Growth Performance of Sheep and Goats Fed Formulated Drought Tolerant Forages in Marsabit County, Kenya

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Research Brief

Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change

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Abstract

In drought prone areas of the world, small ruminant production is mainly constrained by lack of feed and water. Sheep and goats under drought conditions endure feeds that are low in dry matter intake and feed digestibility. The restricted feed intake is further exacerbated by inadequate drinking water. The search for drought tolerant forages for feeding small ruminants that dominate herds in pastoral areas is gathering momentum. In view of this we undertook a study to investigate the effect of feeding rations formulated from drought tolerant forages on dry matter intake, feed digestibility, and weight gain in growing sheep and goats. We conducted an on station feeding experiment in two phases, the performance trial (86 d) followed by the digestibility phase (7 d). The results and the practical implication of the findings are presented in this research brief.

Exploiting the fodder potential of drought tolerant forages

In the Eastern Africa region, sheep and goats supply a substantial proportion of red meat consumed at domestic and export markets. The demand for chevon and mutton in these countries is increasing against the decline in quality and quantity of small ruminants required by the markets. Pastoral herds form the foundation of the small ruminant industry in Kenya. Low live weight gains, small carcass weights, and low market value of animals are the major features of pastoral small ruminant production. The low productivity is associated with limited feed and water intake particularly during the dry season. In building the resilience of pastoral small ruminant herds against drought shocks, which are increasing with climate change, there is growing interest in the use of alternative feed resources for pastoral livestock. Of particular interest are succulent drought tolerant local feeds that can provide nutrients and water to animals. These feeds can be domesticated to grow and fatten pastoral animals. In periods of feed shortages pastoral producers in northern Kenya supplement their livestock with drought tolerant feeds of *Acacia tortilis* pods, *Tinospora caffra* root tuber, and *Euphorbia gossypina* succulent leaves. *Acacia tortilis* pods have been shown to increase milk yield of lactating goats and weight gain in weaner cattle (Lengarite et al., 2014; Bii et al., 2011). *Euphorbia gossypina* evergreen shrub and *Tinospora caffra* root tuber are wild fodder plants that thrive in the mountain ecologies of Marsabit County. The wild underground succulent root tubers weighing more than 10 kg are harvested for feeding homestead livestock (Keya, 2001).

Collection of grasses and other feed materials. (Photo credit: Moses Lengarite)

In the mount Kulal area of Marsabit, small ruminant producers traditionally move their flocks to graze on *Euphorbia gossypina* evergreen shrub. Pastoralists perceive that feeding animals with these succulent fodder plants improves the condition of weak animals, reduces water requirement, and prevents death during drought. In order to exploit the fodder potential of these succulent traditional feed resources we carried out an experiment to determine the nutritional value, feed intake, growth performance, and economic value of growing sheep and goats fed rations formulated from these feeds.

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Feed intake, growth rates and dry matter digestibility

We conducted an on-station feeding trial at KALRO (Kenya Agricultural & Livestock Research organization), Sheep and Goat Institute, Marsabit Centre in northern Kenya. We used twenty four intact young male Blackhead Persian sheep (12) and twelve intact male Galla goats of similar ages (5-6 months) and weighing an average 11 (goats) and 12.9 kg (sheep). The sheep and goats were divided into four groups of three animals each and randomly allocated to one of the four dietary treatments in a completely randomized design. The treatment diets comprised of grass hay (control), grass hay + course ground *Acacia tortilis* pods, grass hay + *Tinospora caffra* root tuber and grass hay + *Euphorbia gossypina* succulent leaves. The experimental animals were housed in group cages.

We purchased feed materials for feeding the animals. Underground root tuber (*Tinospora caffra*) weighed between 1-15.3 kg, fresh leaves of *Euphorbia gossypina* (1.4-0.5 kg/plant), *Acacia tortilis* pods and hay (basal diet) from *Eragrostis superb*, *Cenchrus mutis* (C.echinatus) & *Sporobolus helvolus* grass species. The *Acacia tortilis* pods were coarsely ground using a manual grinding machine, while the root tuber and *Euphorbia* plant were chopped with a knife to small sizes.

We ear tagged, dewormed against endo-parasites, and weighed the animals at the beginning of the experiment and thereafter once a week. We allowed the animals ten days to adapt to the treatment regimes and offered daily feed at 3.3% bodyweight (BW) (sheep) and goats 2.8% BW (goats). The daily ration was divided into two and offered to the group of animals in the morning and afternoon. Daily feed offered and refusals were measured. Water and mineral supplement were offered *ad libitum*. The water and salt intake of animals was measured by recording the amount of water offered and left over. The performance trial lasted for a period of 86 days, while the digestibility trial was conducted for 7 days.

