Supplementation of Inorganic and Organic Zinc Mixtures in Feed of Boerka Goats Fed by Oil Palm Fronds

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ABSTRAK

Ginting SP, Antonius, Simanihuruk K. 2017. Suplementasi campuran Zn anorganik dan organik pada kambing Boerka yang diberi pakan pelepah kelapa sawit. JITV 22(2): 51-56. DOI: http://dx.doi.org/10.14334/jitv.v22i2.1798

Seng (Zn) merupakan elemen pada berbagai jenis enzim maupun hormon yang memiliki peran fisiologis sangat penting di dalam tubuh, yang mempengaruhi produksi maupun reproduksi ternak termasuk aktivitas mikroba rumen dalam pemecahan serat pakan. Penelitian bertujuan untuk meningkatkan performa kambing yang diberi pakan dasar pelepah kelapa sawit yang mendapat suplementasi 35 ppm Zn dalam bentuk Zn anorganik (ZnO) dan organic (Zn-metionin). Tiga puluh ekor kambing jantan persilangan Boer x Kacang (Boerka) umur 9-11 bulan digunakan dalam penelitian ini dan yang dibagi menjadi lima kelompok perlakuan pakan sebagai berikut: P1 (kontrol): pakan komplit berbasis pelepah sawit, P2: P1 + 35 ppm Zn (100% ZnO), P3: P1 + 35 ppm Zn (75% ZnO + 25% Zn-metionin), P4: P1 + 35 ppm Zn (50% ZnO + 50% Zn-metionin), P5: P1 + 35 ppm Zn (25% ZnO + 75% Zn-metionin). Rancangan percobaan yang digunakan adalah Rancangan Acak Lengkap dengan enam ulangan. Peningkatan proporsi Zn organik meningkatkan konsumsi pakan dan konsumsi paling tinggi terdapat pada kelompok yang diberi suplementasi Zn anorganik/Zn organik dengan rasio 25/75. PBBH hanya berbeda (P<0,05) pada kelompok yang mendapat suplementasi Zn dengan proporsi Zn-metionin paling tinggi (75%). Konsentrasi Zn dalam darah meningkat secara nyata (P<0,05) dengan peningkatan proporsi Zn-metionine, namun komposisi asam lemak terbang tidak berbeda antar perlakuan (P>0,05). Disimpulkan bahwa performa kambing yang diberi pelepah sawit sebagai pakan dasar dapat ditingkatkan dengan pemberian suplemen Zn dalam bentuk campuran Zn anorganik (ZnO) dan Zn organik (Zn-metionin)

Kata Kunci: Kambing, Seng, Suplementasi, Pelepah Sawit

ABSTRACT

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Zinc is an element of many enzymes and hormones having very important physiological functions in the body so that it influences the production and reproduction of animals including the activity of the rumen microflora in degrading fiber in a diet. The aim of this study was to improve the performances of goats offered oil palm fronds based diets through the supplementation of 35 ppm of Zn in the form of inorganic (ZnO) and organic zinc (Zn-methionine). Thirty mature male crossing Boer x Kacang (Boerka) goats were divided into five groups and randomly allocated to one of the five feed treatments as follows: P1: complete feed based on the palm oil fronds (Control), P2: P1 + 35 ppm Zn (100% Zn0), P3: P1 + 35 ppm Zn (75% Zn0 + 25% Zn-methionine), P4: P1 + 35 ppm Zn (50% Zn0 + 50% Zn-methionine), P5: P1 + 35 ppm Zn (25% Zn0 + 75% Zn-methionine). The experiment was conducted in a Completely Randomized Design of six replications. Increasing the proportion of Zn methionine in the mixtures elevated feed consumption, and the highest feed intake was observed in goats received 75% Zn-methionine/25% ZnO. Daily body weight gains was only affected (P<0.05) by the 75% Zn-methionine/25% ZnO supplement. The concentration of Zn in the blood increased significantly (P<0.05) when Zn methionine was added and it increased steadily as the proportion of Zn methionine greater in the mixtures, but the VFA compositions of the rumen were not affected (P>0.05) by Zn supplementation. It is concluded that the performances of goat fed complete diets based on the oil palm fronds could be improved by supplementation of inorganic and organic Zn mixture.

