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Effect of supplementing grass diet with *Acacia seyal* and *Balanites aegyptiaca*on feed intake, conversion efficiency and growth of dorper sheep

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Two studies were carried out at the Livestock Improvement Centre, Mogotio division of Koibatek District to evaluate *Acacia seyal* and *Balanites aegyptiaca* as feed supplements to ruminant diets during the dry season. The objectives were to determine the *In vivo* nutrient digestibility and feed intake, feed conversion efficiency and growth rate of sheep fed on *Chloris gayana* hay supplemented with graded levels of the two tree legumes. Feed materials for digestibility studies were harvested at Koibatek District using systematic sampling procedure, ground and fed to sheep in a changeover arrangement. Sheep were housed in individual pens and fitted with faecal collection bags. An adaptation period of 14, faecal collection of 7 and changeover of 10 days were enforced. *In vivo* digestibility results were significant for all nutrients,54.7, 66.5, 32.8, 40.3, 51.7and 82.7; 48.5, 58.9, 67.4, 36.9, 36.3 and 40.6; and 48.1, 50.4, 41.7, 53.7, 63.0 and 62.3% for DM, OM, CP, NDF, hemicellulose and cellulose in *Acacia seyal, Balanites aegyptiaca* and C*hloris gayana* hay. *Acacia seyal* and *Balanites aegyptiaca* had nutrients of low to moderate digestibility. The amounts of DCP indicate that B. *aegyptiaca* is suitable as CP supplement while A. *seyal* can serve for maintenance. The second study involved 28 Dorper sheep fed on Rhodes grass hay and supplemented with the two tree legumes at four levels each. Final weights, average daily gains and feed conversion efficiency improved significantly with supplementation. Supplementation of a grass-based diet with the two tree legumes can improve animal performance during the dry season when pasture is quite mature.

Keywords: Acacia seyal, Balanites aegyptiaca, in vivo digestibility, growth rate, intake and feed conversion efficiency.

Introduction

The arid and semi- arid area of the tropics is suitable for ruminant production, which forms the main source of livelihood for its inhabitants. These animals thrive on annual grass, which does not sustain production throughout the dry seasons and legume browse is being considered as important feed supplements. During the dry seasons, grass is high in fibre and lignin and at the same time low in essential nutrients required for production.

The role played by indigenous legume forages is gaining recognition despite lack of sufficient information on their suitability. Olaloku and Debre (1992) recommended research to address the nutritional evaluation of forage used in dry areas to provide information for their optimal exploitation. This was in recognition of the fact that animal productivity in the range area is limited primarily by insufficient nutrients yet importing them is expensive. Traditional livestock owners do know the importance and utilize these forages with the view of sustainability, but they need information to facilitate better use for higher production.

Le Houerou (1980) reported browse to be richer in protein and some minerals during dry seasons when grass is high in cellulose, lignin and gross energy. The information so far generated from various tree legumes (Larbi *et al.*, 1996, Salem Ben *et al.*, 1997, Sawe *et al.*, 1998) shows the existence of variations in nutrient contents among different tree legumes. These variations could have arisen from species and geographical differences as well as the stem to leaf ratio of the sample taken.

Legume forages have also been reported to maintain moderate digestibility (Nicholson, 1992) when grasses are low in CP and high in indigestible fibre. Their role in the rumen is to increase dietary nitrogen concentration, which in turn enhances microbial multiplication and activity. Inclusion of highly digestible nitrogen supplements in a low quality grass-based diet stimulates intake of digestible OM and CP and may improve feed utilization. Although they are useful as feed supplements for ruminants during the dry season, their *In vivo* digestibility has not been documented.

Ruminants under arid and semi-arid area have low fertility and long calving interval, low growth rates and mature weights due to inadequate nutrition (ILCA 1982, 1983). Production can be enhanced through knowledgeable utilization of indigenous forages, which are reliable due to their perenity (Kamatali *et al.*, 1992) and ability to maintain their nitrogen content at sufficient level to support animal production. The inclusion of legume forages in animal diets will enhance feed intake and utilization efficiency and therefore improve growth rates.

