Supplementation Effect of Herbal and Organic Minerals in Beef Cattle Feed on Consumption, Digestibility, Efficiency and Daily Gain

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Abstract. The experiment was conducted in an attempt to study the effect of supplementation of *Sapindus rarak*, garlic powder and its combinations in beef cattle feed enriched with organic minerals of Cr and Zn on feed consumption, feed digestibility, feed efficiency, daily gain of beef cattle. The study used 16 males Brahman cross cows, which were fed with feeds supplemented with 250 ppm *Sapindus rarak* powder, 250 ppm Garlic powder, and a combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral. The results showed that supplementation of *Sapindus rarak*, garlic and enriched organic minerals increased the consumption of dry matter, organic matter, digestibility of dry and organic matter, daily gain, feed efficiency, and reduced the population of rumen protozoa and bacteria. Conclusively, supplementation with 250 ppm garlic powder and Cr-Zn organic minerals was the best for beef cattle feed to improve daily gain and feed efficiency.

Key words : *Sapindus rarak*, garlic, Cr-Zn, beef cattle, feed efficiency

Abstrak. Penelitian dilaksanakan bertujuan untuk mengkaji pengaruh suplementasi tepung *Sapindus rarak*, garlic maupun kombinasinya yang diperkaya dengan mineral organik Cr dan Zn terhadap konsumsi pakan, kecernaan pakan, pertambahan bobot badan dan efisiensi pakan sapi potong. Penelitian menggunakan 16 ekor sapi Brahman cross, yang diberikan 250 ppm tepung *Sapindus rarak*, 250 ppm tepung Garlic dan 250 ppm tepung *Sapindus rarak* dan garlic yang diperkaya dengan mineral Cr dan Zn. Hasil penelitian menunjukkan bahwa suplementasi tepung *Sapindus rarak* maupun garlic yang diperkaya mineral organik meningkatkan konsumsi bahan kering, bahan organik, kecernaan bahan kering dan bahan organik, pertambahan bobot badan, efisiensi pakan dan menurunkan populasi protozoa dan bakteri rumen. Suplementasi 250 ppm tepung garlic dan mineral organik Cr-Zn merupakan suplemen terbaik pada pakan sapi potong untuk meningkatkan bobot badan dan efisiensi pakan.

Kata kunci : *Sapindus rarak*, bawang, Cr-Zn, sapi potong, efisiensi pakan

Introduction

In overall productivity of cattle in Indonesia is in the low category, this is mostly because beef cattle farms in Indonesia are backyard farms that rely on low quality feed as the main feed. There are at least two problems in the development of beef cattle, namely: (1) the problem of providing high quality feed and (2) the problem of global warming, primarily methane emission. The problem of providing quality feed at this time faces with the nature of the forage in the tropics that are high in lignocellulose and cellulose, in addition, land area for forage cultivation is diminishing. Upon global warming issue, ruminant livestock methane is known as the largest contributor. Data from the United States in 2007, showed that in 2005 methane produced by dairy cattle, beef cattle, sheep and goats accounted for 40.87% of the 539 Tg (Behlke, 2007), where as the data from Environment Canada (2002) showed that dairy adults cow produced 118 kg CH_4/head/year, beef cattle 72 kg CH_4/head/year, bulls 47 kg CH_4/head/year, and sheep 8 kg CH_4/head/year. These datashowedthatthe potential ofbeef cattletoproducemethane gas was not fromdairy cows, but because thebeef cattle populationwas 10 times thepopulation of dairy cows, the methane emission from beef cattle was 5-fold of those from the dairy cows.

Beef cattle farms in Indonesia are based on traditional farming relying on low quality feed as the main feed, in which protozoa population in the rumen ecosystem tends to be high. Protozoa, predators of bacteria, will prey on fiber degrading bacteria or bacterial cellulolytic (Hobson, 1997). Based on the results of several studies, the presence of protozoa in the rumen are more harmful than beneficial (Eugene et al., 2004). Therefore, suppression of protozoa populationhas been attempted, resulting in a change in the microbial composition of rumen ecosystem, including through defaunation, as done by some researchers (Hess et al., 2003; Lila et al., 2005; Vienna et al., 2005; Goel et al., 2008; Suharti et al., 2009). Increased fiber digestibility in ruminants will provide the precursor formation of Volatile Fatty Acids (VFA), mainly acetic acid. On the other hand, an increase in the concentration of acetic acid will also affect the supply of H^+ ions into the substrate for the synthesis of methane. Miller (1995) asserted that the H^+ ions is a potential substrate for methanogens in the synthesis of methane, although there is formic acid, methanol, mono, di and tri-methylamine. Methane emission reduction is almost entirely from defaunation (removal of protozoa), the high availability of H^+ ions and the large potential for methane formation, because only 37% of methanogens association with protozoa (Newbold et al., 1995). Hart et al. (2006) stated that *Allium sativum* (Garlic) has the ability to reduce the production of methane because it contains allicin and organosulfur that will directly reduce methanogens, and the substances do not influence the effect of the bacterial population in the fermenter Rusitec.

