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Performance of Dorper sheep fed on range grass and legume diets in a feedlot system in Taita Taveta and Makueni counties of Kenya

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Abstract

A feeding trial was conducted on-farm at Kasigau Ranch in Taita Taveta County and on-station at Kenya Agricultural and Livestock Research Organization (KALRO) Kiboko in Makueni County, Southern Kenya to determine the performance of Dorper sheep fed on different diets in a feedlot system. The trial animals at KALRO were ewes while those at Kasigau Ranch were rams, all aged between 10 to 12 months and weighing 22.7 ± 2.4 kg. Two grasses i.e. African foxtail (*Cenchrus ciliaris*) and Bush rye (*Enteropogon macrostachyus*) and two legumes, that is, Dolichos lablab (*Lablab purpureus*) and Cowpea M66 (*Vigna unguiculata*) were used to formulate the diets. The six diets representing the treatments included; Diet 1; *C. ciliaris* + cowpea, Diet 2; *C. ciliaris* + Dolichos lablab, Diet 3; *E. macrostachyus* + cowpea, Diet 4; *E. macrostachyus* + Dolichos Lablab, Diet 5; *C. ciliaris* and Diet 6; *E. macrostachyus*. The trial at Kasigau Ranch involved 18 rams while the KALRO Kiboko one involved 24 ewes with 3 and 4 animals assigned to each treatment at Kasigau and Kiboko, respectively, in a completely randomized block design. Nutritive analysis of the diets was performed using wet chemistry for dry matter (DM), crude protein (CP), acid-detergent fibre (ADF) and neutral-detergent fibre (NDF), crude fiber (CF), Nitrogen free extract (NFE) and acid detergent lignin (ADL). All the trial animals were weighed once a week for growth performance data collection. The data collected was analyzed using Genstat 14th Edition and the means separated using Turkey HSD at 5% significant level. Analysis of the Dry Matter Intake (DMI) and weight gain data showed significant differences ($p < 0.05$) between diets where sheep on the *C. ciliaris* + Cowpea diet at Kasigau ranch registered the highest DMI of 977.0 g/day and Average Daily Weight Gain (ADWG) of 245.0 ± 1.4 g. At the Kiboko site, sheep on the same diet 1 of *C. ciliaris* and Cowpea outperformed others registering a DMI of 1023.1 g/day and ADWG of 272.4 ± 0.9 g. The trial concluded that daily DMI and ADWG of the sheep were enhanced when legumes were included in the diet.

Keywords: Feeding trial, grasses, legumes, dry matter intake, daily weight gain

Introduction

The estimated demand for beef in Kenya is about 900,000 against estimated supply of 600,000 suggesting a supply deficit of about 300,000 MT (Mwangi *et al.* 2020) ^[11]. Kenya has an estimated population of 14 – 14.3 million beef cattle, 17 million sheep, 24 – 26.7 million meat goats and 3 million camels (KNBS, 2010; Kilimo News, 2020) ^[5, 6] about 70% of which are in the Arid and Semi-Arid lands. It is important and imperative to close this supply gap. An important cause of this beef supply deficit is feed shortage in terms of quantity and quality, which limits livestock production and productivity in the Arid and semi-arid lands (ASALs). Small ruminants provide food and nutritional security to disadvantaged groups and small-holder farmers in ASAL rain-fed production systems (Juma *et al.*, 2010) ^[4]. The small ruminants are reared under extensive open grazing system dominated by rangeland grasses that are generally of low nutritive value and without protein or energy supplementation (Sagala *et al.*, 2021) ^[13]. Dorper sheep is across of Dorset and Black head Persian (Milne, 2000) ^[9]. The animals take up to 3 years to attain the market weight. There is need to improve the nutritional plane of the animals in order to fast-track the growth.

Practicing feedlot system of production in ASALs is one way of addressing the nutritional challenges faced by grazing ruminants. Excess forages could be harvested during the growing seasons and conserved. These can be fed to livestock for a short period of 90 to 120 days for purposes of finishing them for the market. To cover the protein deficit in the rangeland grasses, well adapted legumes can be planted and used to formulate quality feed rations to feed animals in the feedlot. Such animals would attain the market weights faster thus increasing the flow of economic benefits to the small scale livestock farmers and support the national effort to close the beef supply gap in the country.

