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COMPARISON OF FARM FORMULATED AND COMMERCIAL WINTER MINERAL LICK ON NUTRIENTS UTILIZATION AND SHEEP PERFORMANCE

Nchele KULEILE

Department of Animal Science, National University of Lesotho, P.O. Roma Lesotho

Supporting Information

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ABSTRACT: A completely randomized study with three dietary treatments was undertaken at the National University of Lesotho Faculty of Agriculture farm. The three treatments were made up of control which had no access to winter mineral lick supplement and two treated groups made up of farm formulated and commercial winter lick. All animals had access to basal diet in the form of Teff [*Eragrostis tef* (Zucc.) Trotter]. The main objectives of the study were to assess the influence of supplementary feeding using winter mineral lick on sheep performance and on the utilization of teff. Also to compare both farm formulated and commercial winter mineral lick on the performance of sheep and utilization of *eragrostis tef*. A total of 30 yearling sheep of similar body weight were used in this study and were housed in pairs. Dietary treatments and water were offered ad libitum while basal diet was pre-weighed on daily basis. The findings of this study indicated that dietary treatments had a significant (P<0.05) influence on feed intake, live weight and weight gain while there were no significant (P>0.05) difference on feed conversion ratios. The control group of animals had poor production performance than treated groups and animals were losing weight. Nutrients digestibility were statistically different amongst all the treatments whereby supplement groups had better nutrient utilization than the control group. Mean comparison test revealed that there were no significant difference between farm formulated and commercial winter mineral lick on production and digestibility parameters. Economic benefit analysis indicated that by using farm formulated winter mineral lick farmers can save up to 36% of feed costs. To further reduce the costs of farm formulated lick, there is need to consider non-conventional feeds such as brewery by-products in the formulation of lick.

Keywords: Digestibility, *Eragrostis Tef*, Farm Formulated, Nutrient Utilization, Winter Mineral Lick

INTRODUCTION

A dry season in Lesotho is marked by periods of feed shortages resulting in general retardation in animal growth and production. Small ruminants diets in Lesotho are based on fibrous feeds: mainly mature unimproved pastures particularly at the end of the dry season and crop residues such as wheat straw, maize and sorghum stovers. These feeds are imbalanced particularly deficient in protein, minerals and vitamins and they are highly lignified with low digestibility (Habib et al., 2009; Khattab et al., 2013; Gado et al., 2016 and Sheikh et al., 2018). Not surprisingly the animals are malnourished to a great extent, especially during winter when the grazing land has limited quantities of forage. The lack of supplementary feeding practices by the farmers during this critical phase of production further exacerbated the low body condition scores and increased mortality of both lambs and their dams as well as increased reproductive failures.

In sheep, digestion is done with the help of rumen microbes particularly cellulolytic bacteria which convert structural carbohydrates into volatile fatty acids, carbonic acid and methane gas. Cellulolytic bacteria need a neutral pH between 6 and 9, while a pH less than 5.5 affects fiber digestibility (Castillo-González et al., 2014). The presence of extracellular cellulase enzymes is needed to break β-glycosidic bonds (1-4) of the biopolymer thereby providing sugars for use by microorganisms (Wedekind et al., 1988). Major microbial activities in the rumen involve multiplication and substrate degradation and the latter depends primarily on the availability of fermentable nitrogen, rumen un-degradable protein and readily available source of energy (Alvarez Almora et al., 2012). Factors that can lead to deficiencies of any of the three primaries can negatively affect digestion and digestibility of structural carbohydrates by the rumen microbes (Leng, 1991; Ushida and Jouany, 1990).

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Urea is a form of non-protein nitrogen (NPN) and probably the most common source of fermentable nitrogen. Molassses on the other hand is a source of readily fermentable energy and it also acts as carrier of both urea and mineral supplements for ruminant animals (Hamed et al., 2012). Urea-molasses mineral blocks (UMMB) contains urea, molasses, salt, mineral mixture, bran and vitamins and can improve the utilization of low quality roughages by satisfying the requirements of the rumen microorganisms, creating a better environment for fermentation of fibrous material and increasing production of microbial protein and volatile fatty acids (Trishna et al., 2012). Urea after hydrolyzing into ammonia in the rumen provides a nitrogen source for rumen microflora which in turn improves the digestibility and utilization of fibrous feeds (Mengistu and Hassen, 2017; Azizi-Shotorkhoft et al., 2018 and Selthilkumar et al., 2018). Urea molasses supplement in sheep is effective in reducing the cost of supplementary feeds (Mubi et al., 2013).

