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Effects of non-medicated and medicated urea molasses multi-nutrient block supplements on nutrient intake and blood mineral profile of lactating Saanen goats

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Abstract

Poor nutrition is a major contributor to the performance of dairy goats on smallholder farms. Hence, strategic supplementation is required to overcome nutritional deficiencies. This paper reviews the effects of urea molasses multi-nutrient block (UMMB) and medicated urea molasses multi-nutrient block (MUMB) supplements in comparison with imported commercial mineral blocks (CMB) on nutrient intake and blood mineral profile of Saanen lactating goats. A 90-day feeding trial was conducted at Yusof Ecofarm, Tanah Merah, Kelantan, Malaysia. Twenty four (24) Saanen lactating goats were assigned to four dietary treatments with six (6) goats in each group based on completely randomized block design. Goats in T1 (control) were fed with basal diet only that comprise of roughages and goat pellet while T2, T3 and T4 received equal amount of basal diet and allowed for ad-libitum licking of UMMB, MUMB and CMB respectively. Total dry matter intake (DMI) (kg/d) were 1.14, 1.29, 1.25 and 1.16 in T1, T2, T3 and T4 respectively whereas the UMMB, MUMB and CMB intakes (g/d) were 86.8, 50.4 and 36.6 respectively. There were significant differences ($p<0.05$) between treatments on nutrient intake. Crude protein (CP), crude fiber (CF), ether extract (EE), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were significantly higher ($p<0.05$) in T2 and T3 as compared to T1 and T4. The serum concentrations of calcium (Ca), ferum (Fe), copper (Cu) and zinc (Zn) were significantly higher ($p<0.05$) in T2 with the values of 33.60 ppm, 341.67 ppb, 270.00 ppb and 138.30 ppb respectively as compared to other treatments. Hence, the findings of this research revealed that both UMMB and MUMB were effective in improving nutrient intake and blood mineral profile of lactating Saanen goats.

1. INTRODUCTION

In Malaysia, main feed source for ruminant is forage. The issue regarding its quality is critical and one of the main concerns among the farmers. As oil palm plantation dominates a larger area of the country, the biomass waste from this sector such as palm kernel cake (PKC) and palm kernel expeller (PKE) can be utilized as a feed for ruminants. However, it has been reported that more than 70% of raw feed ingredients has been imported and this country had spent at about RM 6 billion for this purpose (Muhayat, 2013). The dependency on imported feed can cause the increase of production cost (Wan Zahari and Wong, 2009).

The common problem associated with feed quality is nutrient deficiencies particularly protein, energy and minerals which becomes a constraint, limiting the ruminant production. Minerals are important for productive and reproductive physiology of goats. Grazing animals commonly received minerals through feeds, mineral soil and water. Forage is the main feed that provides minerals. However, factors such as soil, plant species, maturity stage, pasture management and climate had influenced minerals content in plants (Zeleke *et al.,* 2015). Poor mineral availability causes negative impact on animal health, immune response and fertility (Godara *et al.,* 2015).

Hence, due to insufficient nutrient and minerals in animal diets, most farmers adopt different supplementation strategies. One of the methods is through concentrate and salt lick or mineral block which are imported and costly. Besides, the most important criteria in ruminant feeding is to meet fermentable nitrogen (N) requirement. Urea molasses multi-nutrient block supplementation (UMMB) is an effective supplementation strategy to enhance the utilization of low quality fibrous feed to optimise performance and better health status (Hatungimana and Ndolisha, 2015).

The main ingredients of UMMB are molasses, urea and other agricultural by-products. Molasses (30-50%) acts as energy and minerals sources, and carrier for urea (Kayastha *et al.,* 2012). Urea (5-10%) is a source of

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fermentable N which considered cost effective (Wan Zahari *et al.,* 2007; Tadele and Amha, 2015). Other ingredients utilised in the formulations of UMMB and MUMB are agricultural by-products (5-25%) such as PKC and rice bran as energy and fibre sources. Ingredients such as quicklime, cement, bentonite and calcium oxide (5-15%) act as a binding agent and carrier for nutrients while salt (1-10%) act as a preservative and sources of sodium and chloride (Manta *et al.,* 2013).