The current study evaluated both *Acacia seyal* (white thorn) bark and *Balanites aegyptiaca* (desert date) leaves, branch tips and fruits and mixed in the same manner fed to livestock in the dry season. The objectives of the studies were to determine *In vivo* digestibility of nutrients, feed intake, feed conversion efficiency and growth rate of sheep fed on *Chloris gayana* hay supplemented with graded levels of *Acacia seyal* and *Balanites aegyptiaca*.

Materials and Methods

Study site

The study was carried out at Koibatek District in Kenya. The region falls within ecological zone IV (lower to upper medium 5, livestock- sorghum zone) at latitude and longitude O^{o} N and 36^{o}E respectively. The site has a bimodal annual rainfall of 700-900 mm (Jaetzold and Schmidt, 1983). The tree legumes were harvested for feeding at Mogotio division where they form important feed resources for ruminants during the dry season. The feeding experiments were carried out at the Livestock Improvement Centre (LIC) of the Ministry of Agriculture and rural development, arid and semi- arid program at Mogotio Township.

Sample collection

Samples for nutrient and digestibility determinations were taken from a wider area covering two divisions. Those from *Acacia seyal* were debarked from harvested branches of less than 2cm in diameter and leaves, soft branches from *Balanites aegyptiaca* were taken. Sampling was based on two randomly selected administrative locations per division, Mogotio and Ngubureti locations of Mogotio division and Kakimor and Kimose locations of Emining. A systematic sampling procedure was used. Ten samples were taken from each location and tree species. The samples were dried under shed for two days, ground and pooled together before sub-sampling for digestibility study and laboratory analysis. *Chloris gayana* hay was harvested on the farm at LIC, fed and sampled for chemical analysis.

Housing

The experimental sheep were housed in a rainproof shed whose sides allowed free air movement. Each sheep was kept in an individual pen measuring 1 x 1 x 1m, fitted with a wooden feed trough measuring 60x30x20 cm and a removable plastic watering container. Pens had lockable doors hinged on strong rubber such that it closes itself when opened.

In vivo digestibility

The digestibility study used 6 Dorper rams aged between 9 and 11 months. Digestibility treatments included *Acacia seyal, Balanites aegyptiaca* and *Chloris gayana* hay. *Acacia seyal* and *Balanites aegyptiaca* were harvested and dried under a shed. *Chloris gayana* hay was harvested at dough stage and dried for a day. It was then baled and stored under shade. All the feeds were ground using a hammer mill to pass through a 17mm sieve before being kept in sisal gunny bags. Hay was offered *ad libitum* to the sheep at 08.00 and 15.00 hours each day. The amount of feed provided and leftovers were weighed using a precision scale. Some 100g of mineral stock lick© were provided to the sheep every second day.

Sheep

Study two used 28 yearling (12 – 13months) dorper lambs balanced for sex in each of the seven treatments. These lambs were born to purebred dorper dams and sires and reared at the Livestock Improvement Centre where they grazed on a pure stand of star grass pasture. The lambs ran and suckled their dams freely from birth to weaning. The Sheep used in the study had initial body weight averages of 24.3, 24, 23.5, 23.5, 25, 24.5, and 24.8 Kg for treatment 1, 2, 3, 4, 5, 6 and 7 respectively.

Treatments

The feeds used in study two included *Chloris gayana* hay as a basal diet and graded levels of *Acacia seyal* and *Balanites aegyptiaca* as supplements. Both the basal diet and the supplements were dried to about 14% moisture level and ground using a harmer mill to pass through a 17mm sieve. Feeding was based on 4% live weight to allow for selection and individual variation in intake and adjusted weekly after weighing of the sheep. Supplements were calculated and offered based on the quantity of intake. The study treatments were as follows; 1- *Chloris gayana* hay (control), 2- *Chloris gayana* hay + 10% *Acacia seyal*, 3- *Chloris gayana* hay + 20% *Acacia seyal, 4-Chloris gayana* hay + 30% *Acacia seyal*, 5- *Chloris gayana* hay +10% *Balanites aegyptiaca*, 6-*Chloris gayana* hay +20% *Balanites aegyptiaca* and 7- *Chloris gayana* hay +30% *Balanites aegyptiaca.* Mineral lick was provided in feed troughs on alternate days.