The successful utilization of UMMB as supplement for small ruminants on production, digestibility and reproductive performance was reported by a number of researchers (Mubi et al., 2013; Hatungimana and Ndolisa, 2015; Gendley and Tiwari, 2016; Yatoo et al., 2016 and Mira et al., 2018). These researchers used UMMB as a supplement to improve utilization of poor quality basal diet and observed that UMMB had improved animal appetite, dry matter intake, milk production, body weight gain, feed conversion ratio, body condition score and digestibility. The aim of the current study was to assess the influence of UMMB as a supplement for merino sheep during a dry season and to compare the effect of commercial and farm formulated licks on production performance and nutrient utilization.

MATERIALS AND METHODS

Ethical Approval

The study met the animal welfare conditions standards for conducting animal science research set by the Faculty of Agriculture of the National University of Lesotho.

Study site

The study was conducted at the National University of Lesotho farm in Roma, some 34 kilometres southeast of Maseru, the capital of Lesotho. The Roma valley is broad and is surrounded by a barrier of rugged mountains which provide magnificent scenery. The climate of this area alternates between the hot and cold months. The winter being the coldest season and is experienced from May to July and temperature may drop as low as -1^{0}C, summer is the hottest season and is experienced from September to February and temperature can be as high as 28^{0}C.

Experimental design and treatments

The study was done using completely randomized design with three dietary treatments replicated five times. Dietary treatments were made up of control (sheep with no access to winter mineral lick), treatment one (sheep with access to commercial winter mineral lick) and treatment two (sheep with access to farm formulated winter mineral lick). Commercial winter mineral lick block was obtained from local animal feed supplier while farm formulated was mixed at the University of Lesotho farm using cold processing technique. Ingredients and their inclusion rates for farm formulated urea mineral block are shown below in Table 1.

Table 1 - Dietary ingredients and binding materials of winter mineral lick

Ingredients	Inclusion rate (%)
Molasses	35
Urea	15
Mineral mixture	2
Salt	5
Cement	13
Wheat bran	30
Total ingredients	100

Animal management

A total of (n=30) yearling male Merino sheep of similar live weight were used in this study where 10 sheep were allotted to each treatment. All animals were stall fed during the entire experimental period. Two sheep were housed in each pen which was cleaned regularly .The sheep were fed a pre- weighted basal diet daily (Table 2) made up of *Eragrostis teff*. Dietary treatments were offered ad libitum to sheep. Clean water was also given ad libitum. All routine management aspects for yearling sheep were observed. The feeding trial lasted for eight weeks including one week of adaptation period.

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Table 2 - Basal diet (Eragrostis tef) chemical composition

Constituents	Percentages
Dry matter	87.0
Ash	5.00
Crude Protein	8.50
Crude Fiber	2.20
Metabolisable energy (MJ/kgDM)	11.0
Ether Extract	2.20
Calcium	0.10
Phosphorus	0.30

Data collection

Data collection for this study was divided into three major areas namely production, digestibility and economic data.

Production data

Animal production data such as feed intake, live weight, weight gain and feed conversion ratio (FCR) were collected on weekly basis using the following formulas;

Feed intake = Total feed offered (kg) - Total feed refused (kg)

Feed Conversion Ratio = Feed Intake/Body Weight

Live Weight was determined by weighing the animals using Weigh Bridge

Weight gain was calculated as the difference in weekly live weight of the sheep

Digestibility data

Digestibility data was used as proxy for nutrient utilization by sheep. Data was collected for dry matter and protein digestibility every two weeks using total collection method for faeces. Digestibility was measured as the difference between feed intake and fecal output. Protein content was determined on both basal diet and small sample of faeces. Fecal samples for each pen was collected for a week, weighed and dried in the oven for 24 hours at 70^{0}C. A small sample of dried faeces was analyzed for protein content using kjeldahl procedure. The following formulas were used in the computation of dry matter and protein digestibility.

Dry matter digestibility = [(dry matter intake –fecal output) / dry matter intake] *100

Protein digestibility = [(protein intake – fecal output) / protein intake] *100

Economic benefits

The cost per kg of the experimental diet was calculated by multiplying the percentage composition of the ingredients with the price per kg of each feed ingredient and summing all the ingredients costs. Total feed intake x cost per kg feed gave total feed cost. Feed cost per kg weight gain was calculated as FCR x cost per kg of diet.

Data analysis

Data was analyzed with the aid of Studentized range Package for Social Sciences (IBM SPSS, 2011) version 20. Analyzes of variance (ANOVA) was used to determine the difference between the three dietary treatments. Least significant difference (LSD) at 5% was used to separate the means.

