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The Use of Local Mineral Formulas as a Feed Block Supplement for Beef Cattle Fed on Wild Forages

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ABSTRACT

The present research was carried out to study the diversity of mineral contents of wild forages and to evaluate the beneficial effect of mineral feed supplement formulated by using locally available materials on the performances of beef cattle. The present research was initiated by analyzing mineral contents of wild forages grown around Limau Manis campus areas. Forage samples were collected at 9 sampling areas scattered at plantation, conservation and idle lands. Samples were then analyzed for macro minerals of Ca, P, Mg, K, Na, and S and micro minerals of Co, Cu, Fe, Mn, Se, and Zn. Feeding trial was then conducted to evaluate the beneficial effect of supplementation of local mineral formulas (LMF) produced by using locally available materials on the performances of cattle. Feeding trial was conducted for 6 weeks by using 9 Simmentals cross bred heifers. The trial consisted of 3 treatments, i.e., P1: only grass without supplementation, P2: grass + LMF and P3: grass + mineral premix enriched LMF. Variables measured were: body weight, feed intake, FCR, feed cost and net return. Results showed that the highest macro mineral content of wild forages was Na of about 13.05 ± 2.22 g/kg, varied from 4.1 to 23.8 g/kg, followed by K (11.09 ± 1.43 g/kg) and Ca (6.10 ± 1.09 g/kg DM). Three minerals of Mg, P, and S were found in relatively small concentrations of 1.34 ± 0.30 , 0.83 ± 0.23 , and 0.17 ± 0.01 g/kg, respectively. Fe, Mn, Cu and Zn were found in relatively high concentrations. The highest concentration of micro minerals was Fe of about 613.8 ± 128.9 mg/kg, followed by Mn of 143.9 ± 23.3 mg/kg, while Zn and Cu were found in relatively small amount of about 31.3 ± 5.5 and 13.2 ± 2.5 mg/kg, respectively. Heifers supplemented with LMF (P2) and mineral premix enriched LMF (P3) showed higher body weight gain, lower FCR and net return than those cattle fed only grass (P1). The most profitable feeding strategy was by supplementation of heifers with mineral premix enriched LMF.

Key words: wild forage quality, local mineral formula, ruminant mineral nutrition

ABSTRAK

Penelitian ini bertujuan untuk mempelajari keragaman kandungan mineral pakan hijauan yang berasal dari tanaman liar dan mengevaluasi manfaat suplementasi mineral terhadap performa sapi. Penelitian dimulai dengan pengambilan sampel dan analisis kandungan mineral hijauan yang tumbuh liar. Sampel hijauan diambil dari 9 lokasi berbeda, yang tersebar di lahan perkebunan, konservasi, dan lahan tidur di sekitar kampus Limau Manis. Mineral yang dianalisis mencakup mineral makro: Ca, P, Mg, K, Na, dan S dan mikro: Co, Cu, Fe, Mn, Se, dan Zn. Selanjutnya dilakukan *feeding trial* untuk mengetahui manfaat pemberian pakan mineral suplemen (LMF) yang dibuat dengan bahan lokal pada performa ternak sapi. *Feeding trial* dilakukan selama 6 minggu, menggunakan 9 ekor sapi betina dara simmental dan terdiri atas 3 perlakuan, yaitu P1: rumput tanpa LMF (P1), P2: rumput + LMF, dan P3: rumput + LMF yang diperkaya dengan mineral premix. Peubah yang diukur antara lain: bobot badan, konsumsi, konversi ransum, biaya pakan, dan penerimaan. Hasil penelitian menunjukkan bahwa kandungan mineral makro tertinggi adalah Na $13,05 \pm 2,22$ g/kg, diikuti oleh K ($11,09 \pm 1,43$ g/kg), dan Ca ($6,10 \pm 1,09$ g/kg BK). Tiga mineral lainnya: Mg, P, dan S terkandung dalam konsentrasi rendah, masing-masing sekitar $1,34 \pm 0,30$; $0,83 \pm 0,23$; dan $0,17 \pm 0,01$ g/kg. Kandungan mineral mikro tertinggi adalah Fe, sekitar $613,8 \pm 128,9$ mg/kg, diikuti oleh Mn $143,9 \pm 23,3$ mg/kg. Zn dan Cu terkandung dalam konsentrasi yang relatif rendah, masing-masing sekitar $31,3 \pm 5,5$ dan $13,2 \pm 2,5$ mg/kg. Ternak sapi yang diberi pakan suplemen LMF berbasis bahan lokal menunjukkan penambahan bobot badan, konversi ransum, dan penerimaan yang nyata ($P < 0,05$) lebih baik daripada yang hanya diberi rumput. Penerimaan tertinggi dapat dicapai jika formula mineral lokal diperkaya dengan mineral premix.