Experimental design

At the beginning of the trials all experimental sheep were dewormed and ran through a spray race of an acaricide (Amitras©) solution to control both internal and external parasites respectively. The sheep were subsequently weighed and ran through the spray race every Monday morning. The In vivo digestibility study used a changeover arrangement of two periods with 2 sheep consuming each forage. The experimental period comprised 14 days of adaptation and 7 days of faecal collection, followed by 10 days changeover and another 7 days of faecal collection for Periods 1 and 2, respectively. The rams were fitted with faecal collection bags at the beginning of the adaptation period. Faeces were removed from the bags twice daily and sun dried. Total accumulated faecal output per ram was weighed at the end of each collection period, sub-sampled and analyzed for DM, OM, CP, NDF, hemicellulose, cellulose as described by AOAC (1990). The second trial used completely randomized design at four levels of the supplements. The sheep were given an adaptation period of 7 days and 90 days of data collection. The feed supplements were provided first and after 30 minutes of consumption, hay was added into the feed trough. The amount of supplements fed was based on dry matter intake and adjusted weekly to match body weight changes. The supplements were provided once at 8.00 a.m. while *Chloris gayana* hay was *adlib*. Feed left overs were weighed every morning before feeding.

A*nalyses*

Forages were analyzed to determine DM, CP, NDF, ADF, ADL and ash according to the method of AOAC (1990). Total ash was determined at 600^{o}C for 3 hours. The ashing of ADL was done at 450^{o}C for 3 hours (Van Soest, 1984). The data obtained from this study were analyzed using the general linear model of Statistical Analysis System (SAS, 1988). The significant data was separated using least significant difference.

Results

Table 1: The nutrient and mineral composition of edible parts of *Acacia seyal, Balanites aegyptiaca* and *Chloris gayana* hay in g per kg dm forage (Kitilit *et al*., 2002).

Forage/Nutr	DM	CP	NDF	ADF	ADL	Ca	P	S	Na	Mg	Co
A. seyal	651	112	370	339	59	28.2	0.06	0.8	1.1	7.0	0.06
B. aegyptia	665	152	443	341	89	16.9	0.13	2.9	1.0	7.5	0.04

Table 2: Feed intake (g) and *in vivo* digestibility of nutrient (%dm) in *Acacia seyal,* B*alanites aegyptiaca* and *Chloris gayana* hay

Forage	n	Feed intake	DM	OM	CP	NDF	D-Value
Acacia seyal	4	445	54.7^{a}	66.5^{a}	32.8^{c}	40.3^{b}	51.3
B. aegyptiaca	4	633	48.5^{b}	58.9^{b}	67.4^{a}	36.9^{b}	46.1
Chloris gayana	4	544	48.1^{b}	50.4^{c}	41.7^{b}	53.7^{a}	30.9
S.e.m			2.0	4.9	4.8	5.0	

Values with different superscripts on same columns are significantly (P<0.05) different.

Feed intake and the in vivo digestibility of various nutrients is provided in Table 2. The digestibility of DM, OM and cellulose was significantly higher (P<0.05) in *A. seyal* than in *B. aegyptiaca* and *C. gayana* hay. Digestibility of CP was significantly (P<0.05) lower in *A. seyal* than the *Balanites aegyptiaca* and *Chloris gayana* hay where it was less than half that of the former legume.

Digestible CP supplied per kg of forage was 102.4 g for *B. aegyptiaca* as compared to 36.4 and 25.3 g for *A. seyal* and *C. gayana* hay respectively. Intake of digestible CP during the study period was 16.3, 64.8 and 15.2 g /day for sheep consuming *A. seyal, B. aegyptiaca* and *C. gayana* hay. The digestibility of OM, CP, NDF and hemicellulose was significantly high (P<0.05) during period 1, but was similar (P≥0.05) for cellulose during period 1 and 2.