RESULTS AND DISCUSSIONS

Production parameters

The influence of winter mineral lick block on yearling sheep performance results are shown in Table 3. According to the results the dietary treatment had a significant ($P \leq 0.05$) influence on feed intake, live weight and daily weight gain whereby sheep that had access to winter mineral lick performed better than sheep without access to mineral lick. This increased *Eragrostis tef* intake by the treated group of animals is due to the resulting intense microbial activities due to increased nitrogen supply from the winter mineral lick. Feed conversion ratio results did not differ significantly ($P \geq 0.05$) between the three dietary treatments. The mean comparison test on the other hand revealed that there was not significant ($P \geq 0.05$) difference between sheep fed commercial and farm formulated winter mineral lick block. These results also highlighted the importance of supplementary feed because animals that were not given supplementary feeding (control group) had lower feed intake, live weight and daily weight gain compared to the supplemented groups. Sheep under control treatment were losing weight at the rate of 40g per head per day while animals receiving supplementary feeding were gaining an average weight of 38gram per head per day.

Data on weekly basis (Figures 1 to 2) also proved that animals that had access to winter mineral lick had higher feed intake and better live weight change across the entire experimental period. It was also observed from the current study that animals that did not have access to dietary treatment started losing weight linearly across all the weeks and this was also the similar case with feed intake which also declined linearly between week one and week four. These results indicated that the use of winter mineral lick had a significant influence on the utilization of *Eragrostis tef* whereby it increased the feed intake of treated group by 32% over the control group.

The findings of the current study are supported by the findings of Peterson et al. (1981); Tiwari et al. (1990); Nyarko et al. (1993); Tiwari et al. (2008); Chanjula and Ngampongsai (2008); Ali et al. (2009); Hatungimana and Ndolisha (2015); Mira et al. (2018) and Mengistu and Hassen (2018) who recorded an increase in dry matter intake by animals that received supplementary feeding in the form of winter mineral lick block than animals that were not offered supplementary feeds. The positive effect of winter mineral lick results on live weight maintenance and gain was confirmed by a number of researchers (Chen, 1993; Hadjipanayiotou et al., 1999; Zhang et al., 1999; Aganga et al., 2005; Mubi et al., 2012; Gendley and Tiwari, 2016; Yatoo et al., 2016; Baa et al., 2018 and Mengistu and Hassen, 2018) who found that animals that were supplemented with multi nutrients block significantly gained more weight than the control group which subsequently lost weight at the same time.

Table 3 - The effect of winter mineral lick on sheep performance

Parameters	Treatments			Significance	
	Control	Commercial	Own formulate	P[1]	CV[2]
Feed Intake(kg)	0.739[a]	1,047[b]	1,081[b]	0.001	3.29
Live weight (kg)	20.5[a]	22.5[b]	23.0[b]	0.001	6.34
FCR[3] (kg/kg)	1.26	1.49	1.64	0.200	3.95
Weight gain (kg)	-0.04[a]	0.038[b]	0.041[b]	0.001	2.44

a, b, Means in rows with different superscripts differ significantly (P<0.05); [1] Probability level at 0.05% [2] Coefficient of Variation; [3] Feed Conversion Ratio (gram feed/gram weight gain)