Kata kunci: kualitas pakan hijauan, pakan mineral lokal, nutrisi mineral ruminansia

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11 INTRODUCTION

Beef cattle productions in West Sumatra are dominated by small-scale farm enterprises. In their efforts to increase revenue, more farmers shift from local to raise exotic breeds with higher body size and meat-carcass portion such as Simmentals. In addition to limited land and capital, the constraints faced by farmers in raising the exotic breed are the limited availability of feed in term of quantity and quality, so that the production performances of cattle are not optimal according to their genetic potencies.

The livestock are almost entirely dependent on wild vegetation forages derived from diverse sources of non-developed pastures, like plantation areas, river banks, rice fields, forest edges and roadsides. Vegetation grown in such areas are considered as weeds, not treated and comprise of various types of wild plants, such as native grass, legumes, broadleaf species and ferns. These feeds not only vary in nutrient contents, but also are often of poor mineral content. Mineral contents of forages are not only limited by the mineral make-up of the soils, but also depend on plant species, plant maturity, grazing management and climate conditions (Khan *et al.*, 2009). Mineral nutrition imbalance were recognized as one of the main factors that restrict beef cattle production in the world (Barg *et al.*, 2013).

The efficiency of utilization of the available feed resources can be optimized by the use of supplements that provide the deficient nutrients. These supplements can be produced by using locally available ingredients and agro-industrial by-products. West Sumatra is rich in mineral feed sources. There are two local materials that are potentially used as mineral sources, i.e. limestone meal of Bukit Kamang and fresh water oyster shell meal. Limestone and fresh water oyster meals contained Ca of about 39% and 35%, respectively (Khalil, 2003; Khalil & Anwar, 2007). Bukit Kamang's limestone meal was also rich in essential micro minerals of manganese (Mn) (205 ppm), iron (Fe) (295 ppm) and selenium (Se) (388 ppm) (Khalil & Anwar, 2007). Minerals have been recognized as potent nutrients and their deficiencies/imbalance exert a significant effect on health and productivity of livestock (Aregheore *et al.*, 2007; Gonul *et al.*, 2009).

Due to uncommon practice of supplementation of ruminants with concentrate in West Sumatra, the minerals should be prepared in palatable block lick forms by mixing with other locally available materials, such as sugarcane and rice bran, kitchen salt and urea. The advantages of mineral feed in blocks over supplementation of minerals in concentrated feed are that they are easy to be handled and used by small-scale farm. Besides as mineral sources, mineral blocks serve as sources of fermentable carbohydrates and nitrogen to meet the requirement of rumen microorganisms and to ensure forage fiber fermentation result, in increasing host animal performances (Hosamani *et al.*, 2003; Emyr *et al.*, 2012; Sahoo *et al.*, 2009). Moreover, feeding of mineral block can be an effective, low-cost way in grazing management to entice cattle into underused and away from overused areas of range and pasture (Bailey and Welling, 2007; Probo *et al.*, 2013), while sweet supplement influ-

ences the location of grazing cattle more strongly than the salty supplement and may be more effective for luring cattle into specific areas of pasture (Aubel *et al.*, 2011).

The objective of the present research was to study the diversity of mineral contents of wild forages from different sources and to evaluate the beneficial effect of mineral feed supplement formulated by using locally available materials on the performances of beef cattle.

11 MATERIALS AND METHODS

Sampling and Analysis of Forages

The study was initiated by analyzing nutrient and mineral contents of wild forages grown around Limau Manis campus area of Andalas University, Padang West Sumatra in December 2013. Most of campus area which occupied about 479 ha is allocated as open green areas. These areas were planted with various perennial trees and crop plantations for several purposes, i.e. soil erosion control, land conservation, field laboratory for study of biodiversity and crop estate production and management. Forage samples were collected at 9 sampling areas scattered at plantation, conservation and idle lands. At each sampling area, 5 sampling points at 3 different land contours of flat, sloping and undulating land was determined.