In MUMB, 0.05% of fenbendazole who acts as anthelminthic agent was included for each kg of block to reduce parasite infestation (Daing and Win, 2006; Wan Zahari *et al.,* 2007). Both UMMB and MUMB enhanced growth, milk yield, reproductive performance and health of ruminants (Wongnen *et al.,* 2006; Makkar, 2007; Rafiq *et al.,* 2007). Hence, this research was conducted to evaluate the effect of UMMB, MUMB as well as imported commercial minerals block on nutrient intake and blood mineral profile in lactating Saanen goats.

2. MATERIALS AND METHODS

2.1. Experimental site and feeding trial

This research was conducted at Yusof Eco Farm, Felda Kemahang 1, Tanah Merah, Kelantan, Malaysia. It was conducted in two stages, i.e: 10 days adaptation period for animals to adapt to new housing condition and experimental diets and 90 days feeding trial for data collection.

2.2. Experimental diets

The experimental animals were fed based on farm routine practice. Basal diets consisted of 1 kg of commercial goat pellet fed at 9 am and 3 kg of roughages fed at 12 pm. The treatment groups are shown in Table 1:

Table 1: Dietary treatments.

Group	Treatments
T1	Basal diet (Control group)
T2	Basal diet + Urea molasses multi-nutrient block (UMMB)
T3	Basal diet + Medicated urea molasses multi-nutrient block (MUMB)
T4	Basal diet + Commercial mineral block (CMB)

2.3. Experimental design

Twenty four (24) Saanen lactating does were randomly assigned to four dietary treatments, with six goats in each group following complete randomized block design (CRBD) based on the initial body weight (Mean±SE) of 40.58±1.50 kg. The goats were housed in individual pen 2 m above the ground.

2.4. Data collection

2.4.1. Proximate analysis of feeds and supplements

The proximate analyses of feed samples were conducted based on Association of Official Analytical Chemists (AOAC, 1990). The dry matter (DM) contents of feed offered and refused were determined by drying the samples in force air oven at 110ºC for 24 h and ash was determined by igniting the sample in carbolite furnace at 600ºC for six hours. Total nitrogen (N) content was determined by Kjeldahl method and crude protein (CP) was calculated as N*6.25. Ether extract was determined by sample extraction with petroleum ether in Foss Extraction System (Foss, USA). Crude fibre (CF), acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined using Gerhardt Fibre Analyser (Gerhardt GMBH & Co.Kg.,Germany). Minerals were determined by filtration process following dilution with deionized water (Perkin Elmer, 1996). Mineral concentrations were detected by Atomic Absorption Spectroscopy (AAS) (Perkin Elmer AAnalyst™ 800, USA).

2.4.2. Dry matter intake and nutrient intake

Feed offer and refusal were weighed daily and feed intake was determined by the difference of feed offer and refusal. For dry matter intake (DMI) determination, DM analysis of feed offer and refusal were done and DMI was calculated based on the Equation 1.

$$\begin{aligned}\text{Daily DMI} = [&\text{Feed offer (kg)} \times \\ &\text{DM of offered (\%)}] - \\ [&\text{Feed refused (kg)} \times \\ &\text{DM of feed refused (\%)}]\end{aligned} \tag{1}$$

Nutrient intake was determined based on the Equation 2.

$$\begin{aligned}\text{Nutrient intake} = &\text{ Daily DMI (g)} \times \\ &\text{Nutrient content in feed (\%)}\end{aligned} \tag{2}$$

2.4.3. Blood mineral profile

Blood samples from 24 goats were collected via jugular venipuncture using 21-gauge (1 ½”) vacutainer needle (Becton, Dickinson and Company©, England) into 10 ml plain tubes (BD Vacutainer® red top, USA) after the completion of feeding trial. Serum was separated from blood sample within 4-5 hours prior to collection. Whole blood sample were centrifuged at 3000 rpm for 15 minutes and serum were then collected and stored at -20°C for further analysis. Mineral analysis was conducted by filtration 3 ml of serum using 45 µm syringe filter (GD/XP™, UK) and filter paper (CHMLAB, Spain) following dilution process. Calcium (Ca), ferum (Fe), copper (Cu) and zinc (Zn) in serum were determined by AAS (Perkin Elmer AAnalyst™ 800, USA) at 422.7, 248.3, 324.8 and 213.9 nm for Ca, Fe, Cu and Zn respectively. The results were then compared with the healthy value for dairy goats.