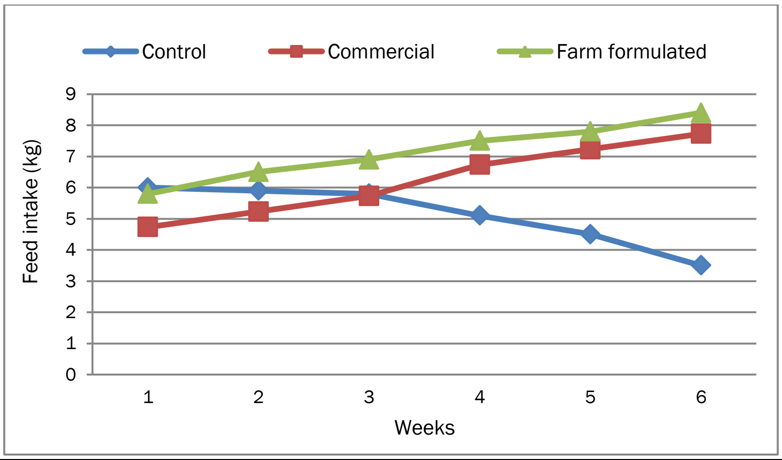

Figure 1 - Weekly feed intake

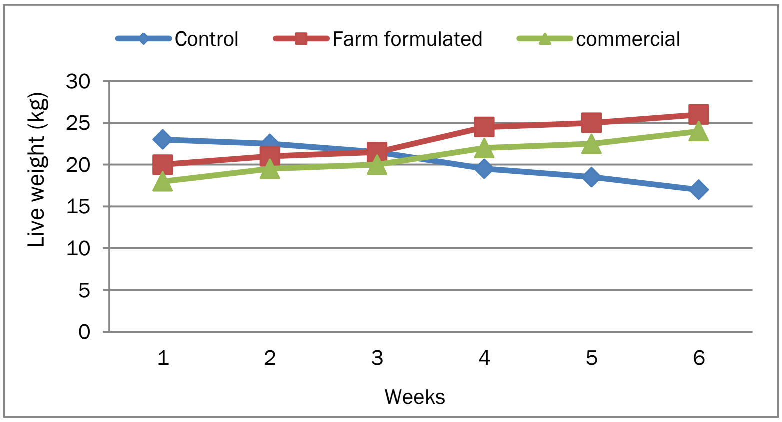

Figure 2 - Weekly live weight change

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Nutrient digestibility

The comparison of farm formulated and commercial winter mineral lick on teff digestibility results are summarized in Table 4 below. The results showed that there were significant (P≤0.05) differences between treatment means in terms of *Eragrostis tef* dry matter and protein digestibility. The results also illustrated that there were significant (P≤0.05) difference between the control group and the two supplemented treatments in terms of teff digestibility and utilization whereby the control group had lower dry matter and protein digestibility. The mean comparison test results however, pointed out that there were no significant (P≥0.05) differences on teff dry matter and protein digestibility between both farm formulated and commercial winter mineral lick. The implication was that farm formulated winter mineral lick quality was good because it was able to give similar results to the commercial lick. The results on the influence of winter mineral lick supplementation on the utilization of teff highlighted that supplementary diet improved the utilization by thirty-two percent. The findings of the current study are in line with the findings of Garg and Gupta (1991); Khattab et al. (2013); Magalhaes et al. (2013) and Mengistu and Hassen (2018) who reported that supplementation of sheep with winter mineral lick improves the utilization and digestibility of low quality forages and maize stover. These results validated the theory that the use of winter mineral lick block improved the utilization and digestibility of low quality fodder in yearling sheep because the sheep that were not supplemented had poor utilization of *Eragrostis tef*.

Economic benefits

Economic benefits analysis results (Figure 3) indicated that the cost of 40kg commercial urea mineral lick was M255.00 while the cost for ingredients used in the formulation of own formulated urea mineral lick was M162.00. This implies that there was a reduction cost of 36% that was saved when using own formulated urea mineral lick as compare to buying commercial urea mineral lick.

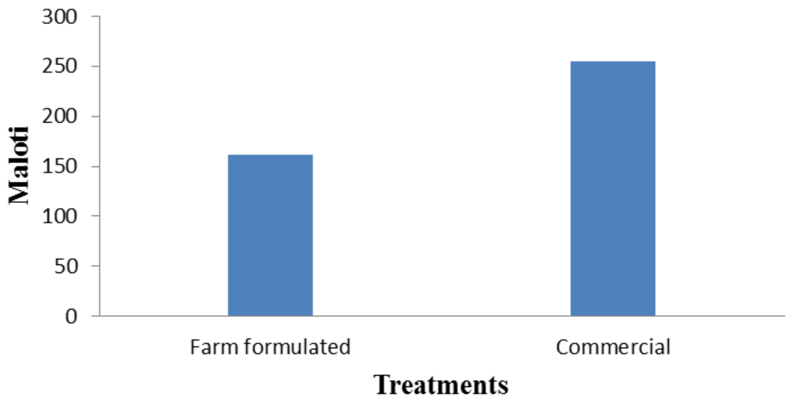

Figure 3 - The economic benefits of using farm formulated lick

Table 4 - The effect of winter mineral lick on *Eragrostis tef* nutrients digestibility

Parameters	Treatments			Significance	
	Control	Commercial	Own formulate	P[1]	CV[2]
Dry matter digestibility	54.07[a]	63.02[b]	63.09[b]	0.001	7.31
Protein digestibility	61.07[a]	70.02[b]	70.09[b]	0.001	6.55

[a, b] Means in rows with different superscripts differ significantly (P<0.05); [1] Probability level at 0.05%; [2] Coefficient of Variation

CONCLUSIONS

It can be concluded from the results that supplementary feeding especially during the dry season is very important for maintaining live weight of yearling sheep in Lesotho. The use of winter mineral lick block was able to maintain live weight, improved feed intake and utilization of *Eragrostis tef* and improved live weight gain by sheep. The adoption of formulating own mineral lick block also proved to be very important aspect that can help farmers to reduce their supplementary feeding by as much as thirty- six percent. The use of winter mineral lick block as a supplement also improved the digestibility and utilization of *Eragrostis tef* during the dry season by thirty-two percent which without the supplement (winter mineral lick block) would not be able to maintain live weight of yearling sheep.

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DECLARATIONS

Corresponding Author

E-mail: Nchelekuleile@gmail.com

Authors' Contribution

NP Kuleile participated in the design of study, performed the experiments, analyzed the data, critically revised the manuscript for important intellectual contents, wrote the manuscript and approved the final manuscript.

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Conflict of interests

The authors have not declared any conflict of interests.

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