Key Words: Goats, Zinc, Supplementation, Palm Oil Fronds

INTRODUCTION

Zinc (Zn) as a component of various enzymes or hormones plays crucial physiological role in the body influencing production and reproduction of animal (Supriyati 2013). It is also an enzyme component, plays a role in antioxidant system of body to eliminate volatile radicals resulted from metabolism process (Flora 2009; Zhao et al. 2014). Zinc is the second most element of micro mineral in the body, but cannot be saved in the body tissue, so that it should be available every time through the diet to meet physiological requirement of the animal (Zalewski et al. 2005; Swain et al. 2016). Maost Zn in the forage is distributed to cell wall (Whitehead et al. 1985; Cheng et al. 2012), so that influencing its availability for ruminant (Spears 2003). The assurance of adequate Zn intake is crucial in order to optimize the activity of fiber breaker enzyme in the rumen as the Zn function as cofactor. This role is more relevant in feeding system which uses oil palm frond as a basic diet consisting of high fiber with cellulose content of 49.8% (Izzuddin 2008).

Inorganic Zn in the form of oxide zinc (ZnO) or sulfate zinc ($ZnSO_4$) has been used as supplement for ruminant and those two inorganic zincs forms were reported having relatively comparable with the availability level (Jia et al. 2009; Jia et al. 2008). Organic Zn in the form of Zn-methionine as methyl (CH_3) contributor is important in the DNA transcription and translation process. However, the use of organic Zn in ruminant diet is relatively limited due to higher price compared to the inorganic Zn. On the other hand, the inorganic Zn availability is limited and indicating environmental pollution resulted from high dose requirement (Feng et al. 2009). So, this study was aimed to improve the performance of goat offered oil palm frond-based diet through Zn supplementation.

MATERIALS AND METHODS

Experimental animal and diet

As much of 30 mature males crossing Boer x Kacang (Boerka) goats aged 9-11 months with the average body weight of 24.56±3.01 kg were used in this study. Those goats were weighed then divided into five groups of five treatments by supplementing 35 ppm Zn that consisted of inorganic Zn (ZnO) and organic Zn (Zn-methionine) as below:

- P1: ZSAZxzspalm oil frond-based complete feed (Control)
- P2: P1 + 35 ppm Zn (100% ZnO)
- P3: P1 + 35 ppm Zn (75% ZnO + 25% Zn-methionine)
- P4: P1 + 35 ppm Zn (50% ZnO + 50% Zn-methionine)
- P5: P1 + 35 ppm Zn (25% ZnO + 75% Zn-methionine)

The goats were reared in the individual metabolic cage and treated with anti-parasite worm medicine. The complete feed consisted of Crude Protein by 17.9% and Digested Energy by 2630 Kcal/kg Dry Material (Table 1). Palm oil frond was used as fiber source in the complete feed by 30%. The wheat of *Indigofera zollingeriana* leaf and soybean meal used as protein source. The ingredients were evenly mixed as complete feed. Zn supplement was processed by mixing the inorganic Zn (commercial) and organic Zn (Zn-methionine) produced in Balai penelitian Ternak, Ciawi in the different ratio and same Zn concentration (35 ppm). Zn supplement was then mixed with corn wheat as carrier (25 g) to ease the way of consumption. Zn supplement was fed in the morning and must be sure to be consumed. Complete feed then was provided *ad libitum* in the morning (08.30 am) and evening (02:00 pm)

The goat was fed with the diet and the left over diet were weighed every day to calculate daily consumption. The drinking water was given *ad libitum*. Goats were weighed every two weeks for 10 weeks to evaluate its body weight gain.

Table 1. Completed diet used in this research

Feed ingredients	Proportion (% BK)
Indigofera zollingeriana leaf meal	20.0
Cake palm cake	19.0
Molasses	5.0
Soybean meal	24.0
Bone meal	1.0
Palm oil frond	30.0
Chemical composition[a]	
Crude Protein (% DM)	17.9
Digested energy (Kkal/kg DM)	2630

[a]Counted.

Sample collection and analysis

To evaluate the volatile fatty acid in the rumen, rumen liquid sample was collected using a tube inserted into rumen through esophagus of each goat. Samples were collected five hours after feeding at the end of feed test. Rumen liquid then was filtered using 4 layers of filter cloth and directly centrifuged (10,000 x *g*) for five minutes. The filtrate was then stored in a refrigerator (-20°C) for further analysis. The VFA was analyzed using a Gas Chromatography. Blood sample (10 ml) was collected from jugular vessel at the time rumen liquid collection. The sample then was separated by centrifuging at 1500 x g 40°C for 20 minutes. The plasma was then transferred into labeled tube and stored at -20°C until further analysis.