2.5. Experimental diets

Data on feed and nutrient intake as well as blood mineral profiles were analysed using two way Analysis of Variance (ANOVA) procedure of statistical analysis system SPSS 23 (IBM Corp., 2015). Duncan Multiple Range test was applied for mean difference comparison

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between treatments at $p<0.05$. The results were presented in mean± standard error (SE).

3. RESULTS AND DISCUSSION

3.1. Chemical composition of basal diets and supplements

Table 2 shows the chemical composition of basal feeds, UMMB, MUMB and CMB (Mira et al., 2018a). It was found that basal feeds contain about 15% CP which meet the requirement for dairy goats (Rashid, 2008). Dry matters of UMMB and MUMB were >85% which are sufficient to prevent mould growth (Suharyono *et al.,* 2014). Ash contents in UMMB and MUMB were 17% indicating the presence of mineral premix and salt. In different findings, Abid *et al.,* (2016) suggested that block contained 25.8% ash. Crude protein contents of UMMB and MUMB at 32-33% due to the inclusion of urea which supply the fermentable nitrogen (Mubi *et al.,* 2013). Commercial mineral blocks were enriched with minerals as it contained 95% ash but deficient with other nutrients.

3.2. Feed intake

Table 3 shows dry matter and nutrient intake in different treatments. Supplement intake (g/d) was significantly higher in T2 (86.8±3.3) as compared to T3 (50.4±2.1) and T1 (36.6±1.4). Factors such as type and animal condition, hardness and palatability affect the block intake. UMMB intake was higher as it was palatable than MUMB (Mira et al., 2018b). The addition of fenbendazole in MUMB caused the bitter taste which reduced its palatability while the hardness of CMB had caused its lower intake (Mubi *et al.,* 2013).

Dry matter intake (kg/d) in T2 (1.29±0.02) and T3 (1.25±0.02) were significantly higher ($p>0.05$) than T1 (1.14±0.02) and T4 (1.16±0.02). The presence of supplementary N, energy and minerals had increased the rate of fermentation of basal diets. There were no significance differences ($p>0.05$) of DMI between T1 and T4 showed goats fed basal diet only were sufficient without CMB supplementation. UMMB and MUMB supplementations had improved DMI at about 20-30% as compared to animal without supplementation (Perera *et al.,* 2006).

Table 2: Chemical composition of basal diets and supplements (Mean±SE) (Mira et al., 2018a).

Variables	Basal feeds and supplements				
	Roughages	Commercial goat pellet	UMMB	MUMB	CMB
DM (%)	16.09±0.01	91.19±0.08	90.06±0.05	90.13±0.03	92.26±0.12
Ash (%)	5.33±0.01	7.19±0.05	17.48±0.10	17.36±0.05	95.05±0.05
OM (%)	94.67±0.01	92.81±0.08	82.52±0.18	82.64±0.08	4.95±0.08
CP (%)	15.54±0.05	17.13±0.74	33.84±0.07	32.84±0.81	ND
CF (%)	33.26±0.09	20.07±0.33	4.49±0.26	4.07±0.22	ND
EE (%)	2.44±0.08	3.33±0.10	0.55±0.11	0.82±0.35	ND
ADF (%)	41.41±0.72	35.24±0.49	5.47±0.09	5.45±0.38	ND
NDF (%)	65.77±0.20	61.21±0.11	10.51±0.48	9.27±0.05	ND
Ca(g/kg)	0.40±0.002	3.86±0.006	36.54±0.13	34.95±0.11	21.23±0.12
Cu(mg/kg)	4.46±0.19	0.97±0.001	0.70±0.004	0.58±0.002	8.23±0.03
Fe(mg/kg)	10.69±0.07	45.18±0.15	11.27±0.03	13.87±0.03	259.07±1.11
Zn(mg/kg)	1.83±0.01	0.25±0.002	1.84±0.02	2.61±0.01	21.27±0.22