Samples of forages were collected using quadrats plate meter of 0.5 x 0.5 m in size. Plate meter was randomly placed at each sampling points. Plant materials in plate meter were cut at ground level and placed in individual plastic bag. The fresh samples were weighed and then separated into species and then weighed for determination of botanical composition. All samples of each sampling area were mixed and chopped. Representative samples of about 100-150 g were dried in a forced draught oven at 60 °C for 24 h and ground to pass through 1 mm screen prior to analysis for dry matter, macro minerals of Ca, P, K, Mg and S and micro minerals of Co, Cu, Fe, Mn, Se and Zn.

Samples for mineral analysis were prepared by wet digestion method by using concentrated sulfuric acid and hydrogen peroxide. The concentration of minerals was determined using an atomic absorption spectrophotometer (AAS, 1980). All analysis results were reported on DM basis.

Feeding Trial

Feeding trial was aimed to evaluate the use of mineral feed supplements formulated with locally available materials which were referred to as local mineral formulas (LMF) to improve the utilization of the available forages. The trial consisted of 3 feeding treatments as follows:

Treatment 1 (P1) : Grass without LMF

Treatment 2 (P2) : Grass supplemented with LMF

Treatment 3 (P3) : Grass supplemented mineral premix enriched LMF.

The LMF was prepared in block lick form by following the UMMB (urea molasses multinutrient

block) process as described by Haili *et al.* (2008). Bukit Kamang's limestone and fresh water oyster shell meal were mixed with other locally available materials, i.e. sugar cane and rice bran as fermentable carbohydrate sources. Other components were the common materials used in making urea molasses block (UMB), i.e. iodized kitchen salt, urea and cement.

In the treatment 3 (P3), LMF was enriched with mineral premix to improve the mineral composition of the formula due to unavailable P and micro mineral sources. For practical application, the mineral premix used was a commercial product with trade name of "Mineral Feed Supplement" for beef and dairy cattle produced by PT. Medion, Bandung. Table 1 shows component nutrient and mineral composition of LMF formulas. The nutrient and mineral compositions which were calculated based on chemical analysis of feed components were justified to meet the standard of feed and mineral supplement for beef cattle recommended by Weinreich *et al.* (1994). LMF were offered about 350 g/head/d.

A total of 9 Simmentals cross-bred heifers were used. The animals which were divided into 3 groups based on body weight, i.e. small (261-300 kg/head), medium (303-330 kg/head) and big (337-381 kg/head). Each group consisted of 3 animals in accordance with treatments, so that each treatment consisted of 3 animals as replication.

Table 1. Composition of local mineral formulas (LMF)

	Formula	
	LMF	LMF + mineral premix
Feed components (%)		
Sugarcane	10.0	10.0
Rice bran	15.0	15.0
Limestone meal	32.5	30.0
Fresh oyster shell meal	12.5	12.0
Salt	10.0	10.0
Urea	10.0	10.0
Cement	10.0	10.0
Mineral premix ^{a)}	-	3.0
Total	100.0	100.0
Nutrient and mineral contents:		
Crude protein, %	22.7	21.1
Crude fiber, %	4.5	4.4
Ca, g/kg	213.4	207.1
P, g/kg	32.1	47.2
Na, g/kg	40.2	44.9
Fe, mg/kg	100	167.4
Mn, mg/kg	66.6	160.5
Se, mg/kg	126.1	116.7
Zn, mg/kg	5.9	155.8
Cu, mg/kg	2.5	77.4
Co, mg/kg	0.1	1.5

Note: ^{a)} 1 kg consists of Ca 165 g, P 52 g, Na 157 g, Fe 2500 mg, Cu 2500 mg, Mn 2000 mg, I 125 mg, Co 50 mg, Zn 5000 mg and Se 10 mg.

Feeding trial lasted for 6 wk. All heifers were fed with chopped grass with nutrient content of 10% CP, 37% C, 0.66% Ca and 0.26% P based on dry matter basis. Parameters measured were body weight, feed intake, FCR, feed cost and net return over feed cost.