Materials and Methods

Study sites

The study was carried out at both Kasigau Ranch in Taita Taveta and Kiboko in Makueni Counties. Kasigau Ranch is on 52,305 acres of land connecting Tsavo West and Tsavo East National Park in Taita Taveta County. It is about 70 kms from Voi Town. It lies within the altitude of 780 m to 900 m above sea level and receives an annual average rainfall of 697mm, distributed in two seasons i.e. March to May and October to December, the latter being more reliable. Kasigau ranch is in Agro-ecological zone LM4, latitude of 3° 49'35" S and longitude of 38° 39'44" E. KALRO- Kiboko Research station is located in Makindu Sub-County, Makueni County. It is about 170 km to the South Eastern of Nairobi. The study area is 1000 m above sea level lying between 2.3° S latitude and 37.8° E longitude. The region is in ecological zone V with a bimodal annual mean rainfall of 615 mm (Mnene, 2006) [10]. An unreliable rainfall occurs in March, April and May while the reliable short rains occurs in October, November and December.

Preparation of the Trial Diets

The diet ingredients were grown in the respective sites, harvested, sun dried and stored as hay bales and in gunny bags for the grass and legumes, respectively. The grass and legume material were processed by chopping to 2cm size using motorized chopper. The diets were prepared by mixing the grass with the legume at the ratio of 3:1, respectively. A total of six diets representing the treatments were formulated, including; Diet 1; *C. ciliaris* + Cowpea, Diet 2; *C. ciliaris* + Dolichos lablab, Diet 3; *E. macrostachyus* + Cowpea, Diet 4; *E. macrostachyus* + Dolichos lablab, Diet 5; *C. ciliaris* and Diet 6; *E. macrostachyus*. The latter two diets represented the controls.

The Trial Animals, Design and Feeding

The trial animals at KALRO were ewes while those at

Kasigau Ranch were rams, all aged between 10 to 12 months and weighing 22.7±2.4 kg. Four and three individually housed animals were randomly assigned to the trial diets/treatments at KALRO and Kasigau, respectively, in a completely randomized design where the individual animals were replicates for each diet. The initial live weight of all the animals was taken using a digital weighbridge for small stock. The Daily share of each diet was provided *ad-libitum* for a period of 90 days. The amount of feed offered to each animal daily was weighed using digital Kitchen balance of capacity 10kg, with accuracy of 1 gram. The daily amount was divided into two where, half portion was offered at 08.00 hrs and the other half at 14.00 hrs in the individual pens. The refusals were weighed the next morning as the first activity of the day. Water and mineral block (Afya Bora® stock lick; Unga Group PLC.) were offered *ad-libitum* to all the animals in the trial.

Samples of each diet were taken every time new formulation was done, mixed at the end of the trial and triplicate composite samples taken for each diet for nutritive value analysis that was done using wet chemistry. After taking the initial weight, the animals were acclimatized for one week in the feedlot, before data collection commenced and thereafter weighed on weekly basis. At the end of the trial period, the final body weight of each animal was taken in order to determine the growth rate. Average Daily Weight Gain (ADWG, g/day) was obtained by calculating the difference between the final and the initial body weight (kg), divided by the number of days in feedlot and multiplied by 1,000 to obtain ADWG in grams.

Statistical Analysis

The data on daily dry matter intake, daily weight gain and the nutritive value were recorded in excel spreadsheet and analyzed using Genstat 14th Edition. Where the analysis of variance was significant, the means were separated using Turkey's HSD at 5% significant level.

Results and Discussion

The regression analysis presented in Table 1 indicates that the variables used in the model were significant at $p=0.000$. The independent variable, 'feed ration' influenced the dependent variable, 'ADWG' by 70.7%. The ADWG performance of the animals was significantly influenced by the feed ration such that an increase in feed quality increased the animal performance and vice versa. The initial weights of the animals did not have a significant influence, ($p=0.278$) on the growth performance which is attributed to the homogeneity in sampling of the animals where the differences in animal weights were negligible.

Table 1: Regression coefficients analysis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	904337.124 ^a	22	41106.233	5.717	.000
Initial weight	195831.441	21	9325.307	1.297	.278
Ration	112787.936	1	112787.936	15.686	.001

Dependent Variable: ADG a. R Squared = .857 (Adjusted R Squared = .707)

Table 2 shows the nutritive content of the six diets fed to trial sheep at Kasigau and Kiboko sites.