Notes: ND- Not defined, DM-Dry matter, OM-Organic matter, CP-Crude protein, CF-Crude fiber, EE- Ether extract, ADF-Acid detergent fiber, NDF-Neutral detergent fiber, Ca-Calcium, Cu-Copper, Fe-Ferum, Zn-Zin

Ash intakes (g/d) in T4 (103.51±1.44) and T2 (93.74±0.84) were significantly higher ($p<0.05$) than those in T1 (75.60±0.85) and T3 (88.36±0.77). Organic matter (OM) and CP intakes in T2 were significantly higher ($p<0.05$) as compared to T1, T3 and T4. However, it was significantly higher ($p<0.05$) in T3 as compared to T1 and T4. OM intake in T2 was 1197.19±10.42 g/d as compared to 1165.18±9.46 g/d, 1068.30±11.99 g/d and 1060.88±9.35 g/d in T3, T1 and T4 respectively. Higher CP intake (g/d) was recorded in T2 (228.25±2.00), followed by T3 (216.73±1.82), T1 (190.27±2.14) and T4 (188.71±1.67). For CF, EE, ADF and NDF intake were significantly higher in T2 and T3 than those in T1 and T4. Nutritional deficiencies and low DMI in basal diet and CMB caused lower nutrient intake. Higher DMI in T2 and T3 had improved ash intake, OMI, CPI, CFI, EEI, ADFI and NDFI (Tegene *et al.,* 2016). However, higher ash (92.51±0.84 g/d), OM (1191.40±10.42 g/d) and CP (225.87±2.00 g/d) intake in T2 due to better palatability of UMMB than MUMB whereby the addition of fenbendazole had caused bitter taste of the block which reduced its intake (Makkar, 2007).

However, in opposite finding, Tegegne *et al.,* (2016) found that total DMI and nutrient intake through concentrate supplementation were significantly higher as compared to UMMB group. The intakes of OM, CP, NDF and ADF in animals supplemented with concentrate were 279.8±4.2, 62.8±1.2, 120.1±2.0 and 83.6±0.8 respectively while 58.5±12.0 OMI, 20.1±3.4 CPI, 14.2±5.6 NDFI and 2.3±1.9 ADFI for UMMB group. Although UMMB contained higher CP and low NDF and ADF than commercial goat concentrate, low UMMB intake at 73.1±11.0 g had affected the DM, OM, CP, ADF and NDF intake. This explained the low DM and nutrient intake in MUMB group in current trial.

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Table 3: The mean daily dry matter intake and nutrient intake in different treatment (Mean±SE).

Intake (g/d)	Treatments				
	1	2	3	4	LS
DMI roughages (g/d)	357.40±0.01^{a}	393.27±0.01^{b}	368.42±0.01^{a}	353.10±0.01^{a}	*
Commercial goat pellet (g/d)	786.50±0.01^{a}	817.66±0.01^{b}	835.12±0.01^{b}	781.29±0.01^{a}	*
Basal DMI (kg/d)	1.14±0.02^{a}	1.21±0.02^{b}	1.20±0.02^{b}	1.13±0.02^{a}	*
Supplement intake (g/d)	-	86.8±3.3^{b}	50.4±2.1^{a}	36.6±1.4^{a}	*
Supplement DMI (kg/d)	-	0.08±0.01^{b}	0.05±0.01^{a}	0.03±0.01^{a}	*
Total DMI (kg/d)	1.14±0.02^{a}	1.29±0.02^{b}	1.25±0.02^{b}	1.16±0.02^{a}	*
Nutrient intake (g/d)					
Ash	75.60±0.85^{a}	93.74±0.84^{c}	88.36±0.77^{b}	103.51±1.44^{c}	*
OM	1068.30±11.99^{a}	1197.19±10.42^{c}	1165.18±9.46^{b}	1060.88±9.35^{a}	*
CP	190.27±2.14^{a}	228.25±2.00^{c}	216.73±1.82^{b}	188.71±1.67^{a}	*
CF	276.72±3.16^{a}	298.50±2.93^{b}	292.18±2.51^{b}	274.25±3.88^{a}	*
EE	34.91±0.39^{a}	41.22±0.32^{b}	40.90±0.30^{b}	34.63±0.31^{a}	*
ADF	425.16±4.78^{a}	455.37±4.19^{b}	449.58±3.71^{b}	421.55±3.72^{a}	*
NDF	716.48±8.04^{a}	767.55±6.95^{b}	758.12±6.21^{b}	710.46±6.27^{a}	*

