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The Influence of Forage Based Supplementary Feeds on Lactating Ewe Performance in the Foothills of Lesotho

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ABSTRACT

Farmer participatory research was implemented in the foothills of Machache Lesotho with aim to investigate the influence of supplementary feeding of ewes using forage based diets. The study followed a completely randomized block design with four dietary treatments replicated three times. A total of 216 lactating ewes were contributed by farmers and were randomly distributed into 12 experimental units. Each treatment had a total of 54 animals with 18 animals per replicate. The experiment lasted for 10 weeks. The diet treatment was as follows; control in the form of pasture, T1 forage alone, T2 forage plus concentrate, T3 forage, concentrate and urea molasses mineral block. The treatment diet was offered in the morning before animals go to the pasture or rangeland and it was offered at the rate of 1000 grams per week per head. Control animals on the hand did not have access to supplementary feeds. Data collection on production parameters such as feed intake and live weight change was taken on weekly basis. Data on blood glucose, BHBA, wool growth and milk quality was taken at the beginning and at the end of feeding trial. The findings indicated that the treatment group performed significantly ($P<0.05$) better than the control group in all tested parameters such as nutritive value of treatment diets, production parameters such as feed intake, live weight change and wool growth, blood parameters such as blood glucose and BHBA and milk quality. The study also revealed that pasture (pasture) and forage supplementation (T1) alone do not meet the nutritional needs of lactating ewes and the animals had to use their body fat reserves to meet their maintenance needs and this was evident by loss of weight and increased blood BHBA from the two treatments.

Keywords: Lactation; Ewe; Supplementary feeding; Forage; Concentrates; Urea molasses mineral block

INTRODUCTION

Lactation is the period of highest demand for nutrients in sheep production cycle. The highest demand is as a result of nutrients needed for milk synthesis and for the maintenance of the ewe.

The newly born lambs are dependent on their mother's milk for the first six weeks depending on the type of weaning practised by the farmer [1]. Milk provides essentially all the lamb's nutritional needs during the first two months. However, the majority of farmers lose their newly born lambs as a result starvation due to low milk production by ewes.

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According to wool and mohair promotion project appraisal report annual feed shortage during dry season is estimated at 40% in Lesotho and this had a negative bearing on ewe productivity during lactation. Feed shortage during dry season in Lesotho is also exacerbated by farmer's habit of not planting supplementary winter forages to alleviate the situation.

In Lesotho farmers follow two lambing seasons and each of them having its advantages and disadvantages in terms of feed availability. However, end of autumn/winter lambing and its subsequent lactation period coincide with dry season which is characterised by poor quality feeds such as crop residues and stubbles that remain after harvest. These types of feeds are well known for their low nitrogen content and poor digestibility and their protein content averaging 5.5% CP and 6 MJ ME for cereal based residues [2]. The lactating ewe on the other hand requires metabolisable energy ranging between 10 and 12.5 MJ ME and crude protein between 12 and 14% CP depending on the number of lambs nursing. The nutritional gap between the basal diet and animal requirements is very big and warrants provision of supplementary feeding otherwise the inevitable high lamb mortality and deadly metabolic disorders for lactating ewes such as ketosis cannot be avoided.

In an effort to promote supplementary fodder production amongst farmers, a completely randomised block design study was implemented in the foothills of Lesotho. The aim of the study was to compare the effects of supplementary forage with other common sources of supplementary feeds such as concentrates and urea molasses mineral block on the performance of lactating ewes [3].

MATERIALS AND METHODS

Study Area

The study was undertaken by the national university of Lesotho, department of animal science contracted by Wool and Mohair Promotion Project Lesotho (WAMPP) funded by IFAD and world bank. The national university of Lesotho also partnered with relevant ministry of agriculture departments such as department of agricultural research, department of livestock and Lesotho agricultural college for knowledge and technology transfer purposes. The on-farm study was conducted at machache foothills covering the two woolshed namely machache and bushmen [4]. Machache falls within the foothills of Lesotho and is situated about 40 km south east of the capital town Maseru. The foothills of Lesotho are situated between 1,800-2,000 metres above sea level. Most of the rainfall occurs from October to April. Rainfall season peaks between December and February when most of the country records over 100 mm per month while the lowest rainfall in most localities (<10 mm) occurs in June and July monthly mean minimum temperatures in winter range from -6.3°C in the highlands to 5.1°C in the lowlands; sub-zero temperatures are common in the winter months (May to July) but may also occur during summer.