Economic Analysis

The cost benefit analysis was made by using partial budget and marginal analysis to identify the most promising treatment in term of net return over feed cost, which was also applied by Merera *et al.* (2013) to evaluate economic feasibility of fattening Horro rams supplemented with different substitution levels of maize grain and molasses in Ethiopia. Partial budget analysis was concerned with evaluating the effect of a change in certain inputs in feeding treatments on net return and to identify the treatment which produced the greatest net return per animal. Marginal analysis was used to calculate the marginal rate of net return (MRNR), i.e. the increase of net return obtained from a given increment of investment (Dillon & Hardaker, 1980).

In the economic analysis, all prices of feeds and outputs of animals and manures were based on the existing price in West Sumatra. The price of animals was set at Rp40000/kg, which was the average price of beef cattle based on live weight in local livestock market.

Statistical Analysis

Data of feeding trial were subjected to statistical analysis by using analysis of variance (ANOVA) in a randomized complete block design consisted of 3 feeding treatments and 3 blocks of body weight as replicates. Duncan's multiple range test (DMRT) was applied to separate means. Differences were considered significant at $P < 0.05$ (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Mineral Profiles of Wild Forages

Mineral contents of forages are presented in Table 2. The highest macro mineral content was Na of about 13.05 ± 2.22 g/kg, varied from 4.1 to 23.8 g/kg, followed by K (11.09 ± 1.43 g/kg) and Ca (6.10 ± 1.09 g/kg DM). Three minerals of Mg, P, and S were found in relatively small concentrations of 1.34 ± 0.30 , 0.83 ± 0.23 and 0.17 ± 0.01 g/kg, respectively.

The data on macro minerals of wild forages showed that the wild forages contained adequate concentration of Na, K, and Mg. The average concentrations of Na, K and Mg were 13.05, 11.09 and 1.34 g/kg, respectively, while their recommended concentrations in the diet of growing cattle were 0.6-0.8, 6.0, and 1.0 g/kg diet, respectively (NRC, 1996).

On the other hand, mineral Ca and P were found deficient in the wild forages. The average content of Ca of wild forages was 6.1 g/kg. In compare to minimum level of Ca in cattle diet of about 35 g/kg to fulfill its maintenance and production requirement (NRC, 1996), the optimum Ca content of forages should range from

17 to 42 g/kg (Sultan *et al.*, 2008). If cattle were only fed grass from such non-developed sources, the animals might be deficient in Ca, because the average dry matter intake was only 4.5 kg/d (Table 3) and a heifer needed 40-44 g Ca per day (NRC, 2001). The wild forages were dominated by low-Ca vegetation, like imperata (*Imperata cylindrica*) of about 35% and axonopus (*Axonopus compressus*) of about 27%. Legumes were found very limited portion of about 7% which were dominated by mimosa (*Mimosa pudica*).

The average P content of wild grass was found quite low of about 0.8 g/kg DM, so that the Ca:P ratio of the grass of about 7.65 was relatively wide. Rogostic *et al.* (2006) also observed wide Ca:P ratio among shrub species. The low of phosphorus content across almost all areas might be due to the low P content in the soil. Mineral P was found to have the highest variation. The P content varied from 0.2 to 2.2 g/kg DM. The variation noted within the present wild forages was in line with the findings by free rangeland grasses and shrubs in miarid region (Sultan *et al.*, 2008; Rahim *et al.*, 2013). Ca and P play vital roles in most body tissues with structural roles in intracellular communication, DNA synthesis, and maintain homeostasis, while decreased growth and milk production, poor conception and deprived appetite are the general symptoms of Ca and P deficiencies (Vitti *et al.*, 2005).

In terms of micro mineral profiles, Fe, Mn, Cu, and Zn were found in relatively high concentration, while Co and Se could not be detected by analysis due to very low concentration (Table 2). The micro mineral content of the wild forages was quite variable, as indicated by the large standard error relative to the average within each feedstuff (Table 2). Factors affecting trace mineral contents of forages include harvest method, soil type, and species (Linn *et al.*, 2011). The highest concentration was Fe of about 613.8±128.9 mg/kg, followed by Mn

of 143.9±23.3 mg/kg, while Zn and Cu were found in relatively small amount of about 31.3±5.5 and 13.2±2.5 mg/kg, respectively. Enjalbert *et al.* (2006) reported that Cu and Zn deficiencies were risk factors for impaired production, reproduction and health in both beef and dairy herds. Socha *et al.* (2010) suggested that there was a need for supplementation of Cu and Zn in dairy cattle diet due to limited and seasonal changes of their concentration in the feed sources.