Statistical analysis

This study was conducted under the Completely Randomized Design with five treatments and six repetitions. Data were analyzed using analysis of variance by SAS (2001). When there was a treatment effect, then the Duncan test was applied (Gomez & Gomez 1984). The mathematical model used was:

$$Y_{ij} = \mu + \tau_i + e_{ij}$$

Where:
Y_{ii} is variable response measured by the treatment-i (i=1-5), μ was general average value and the e_{ij} is error random

RESULTS AND DISCUSSION

Feed consumption and body weight gain

Feed consumption (dry material) with inorganic Zn supplementation was not different (P>0.05) from the control (P1 vs. P2), even increased numerically (Table 2). Increasing organic Zn proportion tended to increase feed consumption and the highest consumption was on the administration of inorganic and organic zinc mixtures by 25/75 of ration. The increase of feed consumption was suspected to relate to more Zn availability in rumen needed for enzymatic fiber degradation. One of restriction factors of consumption is the number and level of digestible fiber (NDF) in the rumen (Harper & McNeill 2015). Consumption level of DM on the whole treatments was around 3.46-4.2% of body weight and was normal. This shows that complete feed can be used to improve palatability of oil palm fronds when it is supplemented as low basal diet (*cafetaria style*). The oil palm frond as fiber source is crucial to assure optimal rumen function.

The effect of Zn supplementation to daily weight gain (DWG) of goat was shown in the Table 2. The highest DWG (P<0.05) was from P5, while the DWG was not significantly different (P>0.05) among the control (P1) and P2, P3 and P4. This shows that increase of consumption of diet supplemented by Zn is expressed linearly with the body weight gain only on

Table 2. Consumption of completed diet and daily body weight gain of Boerka goat offered by inorganic and organic zinc mixtures with different ratio

Parameter	P1	P2	P3	P 4	P5
Consumption:					
DM (g/d)	857.8±78.5[a]	906.5±85.1[ab]	913.3±65.7[b]	1025.6±81.5[bc]	1098.3±89.7[c]
DM (g/kg BW)	34.61±4.7[a]	37.27±4.67[ab]	38.13±9.59[b]	38.47±0.44[bc]	42.11±0.37[c]
DM (% BW)	3.46±0.37[a]	3.73±0.23[ab]	3.81±0.84[b]	3.84±0.78[bc]	4.2±0.51[c]
Body Weight:					
Initial (kg)	23.78	23.40	23.44	25.64	24.94
Final (kg)	25.78	25.24	24.46	27.68	27.22
PBBH (g)	54.57±2.19[a]	52.57±2.37[a]	57.71±2.87[a]	58.29±3.21[a]	65.14±2.93[b]

P1 = Control (without supplementation)
P2 = P1 + 35 ppm Zn (100% Zn0)
P3 = P1 + 35 ppm Zn (75% Zn0 + 25% Zn-methionine)
P4 = P1 + 35 ppm Zn (50% Zn0 + 50% Zn-methionine)
P5 = P1 + 35 ppm Zn (25% Zn0 + 75% Zn-methionine)
BW= Body Weight

the diet with the highest organic Zn composition. The average body weight gain of goat on the whole treatments was around 52-65g and categorized into moderate. Jia et al. (2009) fed Z-methionine on goat by 20 ppm and resulted daily weight gain by 42.7 kg. Zn-methionine supplementation on lamb as much as 30 and 60 ppm resulted in daily weight gain each by 45 g and 55 g (Haryanto et al. 2005). Compared other study, the daily weight gain in this study indicated that the inorganic and organic zinc mixtures supplementation in the form of Zn-methionine and ZnO could be added without reducing the growth response.

Blood Zn Concentration and Volatile Fatty Acid of Rumen Liquid

The effect of Zn supplementation on blood Zn content was shown in Figure 1. Blood Zn concentration of the control group without Zn supplementation (P1) was not different (P>0.05) compared to the one on the 100% inorganic Zn (ZnO) supplementation (P2). Supplementation of inorganic and organic zinc mixtures increased Zn content in the blood (P<0.05). This is proved that organic increased Zn availability was better than the inorganic Zn. Supplementation of 25%