Note: ^{abc} means in the same row with different superscript are significantly different ($p<0.05$), LS- Level of significance, * - Significant at $p<0.05$, DM-Dry matter, OM: Organic matter; CP: Crude protein, CF- Crude fiber; EE: Ether extract; ADF: Acid detergent fiber; NDF: Neutral detergent fiber; T1-Control group; T2-Basal diet+UMMB; T3-Basal diet+MUMB; T4-Basal diet+CMB.

Table 4 shows blood mineral profiles in different treatments. Serum Ca (ppm) in T2 (33.60±0.63) was significantly higher ($p<0.05$) than T3 (27.79±1.07), T4 (26.98±0.81) and T1 (23.42±1.33). Poor availability of Ca in basal diet fed to animals caused the reduction of serum Ca in control group. Serum Fe (ppb) in T2 (341.67±37.90) and T3 (324.00±71.94) were significantly higher ($p<0.05$) than T1 (153.33±52.07) but did not differ significantly ($p>0.05$) with T4 (186.00±35.01). This condition was due to the severe presence of parasite in control group of current trial. Serum Cu (ppb) in T2 (270.00±25.30), T1 (265.00±14.55) and T3 (215.00±22.47) were significantly higher than T4 (105.00±50.58). Besides, serum Zn (ppb) in T2 (138.30±28.10) was significantly higher than T1 (48.33±17.40) but did not differ significantly with T3 (107.50±11.09) and T4 (93.33±11.45). Lower serum Cu and Zn in CMB and control group respectively due to the factors such as infection, stress and erythrocyte haemolysis (Kincald, 1999).

Table 4: Blood mineral profiles in different treatments (Mean±SE).

Minerals	T1	T2	T3	T4	LS
Ca (ppm)	23.42±1.33^{a}	33.60±0.63^{c}	27.79±1.07^{b}	26.98±0.81^{b}	*
Fe (ppb)	153.33±52.07^{a}	341.67±37.90^{b}	324.00±71.94^{b}	186.00±35.01^{ab}	*
Cu (ppb)	265.00±14.55^{b}	270.00±25.30^{b}	215.00±22.47^{b}	105.00±50.58^{a}	*
Zn (ppb)	48.33±17.40^{a}	138.30±28.10^{b}	107.50±11.09^{ab}	93.33±11.45^{ab}	*

Note: ^{abc} means in the same row with different superscript are significantly different ($p<0.05$); SE-Standard error; T1-Control group; T2-Basal diet+UMMB; T3-Basal diet+MUMB; T4-Basal diet+CMB. Reference range for Ca: 50-100 ppm, Fe: 450-1900 ppb, Cu: 500-1600 ppb, Zn: 400-1600 ppb (Aypak *et al.,* 2016).

The findings of the present study agreed with Muralidharan *et al.,* (2015) who established that serum Ca (9.22 ppb) was significantly higher in UMMB group than lambs fed with basal diet only. In another study, Li *et al.,* (2014) established that Zn (8.2±0.3 mg/L) and Cu (5.1±0.25 mg/L) in UMMB group were significantly higher than control group, i.e: 3.15±0.3 mg/L and 2.41±0.2 mg/L for Zn and Cu respectively. Zeleke *at al.,* (2015) reported that serum minerals concentration were within the normal range through mineral supplementation as compared to animals fed with basal diet only. Ca, Fe, Cu and Zn (ppm) in mineral supplemented group were 119.0, 3.24, 1.14 and 1.68 respectively which significantly higher than control group at 114.7, 2.61, 0.5 and 0.94 for Ca, Fe, Cu and Zn respectively.

Overall, the levels of serum minerals in all treatment groups were low as compared to the reference value might due to severe parasite infestation at initial stage of feeding trial. Besides, in different study, the feeding trial was performed for 180 days to achieve healthy blood minerals profile (Muralidharan *et al.,* 2015). However, UMMB and MUMB groups had showed higher minerals value indicated that UMMB and MUMB supplements had overcome problem associated with nutritional deficiencies and lead to higher serum mineral status in lactating goats.