Antimethanogenic activity of garlic that contains isoprenoic alcohols affects the stability of the cell membrane of archea (methanogens). Isoprenoid synthesis of methanogens that is catalyzed by HMG-CoA (Hidroxymethylglutaryl-CoA) reductase and organosulfur of Garlic has strong ability in inhibiting HMG-CoA, therefore inhibiting methanogenesis. Protozoa and inhibition of methanogenesis decline effectively in dairy cows with the supplementation of 0:18% *Sapindus rarak*extract and 250 ppm garlic with adequate Se, Cr and Zn by in vitro (Prayitno et al., 2013). In beef cattle supplementation of garlic extract and coconut oil (8:4) can improve the digestibility of dry matter, but has not been able to increase the body weight gain (Kongmun et al., 2011). This condition occurs only because methanogens reduction will save 15% of the ingested energy. The results of the preliminary study showed a combination of extracts of garlic-*Sapindus rarak* and organic mineral (Chromium) was capable of producing an increase in dry matter by 35% better than the research of Kongmun et al. (2010). The research results of Suharti et al. (2010) in form that the extract of *Sapindus rarak* supplementation only increased the digestibility of organic matter but does not increase body weight. Similar results were reported by Kongmun et al. (2011) on swamp buffalo, that garlic supplementation and coconut oil were not able to increase body weight gain because of suppression of methane emissions would only save 15% of ingested energy (130 KJ/mol, Sahakim et al., 2009). This studyconducted in addition to the inhibition of methanogenesis approach attempted to increase the metabolism of carbohydrates, lipids, amino acid with the addition of mineral Chromium (Cr) and organic mineral Zn.

Materials and Methods

Materials of the Research. The materials used were 16 males Brahman Cross males, with average initial body weight of 300±12.26 kg. Cows were housed individually in pens with a size of 1.5 x 2.60 m fitted with feed and drinking water. Feed consisted of 40% rice straw ammoniation and 60% concentrate. Feed dry matter requirement was set at 4% of body weight. Feeds were given twice a day, in the morning and afternoon at 07.00 and 15.00. Feeds and aorts were weighed every day and drinking water was provided ad libitum. Feed adaptation period was conducted for 2 weeks. Cows were weighed every week for 10 weeks using top brand digital scales with 1 ton capacity. At week 10^{th}, rumen sample was collected to calculate rumen protozoa and bacteria. The compositions of treatment feeds are presented in Table 1. The *Sapindus rarak* was purchased from a distributor in the Purbalingga district, Central Java, whereas garlic was purchased from a traditional market at Purwokerto, Central Java. The *Sapindus rarak* was dried at 70 ^{o}C for 4 days, the seeds were removed before grinding the dry fruit to make powder. The garlic was peeled off, dried and ground to make garlic powder.

Digestibility Trial. Feed digestibility experiments were carried out for 7 days in week 10^{th} of the study. Total collection method was used for the sampling of feed, feed residues and feces. Feed and aorts feed were weighed every day. Samples of feeds and aorts were collected for 7 days to proceed proximate analysis (AOAC, 2000). Samples were carried out on the stoolin the morning, afternoon, evening and night.

Results and Discussion

The effect of supplementation of *Sapindus rarak*, garlic and combination of garlic-*Sapindus rarak* enriched with Cr-Zn on dry matter intake, organic matter intake, and TDN intake are shown in Table 2. These results indicated that supplementation of *Sapindus rarak,* Garlic and