Experimental Design

The study followed a completely randomized block design with four dietary treatments made up of control and three treated groups. Blocking was used to cater for differences in body weight of lactating sheep. Each treatment had a total of 54 lactating ewes. The treatments were replicated three times with 18 sheep per replicate [5].

Dietary Treatments

The study was made up of four dietary treatments in the form control and three treated groups. Control treatment was in the form of pasture and it also served as basal diet for the treated groups. The three treated groups were based on forages in such a manner that treatment one (T1) constituted forage alone, treatment two (T2) was forage and concentrate in total mixed ration and the third treatment (T3) was similar to treatment two with additional urea molasses mineral block. Forage treatment was made-up of a mixture of leguminous and cereal based forages. Concentrates treatment was made up of the mixtures of the following ingredients; sun lower, hominy chop, crushed yellow maize and maxiwol blended together to meet requirements for lactating ewe. Urea molasses mineral block treatment was in the form of mineral lick block. Each treatment was replicated three times. All experimental animals had access to basal diet in the form of pasture. The treated animals had access to supplementary feeding which was offered at the rate of 1000 grams per head per week for all treatment groups while the urea molasses block was offered on ad libitum basis while animals are not in the pastures.

Animal Management

A total of 216 lactating sheep were used in this trial for production parameters. while 10 animals per replicate with the total of 120 animals were used to provide samples for blood, milk and wool parameters. All experimental animals were identified using plastic tags and were managed according to individual farmer's style. Animals were fed supplementary diets in the morning before going to the grazing area. Animals were given ad-libitum access to water. The feeding trial lasted for 10 weeks after lambing plus one week of adaptation period. A total of 27 farmers participated in the study by offering their animals as well as helping with data collection [6].

Data Collection

Supplementary feeds nutritive value analysis: The nutritive value of supplementary feeds and basal diets were determined according to official methods of Analysis by Association of Official Analytical Chemist AOAC. Feed samples were subjected to proximate analysis covering and the following parameters were determined; Dry Matter (DM) by oven method, ash determination by muffle furnace, Crude Protein (CP) by Kjeldahl method, Crude Fibre (CF) by gravimetric method.

Macro minerals such as phosphorus and calcium were determined using atomic absorption spectroscopy. Metabolisable Energy (ME), Rumen Undegradable Protein (RUP) and Total Digestible Nutrients (TDN) were estimated using nutrimix professional animal feed formulation software.

Production parameters: Data on production parameters including feed intake and body weight gain were collected on weekly basis. Weighing scales were used to measure body weight and feeds. Feed intake was estimated as the amount of feed offered less the amount of feed refused.

Blood parameter: Blood samples were collected from the jugular vein using a needle at the beginning and at the end of feeding trial. Samples were directly put onto a relevant test strip and the reading was recorded using Freestyle blood meter.

Wool parameters: The wool growth rate was determined by measuring its length at the beginning of feeding trial and again at the end of feeding trial using a ruler. The total length was divided by the number of weeks which constitute the duration of the experiment in order to determine growth rate per week.

Milk nutritive: The morning samples were kept refrigerated at 4°C and were taken to the laboratory for analysis. A rapid milk test was conducted using milkana multitest equipment which provides a list of parameters on one sample. The parameters included pH, water content, milk fat, protein, lactose and solids non-fat [7].