Collected representative samples of feed were submitted to the laboratory for chemical analysis. The feeds were ground and analyzed for dry matter (DM %), ash, and nitrogen contents according to the official methods of the Association of Official Analytical chemists (AOAC, 1995). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to the methods of Van Soest et al (1991). The macro (Ca, P, Mg, K, and Na) and micro mineral (Fe, Cu, Zn and Mn) contents of the feedstuffs were also determined.

At the end of the performance phase the pens were converted to digestibility crates. The floors of the pens were covered with polythene paper for fecal collection. The groups of sheep and goats in the performance trial were used in the digestibility study. The animals were allowed 5 days to adapt to the digestibility barns and for 7 days feed intake and fecal collection were recorded. The fecal output was collected and air-dried for 2 weeks to a constant weight. The dry matter digestibility was calculated based on the dry matter intake and dry fecal output.

The benefit cost ratio of different rations fed to sheep and goats was determined using the relationship between total feed cost and live weight gains. The market prices of feed ingredients and carcass value of meat were used in the calculations. Data on chemical composition, weight gain, water, and diet intake for the performance and digestibility trials were analyzed by one-way ANOVA in a completely randomized design using GenStat software (2010).

The chemical components varied among the feed ingredients

Laboratory results showed variation in moisture, ether extract, crude protein, crude fibre, metabolisable energy, sodium, and phosphorus contents among the feed ingredients. *Tinospora caffra* root tuber had the highest moisture content (87%), followed by *Euphorbia gossypina* (75%) and lastly by *Acacia tortilis* pods (12.5%) and hay grass (8.5%). The fat content (5.8%) and metabolisable energy (2.3%) in *Euphorbia gossypina* were remarkably high, while it was low in other feed ingredients. Course ground *Acacia tortilis* pods were richer in crude protein (15.1%), followed by hay grass (9.9%). The high moisture feed ingredients on as fed basis were lower in crude protein content (1-2.3%). *Tinospora caffra* was outstandingly rich in soluble cell contents (75.2%) and lower in crude fibre contents (7.3%). The rest of the feed ingredients were high in crude fibre contents (35-55%). Except for *Acacia tortilis* pods (0.17%), the diets were poor sources of phosphorus. The sodium content of hay grass was notably high (0.4%), while it was low in other diets.

Sheep and goats fed dry rations had higher dry matter and water intake than those on high moisture feed rations

Sheep and goats on hay only and Hay plus *Acacia tortilis* pods, on average, eat more dry matter (509 versus 390 g/d) than those offered hay plus *Euphorbia* and *Tinospora caffra* root tuber (428 versus 299 g/d). The lower intake of animals on high moisture rations was attributed to the bulkiness of feeds leading to gut fill. Animals on dry feed rations drank two times more water than those fed high moisture rations (1 versus. 0.5 l/d). High moisture feeds reduced water intake of animals by 50%. Of the animal species, sheep consumed more water by 18% compared to goats. In the case of dry rations, sheep and goats fed *Acacia tortilis* pods consumed more water (5 versus 26%) than those on hay only. The high water demand of animals fed *Acacia tortilis* pods may be attributed to the high protein content of the rations.

Sheep and goats feeding on treatment diets. (Photo credit: Moses Lengarite)

In the performance phase sheep and goats on *Acacia tortilis*-based rations had the highest growth rates

The average daily weight gain of BHP sheep rams fed hay only, hay *Acacia tortilis pods*, hay plus *Euphorbia gossypina,* hay plus *Tinospora caffra* root tuber were 4.1, 56.6, 11.9 and 14.1 g/d, respectively. The corresponding weight gain for Galla goat bucks were -2.6, 34.1, 16.7 and -4.8 g/d. All the sheep groups showed positive growth rates, while goats fed hay only and Hay plus *Tinospora caffra* root tuber exhibited weight losses. The weight losses may be attributed to low dry matter intake by the goats. In contrast sheep and goats fed hay plus *Acacia tortilis* pods rations had the highest weight gain. The hay plus *Acacia tortilis* ration supplied the animals with adequate dry matter and dietary nutrients to support growth. In growth performance, animals fed *Euphorbia gossypina* were second to the groups fed *Acacia tortilis* pods. The intermediate growth rate of animals on *Euphorbia gossypina* may be related to the high metabolisable energy of the browse plant.