The concentration of Fe and Mn recorded in this experiment were similar to the work of Shahjalal *et al.* (2008) who reported that mixed local grasses in Bangladesh contained 845 ppm of Fe and 113 ppm of Mn. Zn content varied from 11.6 to 65.3 mg/kg DM. The average Zn content of 31.3 mg/kg corresponds to the required level of Zn for growing cattle of about 30 mg/kg of diet DM (NRC, 1996). Cu content varied from 2.8 to 23.2 mg/kg DM and the average was 13.2±2.5 mg/kg. As shown in Table 1, enrichment of LMF with mineral premix increased the Cu content from 2.5 to 77.9 mg/kg. These were below the maximum tolerable concentration level of about 100 ppm (NRC, 1996).

Effect of LMF on Cattle Performances

Table 3 shows the mean body weight, feed intake, FCR, feed cost and net return of heifers fed with grass and supplemented with LMF for 6 wk. The mean body weight increased from about 319 kg/head to 332 kg/head during 6 wk of feeding trial. Daily dry matter intakes of about 4.2-4.5 kg/head were not significantly different amongst the treatments. Heifers supplemented with LMF (P2) showed higher body weight gain (325 g/head/day) and much better FCR (14.4) (P<0.05) than those fed only with grass (P1) with average daily body weight gain of only 214 g/head/ and FCR of 20.9. This agrees with the findings of Mubi *et al.* (2012) who reports that

Table 2. The mineral contents of wild forages harvested around Limau Manis' campus areas of Andalas University

Nutrient / minerals	Sampling areas:									Mean	SE ¹⁾
	1	2	3	4	5	6	7	8	9		
Macro minerals, g/kg DM:											
Ca	7.7	5.16	7.3	12.0	8.6	3.9	5.5	0.5	4.5	6.10	1.09
K	17.1	10.6	11.5	10.6	14.6	7.6	10.3	2.6	15.0	11.09	1.43
Mg	1.7	1.0	2.0	1.6	3.1	0.1	1.1	0.2	1.3	1.34	0.30
Na	13.3	13.6	20.7	9.7	23.8	4.9	17.0	4.1	10.5	13.05	2.22
P	1.8	0.6	0.7	0.6	2.2	0.2	0.5	0.4	0.4	0.83	0.23
S	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.17	0.01
Micro minerals, mg/kg DM:											
Co	nd ²⁾	nd ³⁾	nd ²⁾	nd ²⁾	nd ³⁾	nd ²⁾	nd ³⁾	nd ²⁾	nd ²⁾	-	-
Cu	19.4	5.8	22.9	11.3	23.2	9.0	9.0	2.8	15.2	13.17	2.47
Fe	836.6	215.3	764.9	998.8	1233.3	179.9	721.4	186.7	387.6	613.83	128.92
Mn	163.4	40.0	165.7	221.1	167.2	126.3	146.7	31.8	232.9	143.89	23.26
Se	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	nd ³⁾	-	-
Zn	48.0	26.4	29.1	29.0	65.3	14.1	11.6	26.3	31.5	31.26	5.50

Note: 1) Standard error; 2) Not detected by standard concentration of 0.005 mg/kg; 3) Not detected by standard concentration of 0.002 mg/kg.

Table 3. The performances of heifers supplemented with local mineral formulas (LMF)

Variables	Feeding groups:		
	P1	P2	P3
Initial body weight, kg/head	318.7±35.4	319.3±17.9	317.7±16.0
Final body weight, kg/head	327.7±34.0	333.0±16.5	335.7±18.4
Daily body weight gain, g/head	214.3±36.4 ^b	325.4±42.0 ^{ab}	428.6±158.5 ^a
Dry matter feed intake, kg/head/day	4.2± 0.2	4.5± 0.2	4.4±0.2
Feed conversion ratio	20.9± 3.2 ^a	14.4± 2.0 ^b	13.4±6.7 ^b
Feed cost, Rp/head	133,308.5	190,530.1	201,579.7
Return from weight gain, Rp/head	360,000.0	546,666.7	720,000.0
Return from manure, Rp/kg	40,613.3	40,966.7	42,743.3
Total net return, Rp/head	400,613.3	587,633.4	762,743.3
Net return over feed cost, Rp/head	267,304.80	397,103.30	561,163.60
Marginal feed cost, Rp/head		57,221.5	11,049.7
Marginal net return, Rp/head		129,798.5	164,060.3
Marginal rate of net return (MRNR) (Rp)		2.27	14.85

Note: P1= Only grass (no supplements); P2= Grass + LMF; P3= LMF + mineral premix.