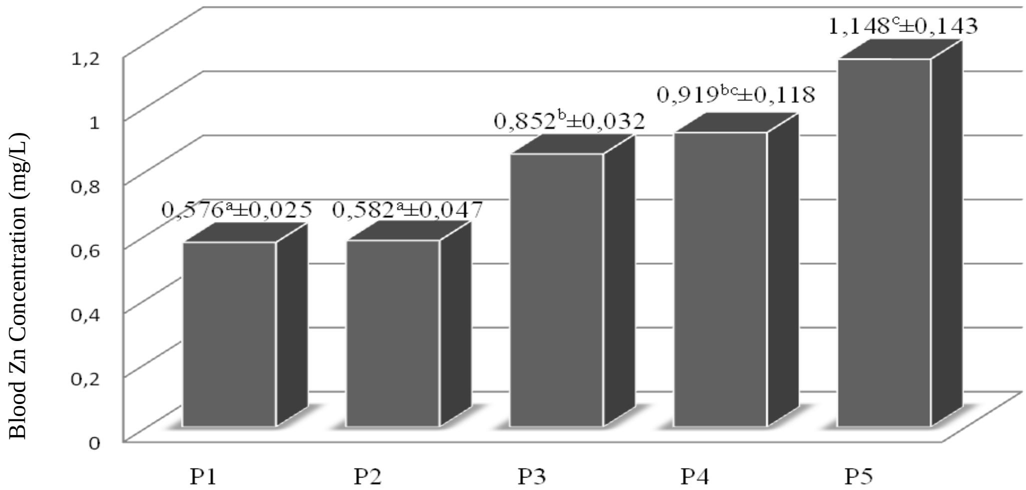

Figure 1. Effect of organic/inorganic ZN to Boerka goat blood Zn concentration offered by oil palm frond as basal diet.
P1 = Control (without supplementation);
P2 = P1 + 35 ppm Zn (100% Zn0);
P3 = P1 + 35 ppm Zn (75% Zn0 + 25% Zn-methionine);
P4 = P1 + 35 ppm Zn (50% Zn0 + 50% Zn-methionine);
P5 = P1 + 35 ppm Zn (25% Zn0 + 75% Zn-methionine).
Different superscripts in the same column show significant (P<0.05).

Table 3. Volatile amino acid concentration of goat (mM) without Zn or mixed-organic and inorganic Zn with different proportion

Volatile amino acid (mM)	P1	P2	P3	P 4	P5
C_2	25.50±4.63	27.37±5.04	27.65±4.38	21.08±2.51	24.34±1.88
C_3	9.78±1.46	9.73±2.42	11.93±3.34	8.73±0.76	7.06±2.50
iC_4	1.65±0.08	1.61±0.25	1.92±0.64	1.98±1.11	1.21±0.35
nC_4	5.12±0.67	5.93±1.82	6.85±1.21	4.31±0.27	4.0±1.71
iC_5	2.28±0.47	1.84±0.56	2.43±1.21	2.07±1.08	1.44±0.43
nC_5	0.72±0.09	0.71±0.15	0.79±0.19	0.60±0.16	0.50±0.17

P1 = Control (without supplementation)
P2 = P1 + 35 ppm Zn (100% Zn0)
P3 = P1 + 35 ppm Zn (75% Zn0 + 25% Zn-methionine)
P4 = P1 + 35 ppm Zn (50% Zn0 + 50% Zn-methionine)
P5 = P1 + 35 ppm Zn (25% Zn0 + 75% Zn-methionine)

inorganic Zn and 75% organic Zn resulted in the highest content of Zn in the blood (1148 mg/L) and it is in accordance with the study of Jia et al. (2012) namely 1.17 mg/L Zn in the goat blood supplemented by 100% Zn-methionine (20 ppm) or is lower compared to study of Aditia et al. (2014): 2.97 mg/L of Zn by supplementing 200 mg of Zn.

The effect of Zn supplementation to the concentration of some volatile fatty acids of goat rumen was shown in the Table 3. There was no effect ($P>0.05$) of treatments on the volatile fatty acid. Numerically, fatty acid (C2) concentration on the P1 was equal to the other groups. Numerically, concentration of propionate acid (C3), isobutirate acid (iC_4) and iso-valerate acid $i(C_5)$ were comparable with all treatments. Composition of acetic acid, propionate acid and butyrate acid were 21.08-25.5, 7.06-11.93 and 1.21-1.98 mM, respectively.

A research conducted by Supriyati et al. (2012) showed an increase on fiber digestibility (neutral detergent fiber and acid detergent fiber) by addition of bio-complex Zn into the goat diet. Jia et al. (2012) reported that the effect of Zn-methionine only influenced digestibility of acid detergent fiber and not on the neutral detergent fiber or dry material digestibility. In this study, there was no difference in volatile fatty acid composition that indicates the Zn supplementation used did not influence fiber digestibility.

CONCLUSION

Supplementation of 35 ppm Zn on oil palm frond for goat based diet did not increase the goat performance. Inorganic and organic zinc mixtures supplementation increased consumption, body weight gain and Zn concentration in the blood but did not affect the volatile fatty acid composition in rumen. An improvement of goat performance was in line with the higher Zn-methionine proportion in the Zn mixture supplement.

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