The final weights, average daily gains, feed intake and feed conversion efficiency of the second feeding trial is summarized in Table 3.

Table 3: Average initial and final weights, daily gain (adg), feed intake and conversion efficiency of dorper sheep

Treatment diets	Initial wt (Kg)	Final Wt (Kg)	Adg[1] (Kg)	Intake (g)	FCE[2]
Hay	24.3	23.4[c]	-0.001[c]	505	-0.02[c]
Hay +10% A. *seyal*	24.0	26.9 [b]	0.03[b]	620	0.05[b]
Hay +20% A. *seyal*	23.5	29.0[b]	0.05[a]	535	0.11[b]
Hay + 30% A. *seyal*	23.5	29.6[b]	0.06[a]	610	0.1[b]
Hay +10% B. *aegyptiaca*	25.0	26.8 [b]	0.02[b]	485	0.04[b]
Hay +20% B. *aegyptiaca*	24.5	29.4[b]	0.05[a]	675	0.08[b]
Hay + 30% B. *aegyptiaca*	24.8	33.4[a]	0.07[a]	605	0.16[a]
LSD		3.3	0.012	194	0.04

Columns with different superscripts are significantly different (P<0.05).

The experimental animals obtained an average CP level of 6.8, 7.2, 7.4, 7.7, 7.5, 8.2 and 8.9% daily during the feeding periods. Table 3 Shows that supplementation levels were effective (P<0.05) for final body weights, average daily gain and feed conversion efficiency. Sheep obtaining more than 20% supplementation from either tree legume showed (P<0.05) better performance than both the control and those receiving 10% of the supplements. Those on 20 and 30% supplementation had similar (P>0.05) final weights.

Average daily feed intake for the various supplementation levels were not different (P>0.05). In contrast, feed intake where the basal diet was supplemented with *Balanites aegyptiaca* shows a linear relationship up to 20% supplementation then it started declining. There were no differences (P>0.05) between *Acacia seyal* and *Balanites aegyptiaca* supplementation in terms of final weights, adg, feed intake and feed conversion efficiency.

Discussion

Forages in the tropics usually have inadequate levels of nutrients, particularly proteins and minerals, resulting in restricted growth rates, slow maturation and low production (Cumberbatch, 1987). Legume forages are important as supplements as long as they have the capacity to supply those nutrients that are limiting performance. These nutrients include those necessary for proper rumen fermentation, alleviation of critical requirements levels and increase utilization efficiency.

Dry matter digestibility values in the current study were lower than for leguminous forages (Nicholson, 1992) except for *A. seyal* which was within the reported range. These differences could be due to maturity and leaf to stem ratio of the sample analysed. An opposite trend was observed for feed intake with the lowest being recorded for *A. seyal.* This was in agreement with the findings of Shem *et al.* (1995) who showed that the relationship between DM apparent digestibility and DMI was low. DMI has been found to be closely correlated to N% but negatively correlated to digestibility (Lambourne *et al.*, 1985). The significantly high digestibility of DM, OM and cellulose in *A. seyal* was attributed to the low rate of feed passage through the gastrointestinal tract due to low feed intake thus increasing feed exposure to microbial and enzymatic action.

The levels of feed intake may have influenced the trend of OM digestibility. Woodward and Reed (1995) found high lignin in *A. brevispica* to result in low OM digestibility. The same authors attributed the low digestibility of OM to high lignin and the presence of polyphenolic compounds in browse. Factors that limit the digestibility of OM are the main causes of differences in nutritive value among forage species after nitrogen has been supplied (ILCA, 1987). In the current study sheep found *B. aegyptiaca* more palatable resulting in high intake of 633 g DM as compared to 445 g for *A. seyal.* Salem *et al.,* (1997) reported that feeding high level of palatable material reduces nutrient digestibility due to high rate of passage. The same authors found sheep fed increasing levels of palatable Acacia having reduced digestibility.