4. CONCLUSION

The supplementations of UMMB and MUMB were highly recommended to replace the use of CMB among local farmers in Malaysia due to its nutritional benefit. UMMB and MUMB supply additional energy, protein and minerals to lactating goats which lead to positive impact on nutrient intake and blood mineral profile as compared to goats without supplementation and supplemented with CMB.

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REFERENCES

Abid, R., Khan, I., Bhatti, J.A., Shah, Z., Zahoor, A., Ahmad, S. (2016). Effect of medicated urea molasses blocks on sub-clinical parasitic infestations in goats. Online Journal of Animal and Feed Research, 6(2):57-71.

Association of Analytical Chemistry (AOAC). (1990). Official Methods of Analysis (Vol. 1, 15th ed.). Virginia, USA: Association of Official Analytical Chemists.

Aypak, S.U., Aypak, S., Voyvoda, H., Guven, G., Fidan, E.D., Tosun, G., Gultekin, M., Simsek, E., Guler, A.G. (2016). Comparative analysis of serum mineral level and parasite load in goats naturally infected with gastrointestinal nematodes. Turkish Journal of Parasitology, 40:141-146.

Daing, T., Win, Y.T. (2006). Evaluation of urea-molasses multi-nutrient blocks as a feed supplement for cattle production and as a carrier for anthelminthic medication in Myanmar, in Makkar, H.P.S., Smith, T. (Eds.), Improving animal productivity by supplementary feeding of multi-nutrient blocks, controlling internal parasite and enhancing utilization of alternate feed resource (pp. 77-90). International Atomic Energy Agency, Austria.

Godara, R.S., Naskar, S., Das, B.C., Godara, A.S., Ghosh, M.K., Mondal, M., Bhat, S.A. (2015). Effect of area specific mineral supplementation on biochemical profile in female black Bengal goats. Journal of Animal Research, 5(2):263-268.

Hatungimana, E., Ndolisha, P. (2015). Effect of urea molasses block supplementation on growth performance of sheep. International Journal of Novel Research in Life Science, 2(3): 38-43.

Kayastha, T.B., Dutta, S., Roy, R.K. (2012). Impact of supplementation of UMMB licks in the ration of dairy animals. Vetscan, 7(1): 107-110.

Kincald, R.I. (1999). Assessment of trace mineral status of ruminants: A review. Proceedings of the American Society of Animal Science.

Li, H., Wang, K., Lang, L., Xu, Y., Zhang, Q., Zhu, W., Zhang, L., You, Y., Xu, F., Lu, W. (2014). The use of urea molasses multinutrient block on pica symptom of cattle. Journal of Food, Agriculture & Environment, 12(3&4): 415-419.

Makkar, H.P.S. (2007). Feed supplementation block technology – past, present and future, in: Makkar, H.P.S., Sanchez, M., Speedy, A.W. (Eds.), Feed supplementation blocks. Urea molasses multi-nutrient blocks: Simple and effective feed supplement technology for ruminant agriculture (pp. 1-12). Food and Agriculture Organization, Rome.

Manta, I.H., Aduba, J.J., Dada, J.T., Onyemize, C.U. (2013). Development of urea molasses multi-nutrient block (UMMB) feed for ruminant animals as a supplementary feed to cushion the effect of draught in Northern Nigeria. International Journal of Environmental Science, 2(3): 106-109.

Mira, P., Wan Zahari, M., Rusli, N.D. & Mat, K., 2018a. Effects of Medicated and Non-medicated Multi-nutrient Block Supplementation on Gastrointestinal Parasite Infestation and Blood Hematological. Sains Malaysiana 47:1447-1453.

Mira, P., Wan Zahari, M., Rusli, N.D & Mat, K., 2018b. Effects of Non-Medicated and Medicated Urea Molasses Multinutrient Blocks on Dry Matter Intake, Growth Performance, Body Condition Score and Feed Conversion Ratio of Saanen Lactating Does Fed Conventional Diets. Journal of Tropical Agricultural Science 41:729-740.

