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Growth performance and feed utilization by Sudan Desert lambs fed on concentrate and roughage ration supplemented with Moringa (*Moringa oleifera)* shoots

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Summary

An experiment was carried out to evaluate the growth performance and feed utilization by Sudan Desert lambs fed concentrate diet (25% sorghum grains, 40% wheat bran, 32% groundnut cake, 2% lime stone and 1% common salt on as fed basis) and roughages supplemented with graded levels of *Moringa oleifera* shoots. Eighteen intact Sudan Desert lambs were allocated to two levels of sun-dried *Moringa oleifera* shoots (200 and 400 g/animal/day) and control diet (0 inclusion of *Moringa oleifera).* All of the experimental lambs received a basal concentrate diet of 150 g/animal/day and alfalfa forage *ad libitum.* The design was a complete randomized design (CRD) with 6 animals per treatment. Lambs were fed in groups.

The daily weight gain (146.8- 163.6 g) of the lambs under study were the same (P>0.05) when fed on different treatments. The feeding period of sheep targeted for 40 kg live weight was not significantly (p>0.05) different between treatment groups. Furthermore, digestibility of dry matter, organic matter, crude protein (g/kg) of different treatments was not influenced by using Moringa shoots as roughage source.

It was concluded that supplementation with *Moringa oleifera* shoots up to 400g/animal/day has no negative effect on either lamb performance or feed utilization suggesting higher inclusion rates.

Keywords: feed utilization, lambs, Moringa.

Introduction

In Sudan, alfalfa (*Medicago sativa*), is the main irrigated forage legume, in the cool season, but is scarcely available during the hot dry/wet seasons (El Amin, 1976). Moringa (*Moringa oleifera*) belongs to the Botanical family Morinaceae is a multipurpose tropical tree. It is mainly used for human food and has numerous industrial, medicinal and agricultural uses, including animal feeding (FAO, 2014; Bosch, 2004; Foidl et al., 2001; Rasshid et al., 2008 and Orwa et al., 2009). *Moringa oleifera* tree is nutritious, fast growing and drought tolerant; and is becoming increasingly popular, among the most economically valuable crops in Asia and Africa,. Recently it is recognized as a new feed resource, seems to be elected as an alternative forage legume for ruminant feeding. It has been shown that at high planting density of Moringa on consistent irrigation and adequate management, an annual yield as high as 78 metric ton/ha of fresh material (approximately 13.26 tons dry matter) could be harvested from Moringa tree (Foidl et al., 2001). The crude protein of leaves is high (26.8%), and *in situ* rumen dry matter digestibility was 79.1 % (Mabrouk et al., 2010).

This study is to investigate:

- The potential *Moringa oleifera* tree as new animal feed in Sudan.
- Assessing the growth performance and feed utilization by lambs, when fed a basal concentrate diet and roughage source supplemented with graded levels of *Moringa oleifera* shoots.

Materials and methods

Location and duration

The study was carried out at Animal Production Research Centre- Khartoum North during the period from July to October of year 2012.

Experimental design

The first part of the experiment was designed to evaluate the growth response of lambs when fed a basal concentrate diet and a roughage source supplemented with graded levels of *Moringa oleifera* shoots. Eighteen lambs were grouped into three groups (6 lambs/group) and were randomly allocated to one of three levels of *Moringa oleifera* shoots as 1200, 2400 g/group/day moringa shoots and control group without moringa supplementation which is equivalent to 200, 400, 0g m /head/day)

(respectively. The design was a complete randomized design (CRD) with 6 replications for each treatment. The second part of the experiment was designed to evaluate feed utilization by lambs (3 replicates for each treatment).

Animals and management

Eighteen apparently healthy Sudan Desert entire lambs , six-seven month old and 26.1 ± 2.91 kg initial body weight were used. Animals were purchased from Khartoum local market, dewormed with Albendazole (for internal parasites) and Ivomec (for external parasites). The lambs were randomly allocated to either of the three dietary treatments resulting into six animals per group ,and group fed.

Experimental feeds

Moringa oleifera shoots in this study were obtained from a private farm located in Soba town south of Khartoum. The forage was machine chopped to 2-3 cm size and dried under shade. After drying, the chopped forage was collected into sacs ready for feeding. All animals received a basal diet of concentrate (25% sorghum grain, 40% wheat bran, 32% groundnut cake, 2% lime stone and 1% salt as fed basis) of 600 g/group/day and alfalfa hay as roughage source (*ad libitum*) as follows:

- 0M: Basal diet of concentrate (600g/group/day) + alfalfa forage (*ad libitum*).
- 200M: Basal diet + 1200 g *Moringa oleifera* forage.
- 400M: Basal diet + 2400 g *Moringa oleifera* forage.

The feed was offered once daily, in the morning (8:00 h). Clean water was available the whole day.

Data collection

In the first part of the experiment, feeds were offered and, refusal were collected daily and, weighed to measure daily feed intake. Representative samples of feeds offered and refusal were collected for chemical analysis. Live body weight of lambs was taken at the beginning of the study and then every week until the end of the study. The feeding trial continued until animals reached 40 kg live body weight.

At the end of the feeding trial, the second part of the experiment was commenced, by random selecting three lambs, from each group with an initial live body weight of 40.3 ± 1.18 kg. Animals were placed individually into metabolic crates. The animals were provided with their respective diets and clean water throughout the trial. The trial lasted for 14 days. The first 7 days were adaptation period and during the following 7 days the animals were fitted with canvas bags for collection of faeces. Each animal in each group received its respective diet once daily at 8:00 am. All feeds offered, refusals and faeces were collected and weighed daily throughout the experimental period. Sample of fresh faeces (10%), was measured from each animal, stored into refrigerator until analyzed. Feeds, refusals and faecal samples collected were pooled and mixed for each animal and sub sampled for chemical analysis.