A high CP digestibility in a diet is indicative of a feed that has the potential to support production among domestic livestock. Since the main interest in the use of tree legumes is to improve the CP level of the diet, its high digestibility is important too for ruminants. *Acacia seyal* had a low CP digestibility of 32.8% and is thought to have been affected by the high amount of condensed tannins which have been reported to be 25mg /g DM (Abdulrazak *et al*., 2000). *Balanites aegyptiaca* supplied significantly more digestible CP per unit of forage than A. *seyal* and *C. gayana* hay. This amount was more than the minimum DCP required to support both growth and low milk production (Ekern, 1982).

The digestibility of NDF in the current study was significantly high for C. *gayana* hay than in *A. seyal* and *B. aegyptiaca*. The NDF digestibility among legume forages has been reported to be low and even when hay is supplemented with these forages, the NDF digestibility becomes lower (Kaitho *et al.,* 1998). The digestibility of hemicellulose, followed the same descending order where *C. gayana* hay > *A. seyal* > *B. aegyptiacia*.

The nutrient supply that improved due to supplementation was nitrogen supply because as a result CP improved from 6.8 in the basal diet to 8.9% among those receiving 30% *Balanites aegyptiaca*. Feed conversion efficiency was elevated as shown in Table 3.The supplements began being effective ($P<0.05$) at 20% supplementation as compared to the control. This was at the rate of about 140 g of supplement per day, which was in agreement with the findings of Sawe *et al.* (1998) who reported this amount to be the optimum level of supplementation for goats. The sheep receiving 10% supplementation performed better ($P>0.05$) than the controls, but the additional N was not sufficient to effect remarkable growth rate. This was however in conformity with Chriyaa *et al.,* (1997) that palatable legumes can be effective protein supplements for livestock consuming cereal based diets.

The live weight gains were within the ranges reported by other workers (Kevelenge, 1992, Kaitho *et al.,* 1998, Sawe *et al.,* 1998) for diets supplemented with legume tree forages. Despite the possible differences in intake of digestible nutrients, variations in stages of maturity, seasonal and ecological zone differences, performance on the forage legumes did not differ much with the reported values.

Feed conversion efficiency differed significantly ($P<0.05$) among the various supplementation levels with 30% supplementation being the most efficient. All the treatment groups with supplements were different ($P<0.05$) from the control. This indicated that the elevation of CP level beyond the 7% critical level was effective in improving feed conversion efficiency. Purroy *et al.* (1993) found feed conversion efficiency of growing lambs to be best at CP levels of above 12%, which was not attained during the current supplementation level. Feed conversion efficiency, when Leucaena was used as supplement, was best at 10% but dropped with increasing levels due to increase in feed intake (Balogun *et al*. 1995).

Feed intake at the various levels of supplementation was similar ($P>0.05$) for the treatments. Low feed intake at less than 20% supplementation may be attributed to insufficient intake of nitrogen to support microbial activity in the rumen. The high intake on supplementation with *Balanites aegyptiaca* may be an indication of palatability. The lack of significant differences in intake at the various supplementation levels may have resulted from tannin contents, which has been reported to depress intake of metabolizeable energy (Kaitho *et al.,* 1998). This however differed with the findings of Salem *et al.* (1997) who found increasing levels of acacia to cause an increase in feed intake.

Conclusion

Acacia seyal and *Balanites aegyptiaca* had nutrient contents of low to moderate digestibility. Their inclusion in grass-based diets is bound to improve intake and digestibility and consequently animal performance during the dry season. The supplementation of Rhodes grass based diet with above 20%of *Acacia seyal* and *Balanites aegyptiaca* improved feed conversion efficiency and average daily gain but had no effect on feed intake of sheep. The effects the supplements caused by changing growth rate from negative to positive is important for the survival of ruminants in drought prone areas where these forages grow.

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