Mubi, A.A., Mohammed, I.D., Kibon, A. (2013). Effects of multinutrient blocks supplementation on the performance of Yankasa sheep fed with basal diet of rice straw in the dry season pf Guinea Savanna region of Nigeria. Archieved of Applied Science Research, 5(4):172-178.

Muhayat, F. (2013). Animal feed resources and management in Malaysia. Regional workshop on animal feed resources, 13-15 August, Bangkok Thailand. http://cdn.aphca.org/dmdocuments/Events/FAOAPHCA_Regional_Workshop_on_Animal_Feed_Resources_Bangkok/130814_S5_Malaysia_Muhayat.pdf on Mei 5, 2017.

Muralidharan, J., Jayachandran, S., Thiruvenkadan, A.K., Anandha Prakash Singh, D., Sivakumar, K. (2015). Effect of concentrate and urea molasses mineral block supplementation on the blood biochemistry of off season Mecheri lambs. Indian Journal of Animal Research, 49(3): 409-412.

Perera, A.N.F., Perera, E.R.K., Abeygunawardane, H. (2006). Development, evaluation and popularization of medicated and non-medicated urea-molasses multi-nutrient blocks for ruminant livestock production under smallholder conditions of Sri Lanka, in: Makkar, H.P.S., Smith, T. (Eds.), Improving animal productivity by supplementary feeding of multi-nutrient blocks, controlling internal parasite and enhancing utilization of alternate feed resource (pp. 119-129). International Atomic Energy Agency, Austria.

Perkin-Elmer Corporation. (1996). Analytical methods for atomic absorption spectroscopy (pp. 138-154). Perkin Elmer Corporation, USA.

Rafiq, M., Mumtaz, S., Akhtar, N., Khan, M.F. (2007). Effect of strategic supplementation with multi-nutrient urea molasses blocks on body weight and body condition score of Lohi sheep owned by tenants. Pakistan Small Ruminant Research, 70: 200-208.

Rashid, M. (2008) Goat and their nutrition. Manitoba Goat Association, Canada.

Suharyono, Sutanto, H., Purwanti, Y., Martanti, Agus, A., & Utomo, R. (2014). The effect of urea molasses multi-nutrient and medicated block for beef cattle, beef and dairy cow. Atomic Indonesia, 40(2): 77-87.

Tadele, Y., Amha, N. (2015). Use of different non protein nitrogen sources in ruminant nutrition: A review. Advances in Life Science and Technology, 29:100-106.

Tegegne, M.T. (2016). Effects of different supplements on nutrient intake, body weight gain and economic feasibility of grazing Abera sheep. Global Journal of Science Frontier Research: Agriculture and Veterinary, 16(8):45-50.

Wan Zahari, M., Chandrawathani, P., Sani, R.A., Nor Ismail, M.S., & Oshibe, A. (2007). Production and evaluation of medicated urea-molasses mineral blocks for small ruminants in Malaysia, in: Makkar, H.P.S., Sanchez, M., Speedy, A.W. (Eds), Feed supplementation blocks. Urea molasses multi-nutrient blocks: Simple and effective feed supplement technology for ruminant agriculture (pp. 213-231). Food and Agriculture Organization, Rome.

Wan Zahari, M., Wong, H.K. (2009). Research and development of animal feed in Malaysia. WARTAZOA, 19(4):172-179.

Wongnen, N., Parinyasutinun, U., Chantapasarn, B., Thong-Untang, D., Sukarin, A., Pangchantuk, S., Naksuwan, M., Thong-Untang, D., Yotikol, S., Nguadchai, S., Petlum, A., Wanapat, M., Wachirapakorn, C., Polpak, S., Polpak, M. (2006). Feed supplementation of dairy cattle in the North-Eastern region of Thailand., in: Makkar, H.P.S., Smith, T. (Eds.), Improving animal productivity by supplementary feeding of multi-nutrient blocks, controlling internal parasite and enhancing utilization of alternate feed resource (pp. 131-139). International Atomic Energy Agency, Austria.

Zeleke, M. (2015). Effects of dietary inclusion on mineral supplements with concentrates on nutrient utilization and economic efficiency of sheep fed hay as basal diet. PhD. Dissertation, Haramaya University, Ethiopia.

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