mg of mineral supplementation.

Zn and Se supplementation showed increase in blood concentration of zinc, but not on growth performance. Selenium content in the forage, feed and blood in this study could not be detected by AAS and ICP. Both dry and wet ashing methods were used to digest the sample, and sample size was also increased. This was due to the small amount of selenium in the sample used.

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