Table 1. Composition and nutrient content of treatment feed

Formulation	CTL	S-MO	A-MO	AS-MO
Ammoniated rice straw (40%)	100	100	100	100
Concentrate (60%)				
Cassava waste, %	36	36	36	36
Wheat pollard, %	27	27	27	27
Coconut cake meal, %	18	18	18	18
Rice brand, %	10	10	10	10
Corn meal, %	5	5	5	5
Mineral-mixed, %	1	1	1	1
Ca- Dolomit, %	0.5	0.5	0.5	0.5
NaCl, %	1.5	1.5	1.5	1.5
Urea, %	1	1	1	1
Suplement				
Sapindus rarak (%/kg DM)	0	0.18	0	0.18
Garlic (mg/kg DM)	0	0	250	250
Cr Organic (ppm)	0	1.5	1.5	1.5
Zn Lyzinate (ppm)	0	40	40	40
Nutrient				
Dry matter, %	88.98	89.55	89.34	89.90
Crude protein, %	14.68	14.44	14.01	13.82
Crude fiber, %	15.27	15.62	14.65	16.03
Ether extract, %	3.60	3.47	3.41	3.84
Ash, %	6.37	7.52	7.40	7.46
BETN, %	60.08	58.96	60.54	58.85
TDN, %	72.39	71.81	72.54	71.70

CTL: Control, S-MO: feeds supplemented with 250 ppm *Sapindus rarak* powder, A-MO: 250 ppm Garlic powder, AS-MO: combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral combination of *Sapindus rarak*-garlic and enriched with organic minerals (Cr and Zn) were able to increase the consumption of dry matter and organic matter than the control diet (Table 2). The increase in DMI and OMI indicated that feed supplements improved feed digestion process because feed supplements stimulate the activity of the rumen microbes to provide a comfortable condition for the rumen microbes. Other studies found no effect of *Sapindus rarak* powder on DMI in beef cattle feed (Suharti et al., 2010). Ghosh et al. (2011) conducting a research of garlic extract supplementation in calves showed that supplementation with garlic extract increased DMI, TDN and crude protein intake.

The effect of supplementation of *Sapindus rarak*, garlic and combination of garlic-*Sapindus rarak* enriched with Cr-Zn on dry matter digestibility (DMD), organic matter digestibilty (OMD) and crufe fiber digestibility (CFD) are shown in Table 3.

Table 3 shows that supplementation with a combination of *Sapindus rarak* and garlic-enriched with Cr and Zn had higher dry matter, organic matter and crude fiber digestibilities than other treatments. Improved digestibility of dry matter and organic matter indicated an improved rumen ecosystem, while improved digestibility of feed (dry matter and organic matter) provided opportunities and availability of sufficient nutrients for muscle synthesis. Increased feed digestibility was probably due to increased rumen microbial activity. An other researcher scored digestibility of dry matter and crude fiber of beef cattle feed supplemented with *Sapindus rarak* powder, i.e 57.65-67.76% and 18.39-36.44% respectively (Suharti et al., 2010).

The effects of supplementation of *Sapindus rarak*, garlic and combination garlic-*Sapindus rarak* enriched with Cr-Zn on rumen protozoa and bacteria population are shown in Table 4.

Sapindusrarak, garlicora combination of both with organic mineral enriched feeds were effective as a defaunation agents (Suharti et al., 2010; Prayitno and Hidayat, 2013), as seen from the sharp decline in the population of protozoa. Protozoa population decline allowed the reduction of methano gens, because approximately 37% of methanogens was in symbiotic with protozoa (Newbold et al., 1995). Garlic and organicmineral-enriched feedsloweredrumen bacteria, where as supplementation or combination garlic-*Sapindus rarak* and organic mineral did not affect rumen bacterial populations. The effects of supplementation of *Sapindus rarak*, garlic and combination of garlic-*Sapindus rarak* enriched with Cr-Zn on daily gain and feed efficiency are shown in Table 5. The data in Table 5 shows that supplementation of *Sapindus rarak* combined with organic minerals was not able to increase daily body weight gain, whereas supplementation of garlic and combination of garlic-*Sapindus rarak* plus organic minerals increased body weight gain. These results indicated that *Sapindus rarak* as protozoa defaunating agent was effective in lowering protozoa count (Table 3), significantly decreased protozoa but did not improve the utilization of nutrients in the gastrointestinal tract. Instead, a combination of garlic and organic minerals significantly increased daily body weight gain, as well as the combination of garlic and *Sapindus rarak* with organic minerals. Garlic as a source of alicin effectively lowered methane (Prayitno and Hidayat, 2013; Hart et al., 2006), so that the energy normally spentfor the synthesis of methane was used for the synthesis of muscle and meat. The Chromium mineralis thought to give a significant role in the increase in body weight gain. A research results of Suharti et al. (2010) showed that supplementation of *Sapindus rarak* in beef cattle feed did not affect body weight gain.