All the control diets i.e. pure grasses and *E. macrostachyus* + Cowpeas diet at Kiboko and Kasigau had CP levels falling below 7% to 13% previously reported for *Cenchrus ciliaris* and *Enteropogon macrostachyus* (Gohl, 1981; Machogu, 2013) [3, 8]. The acid detergent fibre for all the diets was high, ranging between 42% and 52% compared to 30% to 41% reported by Machogu (2013) [8] for rangeland grasses and

Brachiaria Mulato II. These diets also had marginal level of metabolizable energy. The low crude protein, high fiber and low ME suggested low quality of the grasses. The other diets combining grass and legume had slightly higher levels of CP and metabolizable energy compared with the recommended minimum for quality livestock feed, suggesting fair quality. The diet, *E. macrostachyus* + *Dolichos lablab* had exceptionally high level of CP in both sites.

Table 2: Nutritive Composition of Diets Fed to the Trial Dorper Sheep

DIET	DM g/kg	ME* (MJ/kg)	CP g/kg	CF g/kg	NFE g/kg	NDF g/kg	ADF g/kg	ADL g/kg
<i>C. ciliaris</i>	915.0±3.9	8.2 ^a	43.8 ^{ab}	358.9 ^{ab}	494.0 ^{ab}	773.1 ^{ab}	553.7 ^{ab}	122.5 ^{ab}
<i>C. ciliaris</i> + Cowpeas	926.9±23.2	8.2 ^a	72.3 ^a	435.4 ^a	372.5 ^a	770.5 ^a	471.4 ^a	79.7 ^a
<i>C. ciliaris</i> + Dolichos lablab	905.1±2.1	8.7 ^b	81.8 ^b	482.6 ^b	287.5 ^b	726.6 ^b	427.9 ^b	101.6 ^b
<i>E. macrostachyus</i>	917.9±7.9	7.7 ^c	54.9 ^{ac}	424.5 ^{ac}	420.9 ^{ac}	751.7 ^{ac}	493.8 ^{ac}	82.2 ^{bc}
<i>E. macrostachyus</i> + Dolichos lablab	934.5±25.6	8.3 ^a	166.1 ^{bc}	441.9 ^{bc}	300.7 ^{bc}	715.4 ^{bc}	468.8 ^{bc}	82.2 ^{bc}
<i>E. macrostachyus</i> + Cowpeas	912.9±12.1	7.5 ^{ab}	60.7 ^c	448.3 ^c	405.3 ^c	730.7 ^c	443.6 ^c	87.0 ^c

** The asterisk indicates the values were obtained through computation. Column means with different letter superscripts are significantly different at $p < 0.05$

Dry Matter Intake of the Diets and the Performance of Trial animals

Table 3b indicates that at Kasigau, sheep on *C. ciliaris* + Cowpea diet exhibited the highest DMI followed by *E. macrostachyus* + Dolichos lablab diet while the control sheep on *E. macrostachyus* registered the lowest ($p < 0.05$) DMI. Four diets showed no significant differences ($p > 0.05$), that is; *C. ciliaris* + Dolichos lablab, *C. ciliaris*, *E. macrostachyus* + Dolichos lablab and *E. macrostachyus* + cowpea. For the control sheep, *C. ciliaris* diet was more preferred than *E. macrostachyus* but both had the least daily dry matter intake. At Kiboko (table 3a), sheep on *C. ciliaris* + Dolichos lablab and *E. macrostachyus* + Dolichos lablab diets recorded similar and the highest DMI while sheep on pure *E. macrostachyus* control diet had the lowest DMI. The finding for the control sheep on *E. macrostachyus* diet is attributed to high acid detergent fiber of between 474 and 504 g/Kg DM and low crude protein of between 37 to 57 g/Kg DM.

Generally, the DMI for all the trial animals at Kiboko and Kasigau including the controls was high, exceeding 2% of live weight possibly as the animals struggled to cover for the protein and energy shortfalls.

On the performance, the results (Table 3) indicate that there was a significant difference ($p < 0.05$) in ADWG between the treatment diets and controls, the latter being lower. The *C. ciliaris* + cowpea diet registered the highest ADWG of 245.0 g at Kasigau and 272.4 g/day at Kiboko, while the control sheep on the pure *E. macrostachyus* diet attained the lowest gains of 121.7 and 89.4 g/day at Kasigau and Kiboko, respectively. The explanation for this observation was poor quality of the grasses in terms of low energy and protein, high level of acid detergent fibre. Otherwise, all the sheep on the four diets combining grass and legume were gaining weight but the difference in ADWG between the diets within sites was not significant ($p > 0.05$).