RESULTS AND DISCUSSION

Proximate Composition of Experimental Diets

The dietary factors proximate composition results are illustrated in Table 1. The results revealed that supplementary feeds based on forage were significantly (P<0.05) better than the control in terms of CP, ME, TDN, RUP and macro minerals (Ca and P). The level of nutrients within the treated group also improved linearly from T1 up to T3 and T1 was also differing significantly (P<0.05) from T2 and T3 respectively. The crude fibre content of control and T1 were significantly (P<0.05) higher than that of T2 and T3 and this can affect the utilization and metabolisability of the treatment feeds. The lowest crude protein value of 8.4% observed in control was enough to meet the minimum requirements for microbial protein synthesis and maintenance requirement of ewe which stands at 7%CP. However, this value was lower than the minimum requirements for lactating ewe nursing single and twin lambs. It was also observed that T1 crude protein content was also lower than the requirement for lactating ewe estimated between 12% and 14% CP. The overall low nutritive value and high crude fibre content implied that it will not support the high nutritional needs of lactating ewes unless some form of supplementary feeds is offered.

Table 1: Proximate composition of dietary factors.

Parameters	Forage treatments				Significance	
	Control	T1	T2	T3	P^1	CV^2
CP (%)	8.4^a	11^b	14^c	16^c	0.001	1.23
ME (kcal)	1890^a	2108^b	3298^c	3641^c	0.001	4.35
TDN (%)	49^a	60^b	79^c	84^d	0.001	1.08
CF (%)	30^a	33^a	19^b	20^b	0.001	2.66
RUP (%)	0.7^a	1.3^a	3.79^b	4.10^c	0.001	12.11
Ca (%)	0.50^a	1.24^b	2.35^c	2.56^c	0.001	8.01
P (%)	0.36^a	0.63^b	0.79^c	0.86^c	0.001	15.37

Note: a, b, c, d-Means in rows with different superscripts differ significantly (P<0.05); P^1-Probability @ 0.05%; CV^2-Coefficient of variation; $T1^3$-Forages; $T2^4$-Forages+concentrates; $T3^5$-Forage, Concentrates+Urea molasses block

Sheep Performance

The effects of supplementary feeding on sheep performance results are shown in Table 2. According to the results the dietary treatments had a significant (P<0.05) influence on protein intake and live weight change. Animals fed control diet and forage alone (T1) had the lowest protein intake and they also lost weight during the experiment. The loss of weight was ranging between 1.3 kg and 800 gram and this results revealed that the rangeland in Lesotho are not very bad when compared to other regions where observed a weight loss as high as 10% of body weight. Animals fed a mixture of forage and concentrate diets (T2 and T3) maintained their body weight during this critical phase associated with weight loss. The poor performance of animals fed control diet could be associated with low dry matter yield of pastures during spring and early summer because pastures were in their worst condition with little grass cover. The condition was also exacerbated by long spell of drought as well. Under the prevailing conditions animals had to spend a lot of energy in the movement from home to far away pasture as well as travel to drink points because other points had dried up as a result of severe drought. The control animals were at higher risk as evident by the results where animals lost weight by as much as 3.7% of their body weight. The result of the current study is in contrast to the findings of who observed no significant (P>0.05) difference between supplemented and non-supplemented sheep in live weight change. The difference could have been due to difference in basal diet which was wheat stubble in their study and their animals were able to meet their dry matter intake. Reported partly similar results because researchers observed significant differences in live weight changes between the control and supplemented group of animals but however the rate of change was quite steep in their study where control animals lost about 3.31 kg during the 4 weeks of gestation [8].

Table 2: The effects of supplementary forages on sheep performance.

Parameters	Treatments				Significance	
	Control	T1	T2	T3	P	CV
Initial BW (kg)	36.2	35.9	36.7	36	N/A	N/A
Final BW(kg)	34.9	35.1	37.3	37.4	N/A	N/A
Protein intake (grams)	70^{a}	110^{b}	140^{c}	160^{c}	0.001	1.23
Live weight change (kg)	-1.3^{a}	-0.8^{b}	+0.6^{c}	+1.4^{d}	0.001	2.56
Live weight change (%)	-3.7^{a}	-2.23^{b}	+1.61^{c}	+3.74^{d}	0.001	2.08

Note: a, b, c, d-Means in rows with different superscripts differ significantly (P<0.05); P1-Probability @ 0.05%; CV2-Coefficient of variation; T13-Forages; T24-Forages+concentrates; T35-Forage, Concentrates+Urea molasses block.