Apparent dry matter digestibility (7 days) was highest for groups fed hay plus *Acacia tortilis* rations and lowest for groups on hay only

The mean dry matter digestibility of sheep rams consuming hay only, hay *Acacia tortilis* pods, hay plus *Euphorbia gossypina*, hay plus *Tinospora caffra* root tuber were 48.2, 68.3, 56.9 and 59.3%, respectively. The corresponding dry matter digestibility of Galla goat bucks were 49.8, 69.5, 57.1 and 54.5%. The dry matter digestibility were higher for sheep and goats fed hay plus *Acacia tortilis* pods rations. The observed high digestion may be supported by inclusion of protein rich *Acacia tortilis* pods in the rations. The low digestibility of rations containing *Euphorbia gossypina* and hay only may be due to the fibrous nature of the diets.

The benefit cost ratio was only profitable for sheep fed hay plus *Acacia tortilis* pods (50:50 ration ratio)

Table 1 shows the total cost of feed, total value of gain and the benefit cost ratio analysis of the treatment diets. The most expensive ration was hay plus *Acacia tortilis* (40:60) fed to goats (Kshs.37.4) followed by hay plus *Acacia tortilis* (50:50) consumed by sheep (Kshs.35.8). The cheapest were those containing high moisture feeds of *Euphorbia gossypina* and *Tinospora caffra* root tuber. Inclusion of *Acacia tortilis* pods in the rations increases the cost of the rations. Of the rations, the bulky ration containing *Tinospora caffra* root tuber had the highest feed cost. The high cost was related to the large proportion of the fresh tuber added to the rations.

The value of meat produced was highest for sheep and goats fed Acacia based rations (Kshs. 1,960 versus 1,240). All the sheep had a positive value of weight gain, while goats on control and hay plus *Tinospora caffra* root tuber had a negative gain. The negative weights translated to loss of meat and market value of animals. The benefit cost ratios for sheep on hay only, hay plus *Acacia tortilis* pods, hay plus *Euphorbia gossypina*, hay plus *Tinospora caffra* were 0.1, 1.1, 0.3 and 0.2. The corresponding for goats were -0.1, 0.8, 0.6 and -0.2. Of the rations, hay plus *Acacia tortilis* ration fed to sheep (50:50) had a net profit, while the rest were not economically profitable.

Conclusion & practical implication

Adding protein rich *Acacia tortilis* pods to rations was found to stimulate dry matter intake, feed digestibility and weight gain in growing sheep and goats. Inclusion of ground *Acacia tortilis* pods above 50% of total ration increased the cost of feeding. The cost effective level of ground *Acacia tortilis* pods to incorporate in rations should not exceed 50% of total dry matter. Our study finding has provided baseline information on the nutritional value of two succulent drought tolerant forages found in the mountain ecologies of Marsabit County. The high moisture feeds of *Tinospora caffra* root tuber and *Euphorbia gossypina* shrub reduced water intake in growing sheep and goats by 50%. These succulent forages can be incorporated in pastoral small ruminant feeding systems to solve the problem of water shortages faced in arid environments. Since these succulent forages occur in defined habitats, conservation measures are required to ensure sustainable exploitation and where possible domesticated for feeding home based small ruminants. Further studies are required to investigate the phenological characteristics of these succulent forage species.

Table 1. The benefit cost ratio analysis of sheep and goats fed different ration diets

	Black head Persian sheep rams				***Galla goat bucks***			
Variable	HO	HA	HE	HT	HO	HA	HE	HT
Ration ratio	100:0	50:50	80:20	70:30	100:0	40:60	70:30	80:20
Ration cost/ kg (Kshs)	28.2	35.8	26.7	23.5	28.2	37.4	26.0	25.0
Total ration (kg)	41.5	46.0	56.3	92.9	28.7	38.4	39.2	67.9
Total ration cost (Kshs.)	1,170	1,647	1,503	2,183	809	1,436	1,020	1,698
Salt & water cost (Kshs.)	127	121	71	54	60.7	90.4	44.6	38.6
Total feed cost (Kshs.)	1.297	1,768	1,574	2,237	870	1,526	1,065	1,737
Weight gain/loss (kg)	0.4	4.9	1.0	1.3	-0.2	3.1	1.5	-0.4
Total value of gain/loss (Kshs.)	160	1,960	400	520	-80	1,240	600	-0.160
Benefit/cost ratio	0.1	1.1	0.3	0.2	-0.1	0.8	0.6	-0.2

HO: Hay only; HA: Hay +Acacia tortilis; HE: Hay +Euphorbia; HT: Hay +Tinospora; 1 kg of meat = Kshs. 400 (USD 4.5)

Further Reading

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Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change is dedicated to catalyzing and coordinating research that improves the livelihoods of livestock producers affected by climate change by reducing vulnerability and increasing adaptive capacity.

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