Table 2. Effect of herbal supplementation on consumption of dry matter (DMI), organic matter (OMI) and total digestible nutrients (TDN)

Items	CTL	S-MO	A-MO	AS-MO	P
DMI ($kg.d^{-1}$)	9.23±0.85[a]	10.53±1.02[b]	10.68±0.69[b]	10.94±0,47[b]	0.006
DMI (%BW)	2.89±0.19[a]	3.26±0.22[b]	3.31±0.19[b]	3.40±0.08[b]	0.006
OMI($kg.d^{-1}$)	7.63±0.92[a]	8.13±0.62[a]	9.18±0.79[b]	9.05±0.49[b]	0.003
TDN-intake ($kg.d^{-1}$)	3,47±0,23	3,59±0,31	3,88±0,21	3,92±0,14	

Values bearing different superscript at the same row shows significant (P<0.05).

CTL: Control, S-MO: feeds supplemented with 250 ppm *Sapindus rarak* powder, A-MO: 250 ppm Garlic powder, AS-MO: combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral

Table 3. Effect of herbal supplementation on digestibility of dry matter (DMD), organic matter (OMD) and digestibility of crude fibre (CFD)

Items	CTL	S-MO	A-MO	AS-MO	P
DMD (%)	61.87±0.82[a]	62.58±1.73[b]	61.06±1.27[a]	64.47±0.99[b]	0.001
OMD(%)	59.62±1.14[a]	61.15±1.07[a]	59.77±1.92[a]	63.96±1.60[b]	0.000
CFD(%)	43.04±1.59[b]	44.99±1.77[b]	39.16±2.03[a]	47.77±2.11[c]	0.000

Values bearing different superscript at the same row shows significant (P<0.05).

CTL: Control, S-MO: feeds supplemented with 250 ppm *Sapindus rarak* powder, A-MO: 250 ppm Garlic powder, AS-MO: combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral

Table 4. Effect of herbal supplementation on rumen protozoa and bacteria populations (log CFU/ml rumen fluid)

Items	CTL	S-MO	A-MO	AS-MO	P
Protozoa (log CFU)	7.09±0.235[a]	6.79±0.064[b]	6.73±0.090[b]	6.62±0.063[b]	0.001
Bacteria (log CFU)	8.93±0.521[a]	8.88±0.624[a]	7.947±0.717[b]	8.45±0.212[a]	0.045

Values bearing different superscript at the same row shows significant (P<0.05).

CTL: Control, S-MO: feeds supplemented with 250 ppm *Sapindus rarak* powder, A-MO: 250 ppm Garlic powder, AS-MO: combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral

Table 5. Effect of herbal supplementation on daily gain and feed efficiency

	CTL	S-MO	A-MO	AS-MO	p
Initial body weight (kg)	275.02±14.73	297.33±24.17	316.33±21.13	320.67±5.69	
Final body weight (kg)	343.40±4.62	365.13±29.51	406.93±18.01	408.87±6.00	
Daily gain (kg)	1.14±0.06[a]	1.13±0.02[a]	1.51±0.04[b]	1.47±0.04[b]	0.000
Feed efficiency (%)	13.43±1.67[a]	11.40±0.70[a]	15.06±0.17[b]	14.32±0.25[b]	0.003

Values bearing different superscript at the same row shows significant (P<0.05).

CTL: Control, S-MO: feeds supplemented with 250 ppm *Sapindus rarak* powder, A-MO: 250 ppm Garlic powder, AS-MO: combination of 250 ppm garlic-*Sapindus rarak* enriched with Cr and Zn mineral

Kongmun et al. (2011) reported that supplementation with garlic powder in swamp buffalo diet did not affect body weight gain.The results of this study also showed that supplementation of garlic and garlic combination with *Sapindus rarak* enriched with organic minerals improved feed efficiency by 11.39% and increased body weight gain by 30.70% compared to the control diet. The addition of 250 ppm garlic powder plus 1.5 ppm Cr and 40 ppm Zn in beef cattle feed produced cheaper feed for every kg of body weight gain. This condition occurred allegedly because of increased nutrient utilization or increased glucose metabolism (Yan et al. 2010). Another emphirical study provided information to an increase in body weight gain of calves fed garlic xtract (Ghosh et al., 2011). Wanapat et al. (2013) stated that a combination of peppermint with garlic powder as rumen additives showed no negative effect on ruminal fermentation charactericticss and nutrient utilizations.

Conclusion

Supplementation of garlic and combination of garlic with *Sapindus rarak* enriched with organic minerals (Cr and Zn) in beef cattle feed was able to improve the performance of rumen fermentation, feed efficiency and daily body weight gain.

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