5 heifers supplemented with multi-nutrient blocks under tropical wet grazing conditions in Nigeria are superior to those in-supplemented heifers.

The higher performance of the supplemented groups over the control group may be due to the LMF which supplied more quantities of nutrient compared to those fed only grasses. This increased body weight and feed utilization efficiency may also be related to the better mineral availability. Besides as better mineral availability, this is probably due to the presences of sugarcane, rice bran and urea in LMF. The readily fermentable sources of energy in the form of sugar and starch might enhance the utilization of urea from LMF by the microbes in the rumen (Hosamani *et al.*, 2003). Studies on rumen characteristics of steers reported by Zarah *et al.* (2014) showed that the inclusion of multi-nutrient blocks in the diet of crossbred steers result in significant improvement in DM degradation in the rumen and therefore improvement of the animal performances.

Haili *et al.* (2014) reported that the symptom of pica was gradually disappeared and the color of hair was bright and bushy in the cattle supplemented with UMMB in China. They concluded that UMMB supplementation was an effective strategy to increase the production, maintaining animal performance and feed efficiency. UMMB can also be used as a treatment and prevention of many diseases. The parasite was significantly reduced by giving male lamb UMMB (Molina-Alcaide *et al.*, 2010). UMMB could also treat the water buffalo's lack of mood disorder, which is the most common summer buffalo reproductive disorders (Atta *et al.*, 2012; Kang *et al.*, 2005). Hossain *et al.* (2011) reported that UMMB supplementation enhanced the body weight and hemato-biochemical physiology of Black Bengal goats in Bangladesh. Mubi *et al.* (2013) suggested that the positive effect of multi-nutrient blocks on overall performance of an animal would be more pronounced on a low plane of nutrition, such as a crop residue or straw-based diet given in large quantities.

The deficiencies of Ca and P in the forages could be overcome by supplementation with LMF. As shown in Table 3, supplementation of heifer with LMF (P2) could improve performances of heifers, even though the Ca:P ratio of LMF was relatively wide of about 7:1 (Table 1) due to unavailable locally safe P sources for ruminant animals in West Sumatra. Limestone meal in general and fresh water oyster shell contain relatively low P of about 0.1% (Khalil & Anwar, 2007; Khalil, 2003; Abezage, 2014). The dietary concentration of P per se was inadequate in the LMF. Ruminant can tolerate Ca:P ratio as wide as 7:1 (NRC, 1985). Higher Ca:P ratio reduces absorption of P (NRC, 2001). Phosphorus deficiency in animals is most prevalent when feed offered is low in P and high in Ca (Sultan *et al.*, 2008). Therefore, P supplementations appear to be essential. Prakash *et al.* (2009) suggested that such wider Ca to P ratio could be alleviated by feeding cereal byproducts supplemented diets containing low Ca and high P. Table 3 showed that enrichment of LMF with mineral premix which contained P of about 52 g/kg (Table 1) improved daily body weight gain, even though there was no statistically significant difference. There is a need to explore locally available P sources for better LMF formulation.

Moreover, the most important minerals deficiencies in the wild forages are Se and Co. The lack of trace element will lead to metabolism disorder, which affects livestock production performance (Gandra *et al.*, 2011; Xin *et al.*, 2011; Romero-Huelva *et al.*, 2012). Krys *et al.* (2009) reported that in Czech Republic dairy cows suffer from deficiencies of Mn, Co, and Se. Se is required as component of glutathione peroxidases and thioredoxin reductases and appears to have the largest trace mineral role in the antioxidant system (Andrieu, 2008). Se deficiency decreases the activity and lifespan of neutrophils, macrophages, and lymphocytes (Hefnawy & Tórtora-Pérez, 2010). Se deficiency in this experiment could be covered by Se from limestone of Bukit Kamang which was rich in Se (Khalil & Anwar, 2007). Emyr *et al.*