Blood Glucose

The blood glucose results (**Table 3**) indicated that there was significant (P<0.05) differences amongst the treatments whereby the control animals had the lowest blood glucose than the supplemented groups. The animals under control and T1 blood glucose was also declining between successive blood sampling while animals in T2 and T3 blood glucose was improving at the same time. Despite this observation blood glucose during the entire experimental period was within the normal glucose range according to who provided reference range values for albumin, total protein, glucose and cholesterol as follow: 2.4 to 3.09 g dL^{-1}; 6.0 to 7.0 g dL^{-1}; 50.09 to 80.0 mg dL^{-1}; 52.12 to 76.06 mg dL^{-1}, respectively. The findings of the current study are in agreement with the findings of who observed significant (P<0.05) difference between blood glucose of supplemented group (66 mg/dL) and the control (44 mg/dL). The declining blood glucose in the current study under control and T1 was an indicator that animals were not meeting their nutritional needs for energy and hence were in a negative energy balance [9]. Indicated that a decrease in blood glucose concentrations could lead to lipid mobilization, which is reflected by high concentration of NEFA, which are mobilized in the liver as an alternate energy source. Blood metabolic profile is an important laboratory diagnostic technique that can be used efficiently to assess the nutritional status and animal health. This information is very crucial to guarantee the metabolic and nutritional needs of ewes during the early lactation to reduce the mortality rates of new-borns and consequently economic loss.

Table 3: Blood glucose.

Parameters	**Treatments**				**Significance**	
	Control	**T1**	**T2**	**T3**	**P**	**CV**
Initial blood glucose(mg dL^{-1})	54.6	55	55	54	N/A	N/A
Final blood glucose (mg dL^{-1})	52.2	54.8	60	64.4	N/A	N/A
Blood glucose response	-2.4^{a}	-0.2^{b}	+5.0^{c}	+10.4^{d}	0.001	3.71

Note: a, b, c, d-Means in rows with different superscripts differ significantly (P<0.05); P[1]-Probability @ 0.05%; CV[2]-Coefficient of variation; T1[3]-Forages; T2[4]-Forages+concentrates; T3[5]-Forage, Concentrates+Urea molasses block

Blood β-Hydroxybutyric Acid (BHBA)

The effects of supplementary feeding on sheep blood β-Hydroxybutyric Acid (BHBA) results are shown in **Table 4**. According to these results the dietary factors had a significant (P<0.05) influence on final blood BHBA and BHBA response whereby the control group had the highest blood BHBA than the supplemented groups and the current study BHBA value were within the range associated with subclinical ketosis. Threshold blood BHBA in sheep with subclinical ketosis is variable and it ranges between 0.5 mmol/l to 1.6 mmol/l while in sheep with clinical ketosis ranges from 1.6 mmol/l to 7 mmol/l. Reported higher BHBA levels in sheep with pregnancy toxaemia as compared to lactating sheep. The blood BHBA of the supplemented groups with the exception of T1 had lower BHBA values indicating that animals were not experiencing negative energy balance.

Table 4: Blood β-Hydroxybutyric Acid (BHBA).