Table 3: Performance of Sheep in Feedlot Fed on Range Grasses and Legumes at Kiboko and Kasigau

Diet	Initial Weight (Kg)	ADWG (g)	Final Weight (Kg)	Net Weight Gain (Kg)	DMI g/day	DMI as a % of LWT
a) Kiboko						
<i>C. ciliaris</i> + Cow pea	20.5 ^a	272.4 ^a	45.0	24.5	1023.1 ^a	3.7 ^{cd}
<i>C. ciliaris</i> + Dolichos lablab	20.6 ^a	269.4 ^a	44.9	24.3	1080.4 ^b	3.9 ^d
<i>E. macrostachyus</i> + Cow pea	22.26 ^a	229.6 ^a	43.0	20.7	844.7 ^c	3.8 ^d
<i>E. macrostachyus</i> + Dolichos lablab	21.4 ^a	222.8 ^a	41.5	20.1	1079.6 ^b	3.3 ^{cd}
<i>C. ciliaris</i>	22.4 ^a	136.3 ^b	34.7	12.3	909.8 ^a	3.3 ^{cd}
<i>E. macrostachyus</i>	27.5 ^a	121.7 ^b	38.5	11	641.4 ^d	2.9 ^c
b) Kasigau						
<i>C. ciliaris</i> + Cow pea	22.2 ^a	245.0 ^c	44.3	22.1	977.0 ^b	2.9 ^d
<i>C. ciliaris</i> + Dolichos lablab	20.7 ^a	193.1 ^d	38.1	17.4	784.3 ^{bc}	2.7 ^d
<i>E. macrostachyus</i> + Cow pea	22.5 ^a	186.7 ^d	39.3	16.8	746.3 ^{bc}	2.4 ^d
<i>E. macrostachyus</i> + Dolichos lablab	23.7 ^a	167.2 ^d	38.8	15.1	814.3 ^{bc}	2.6 ^d
<i>C. ciliaris</i>	24.5 ^a	108.9 ^e	34.3	9.8	793.5 ^{bc}	2.7 ^d
<i>E. macrostachyus</i>	22.5 ^a	89.4 ^e	30.6	8.1	554.4 ^c	2.1 ^e

Means within a column with different superscripts differ significantly at ($p < 0.05$)

The high fibre content coupled with low energy and crude protein in pure grasses compared with rest of the diets explains the poor performance of sheep on the control diets. The pure grass (control) diets had CP and energy contents below the critical levels recommended for quality livestock feed i.e. 7% CP and 8MJ ME/kg DM, respectively (NRC, 2000) [12]. The ADF level of the diets was also higher than 45% recommended for quality livestock feed.

Generally, animal performance is determined by feed availability, feed nutrient content, intake, extent of digestion, and metabolism of the feed digested (Abebe and Tamir, 2016) [1]. Nutrient requirements of all livestock are based on the size of the animal, how active the animal is, the body growth rate, and/or the animal's level of milk production and fat content in milk produced (Simões, et al 2021) [14].

The amounts of digestible energy, protein, vitamins, and minerals needed for maintenance is low relative to other animal processes. Forages that contain less than 70% NDF and more than 8% crude protein will contain enough digestible energy and protein, to maintain older animals (Ball et al., 2001) [2]. Thus, even many low quality forages and crop residues can meet the maintenance needs of some classes of animals, if protein and minerals are adequate. The NDF values of both Kiboko and Kasigau diets were beyond the critical values recommended for efficient animal performance i.e. 600- 650 g/Kg DM (van Soest et al., 1991) [15]. The ADWG values recorded in the trials were higher than what had been reported earlier by Lengarite et al. (2014) [7], with indigenous goats.

Conclusions and Recommendations

The nutritive quality, dry matter intake and average daily weight gain were enhanced when legumes were included in the diets. This finding confirmed that feed quality and quantity are essential for growth and productivity of livestock. The study also concluded that it is possible to fast-track finishing of small ruminants on high quality diets in a feed lot system compared to the common practice where the animals are finished under free grazing conditions taking too long thus not making economic sense. The research team gives two recommendations, that; farmers harvest forages at the right stage of growth (40 to 50% flowering) to maximize on benefits such as high biomass, nutritive value, palatability, intake by livestock and good performance. In addition, farmers should ensure to include legumes in the feed rations always for better performance of livestock, preferably by growing it on own farm or supplementing with commercial high protein concentrates.

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Conflict of Interest

Not available

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Not available

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