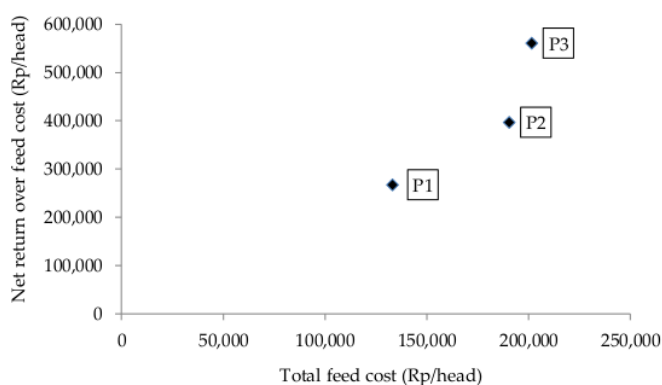


Figure 1. Feed cost and net return over feed cost of heifers fed only grass and grass supplemented with local mineral formulas (LMF) and concentrates. The capital letters represent: P1: grass without LMF; P2: grass supplemented with LMF; P3: grass supplemented with mineral premix enriched LMF.

(2012) reported that supplementation of trace elements of Se and I improved ruminant livestock production performances (weight and lactation).

Recommended level of Co in the diet of growing cattle was about 0.1 mg/kg (NRC, 1996). In the feeding trial, the Co requirement was covered by enrichment of LMF with mineral premix which contained Co of about 50 mg/kg (Table 1). As shown in Table 3, enrichment of LMF with mineral premix (P3) could improve average daily body weight gain from 325 g (P2) to 429.0 g (P3), even though there was no statistical difference. In relation to the present experiment, Dorton *et al.* (2006) reported there was no significant effect of supplementation of micro minerals Cu, Zn, Mn, and Co on performance of steers during on-farm trial. There were many factors affecting significant effect of micro mineral supplementation on cattle performance, such as overall animal management, environment, reduced feed intake during receiving, breed type, antagonistic compounds to trace mineral absorption/metabolism present in the diet and water, and disease status (Dorton *et al.*, 2006).

Economic Feasibility of LMF Supplementation

In term of economic parameters, the cheapest feed cost of about Rp133,309 per head was shown by the heifer fed only with grass (P1), followed by P2 (Rp190,530) and P3 of Rp201,580. This agrees with the results of Mubi *et al.* (2012) who notes that the feed cost per kg gain is higher in the group supplemented with multi-nutrient blocks, mainly due to the high cost of molasses. Supplementation of heifers with LMF increased feed cost of about Rp57,222/head (from Rp133,309 in P1 to Rp190,530 in P2), but net return increased by Rp129,799 (from Rp267,305 in P1 to Rp397,103 in P2). The highest net return of about Rp561,164/head was shown by heifers supplemented with mineral premix enriched LMF of P3 (Table 3).

Figure 1 shows the relationship between feed cost and net return. Feeding of beef cattle with only grass

(P1) revealed as a low-input/low-output feeding treatment. Such feeding system was widely practiced by traditional small-scale farmers in West Sumatra as a response to limited resources and skills. The increase of net return was as consequences of increase body weight gain and feed utilization efficiencies (FCR) (Table 3).

The most profitable treatment was shown by the heifers supplemented with mineral premix enriched LMF of P3 which had the highest net return of about Rp561,164/head. In addition, P3 gave significant marginal rate of net return (MRNR), i.e. Rp14.85 per each rupiah additional cost incurred, when P3 was selected instead of P2 (Table 3). Therefore, if capital is available, P3 was the most profitable treatment to be selected by farmers, because higher benefit could be captured to cover the increases of feed expenditures. The use of LMF as feed supplement will ensure that the animals are not just being maintained but can be sustained for productive performance. The ease of preparation and maintenance make the blocks technology practicable for adoption by small-scale farmers.

CONCLUSION

Wild forages grown around campus areas show high variability in mineral content. Some essential minerals of Ca, P, Se, and Co are found in marginal concentration. There is a need of adequate feed supplements to ensure proper protein and mineral content in the feed. The animal performances can be improved by offering mineral feed supplement by using locally available materials and enriched with mineral premix.

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