Parameters	Treatments				Significance	
	Control	T1	T2	T3	P	CV
Initial blood BHBA (mg dL^{-1})	0.49	0.5	0.51	0.5	N/A	N/A
Final blood BHBA (mg dL^{-1})	0.7	0.62	0.43	0.25	N/A	N/A
BHBA response	$+0.21^a$	$+0.12^b$	-0.08^c	-0.25^d	0.001	3.71

Note: a, b, c, d-Means in rows with different superscripts differ significantly (P<0.05); P1-Probability @ 0.05%; CV[2]-Coefficient of variation; T1[3]-Forages; T2[4]-Forages+concentrates; T3[5]-Forage, Concentrates+Urea molasses block

Wool Growth

Wool growth rates results clearly pointed out the importance of supplementary feeding on wool growth. Animals that were offered supplementary feeds had better wool growth (279 microns) than (P<0.05) control animals deprived of supplementary feeds (150 microns). The differences in wool growth between supplemented and control were in the range of 6% to 8% higher and this results were comparable to the findings of who reported 8% higher wool growth for supplemented sheep than the control. The wool growth rate per day in microns was the highest in T3. However, there were no significant (P>0.05) differences in wool growth percentage amongst the supplemented animals [10]. The control group had the lowest wool growth and it was also the lowest in crude protein, metabolisable energy and rumen undegradable protein. Wool growth rate to large extent depends on the quality and quantity of protein which is influenced by amino acid profile. Sulphur containing amino acids cysteine and methionine as well as lysine are precursors for wool growth. Reported that by pass protein (RUP) increases wool growth. These researchers also indicated that optimum energy level is required for synthesis of wool in the presence of amino acids.

Milk Quality

The effects of supplementary feeding on milk quality results. The results indicated that offering supplementary feeding to lactating sheep resulted in a significant improvement of milk composition for the lambs. The milk composition for supplemented sheep was superior to control sheep in all parameters measured. Within the treated group T3 animals were better than animals in T2 and T1 in terms of protein, SNF and density.

Ewes fed forage treatment (T1) were better in milk butterfat than any other treatment. These results are in agreement with the findings of who reported high protein content and SNF for supplemented ewes than the control group offered no supplementary feeds. The butterfat of T1 was the highest probably because it had relatively larger particle size than all the diets in the experimental and therefore conformed to the fact that feeding of finely ground forages inadequately stimulates rumination and lowers saliva production. This results in a rumen fermentation pattern that produces a higher proportion of propionic acid and in turn, reduces milk fat percentage. On the other hand T3 was superior in milk protein, SNF, lactose and milk density, the findings can be interpreted relative to nutritive value of dietary treatments whereby T3 had the highest rumen undegradable protein (RUP) and metabolisable energy and the two components contributes significantly to gluconeogenesis that contributed to high lactose, SNF and milk density [11].

CONCLUSION

The deterioration of rangelands, inability of farmers to engage in fodder production, high nutrient requirements of lactating ewe especially those nursing twins and high mortality of lambs justify the need to practice supplementary feeding. The finding of the current study concluded that pasture alone and forage alone cannot meet the nutritional needs of lactating ewes and this was evident by proxy indicators for nutritional status such as loss of weight, low blood glucose and high blood BHBA.

Production indicators were also very low for ewes on pastures and forage alone because animals under these treatments experienced low wool growth rates and milk of with low nutritive value for lambs. The use of forage and concentrate mixture in total mixed ration coupled with urea molasses mineral block proved to be adequate for lactating ewes because animals were able to maintain and improve their body condition during the critical phase. Animals also had better production in terms of wool growth and milk composition. The use of forage supplementation alone can be used for maintenance of ewe and during other production phases such as dry period when dry matter yield of rangeland and pastures are low.

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AUTHORS CONTRIBUTION

Prof Oluremi was the study leader and he approved the study and moderated the write-up, Molapo was part of study design and the overall coordinator of the project, Kuleile designed the study and drafted the manuscript, Mosebi participated in the design of the study and was responsible for fodder production, Mahlehla was the overall supervisor of data collection and she worked with postgraduate students to plan and execute activities of the trial, Lefoka, Mantsoe and Mochoa supervised data collection and play vital role in the selection of farmers. Postgraduate students Moea and Ranchobe were responsible for day to day running of the trial, data collection and arranging data in excel and statistical tools.

CONFLICT OF INTEREST

Animal nutrition team that carried out the study reported no conflict of interest.

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