Chemical analysis

Feeds, refusals and faeces were analyzed for dry matter (DM), ash, crude protein (CP), crude fibre (CF), ether extract (EE) according to AOAC (1990); and Neutral detergent fibre (NDF) were determined according to Goerging and VanSoest (1970).

Statistical analysis

Data for growth and digestibility trials were analyzed by analysis of variance (ANOVA) using Statsoft (2001) computer program. The significance differences between means were separated, using Duncan multiple range test.

Results and discussion

Animal health

There were no signs or symptoms of disease or toxicity in the animals during the experiment.

Chemical composition of diet

Chemical constituents of concentrate mixture, alfalfa hay and *Moringa oleifera* are given in Table 1.

Table 1: Chemical composition of feed ingredients (g/kg DM)

Ingredient	DM	OM	Ash	CP	EE	CF	NDF	ME MJ/kg DM
Concentrate mixture	938.0	894.5	105.5	196.4	16	112.0	-	12.42[1]
alfalfa hay *(M. sativa*)	920.0	917.7	82.4	158.1	18	415.0	460.0	8.83[1]
Moringa oleifera hay	918.0	896.5	103.5	91.7	24	460.0	560.0	9.5[2]

DM= Dry matter, OM= Organic matter, CP= Crude protein, EE= Ether extract, CF= Crude fibre, NDF= Neutral detergent fibre.

The crude protein (CP) content of the concentrate mixture was higher than that of alfalfa hay and *Moringa oleifera* hay . This shows that the CP content of alfalfa hay in the present study was consistent with reported values of Sulieman and Mabrouk (1999) for alfalfa in the mid bloom stage (159.3 g/kg). However the CF content of alfalfa was very high compared to the value reported by Sulieman and Mabrouk (1999) of 292.7 g/kg DM. The CP content of *Moringa oleifera* shoots obtained in this study was much lower, and fibre contents was much higher compared to reported values by Mabrouk et al., (2010); Sanchez et al., (2006) and LuuHuuManh et al., (2005). Those workers reported CP and CF contents of 200, 270 and 178.0, 376.3 g/kg DM respectively. Whereas ash contents in the present study fell within the range reported by Mabrouk et al., 2010) of 123.7 and Sanchez et al., (2006) of 107.6 g/kg DM.

Growth performance

Feeding period, daily gain, and dry matter intake of the tested diets are summarized in Table 2.

Table 2 : Growth performance and feed intake of lambs fed concentrate diet and lucerne-based mix supplemented with graded levels of *Moring aoleifera* forage.

Item	**0M**	**200M**	**400M**	**SEM**	**Sig. level**
No. of animals	6	6	6	-	-
Period (weeks)	9.8	9.5	8.8	0.82	NS
Live body weight					
Initial weight (kg)	28.6	29.1	30.6	1.58	NS
Final weight (kg)	39.8	40.5	40.8	0.33	NS
Total gain (kg)	11.2	11.4	10.2	1.63	NS
Daily gain (g)	145.5	158.5	158.5	12.98	NS
Dry matter and protein intakes					
Concentrate (g/anim/day)	150	150	150	-	-
Alfalfa (g/anim/day)	1179	1019	1013	-	-
Moringa forage (g/anim./day)	-	154	279	-	-
Total intake (g/anim/day)	1329	1323	1442	-	-
Intake (% live body weight)	3.9	3.8	4.0	-	-
Intake (g/kg metabolic weight)	97.1	96.9	103.0	-	-
Total forage DM intake g/day	1179	1173	1292	-	-
Forage/concentrate ratio	8:1	8:1	9:1	-	-
Moringa % total forage intake	0	11.6	19.3	-	-
CP intake (g/day)	215.9	204.7	215.2	-	-

SEM= Standard error of mean, NS= No significant difference (P>0.05)

The feeding period of sheep targeted to a 40 kg live weight was not significantly (p>0.05) different between treatment groups. Furthermore there was a tendency for the feeding period to decrease as the inclusion rate of *Moringa oleifera* increased, indicating better utilization of diets containing higher levels of *Moringa oleifera* forage. The daily gains recorded in the present study were in accordance with some other values obtained for Sudan Desert sheep, their daily growth rates of 166-191 g/day

(El Karim and Owen, 1987), 120-205 g/day (Mansour et al., 1988) and 161-196 g/day (El Khidir et al., 1988) implying that there was no limiting effect concerning dietary composition, that may be ascribed to increasing Moringa in the ration, as in the present study.

Daily DM and CP intakes for the different dietary treatments are shown in Table 2. It can be observed for both DM and CP intake, a tendency to increase, as Moringa proportion in diet increased. The experimental diets were predominately roughage based, where roughage/concentrate ratio were 8:1 and 9:1 in Moringa supplemented rations, in which Moringa constituted 12% and 19%, in 200M and 400M respectively. The crude protein concentration of the tested diets is likely to furnish an optima rumen ammonia nitrogen (50 mgN/L), to maintain normal microbial function in the rumen, as suggested by Satter and Styler (1974) in their earlier study. In the current study, a range of 9-11 mg ammonia-N/100 ml rumen fluid can be calculated from Satter and Roffler (1975) equation, which is sufficiently high for optimal ruminal function.

Feed digestibility and utilization:
Apparent digestibility coefficients and metabolizable energy contents of the treatment groups are shown in Table 3.

Table 3: Digestibility of dry matter, organic matter, crude protein (g/kg) and digestible organic matter (%) by lambs fed concentrate diet and lucerne-based mix supplemented with graded levels of *Moringa oleifera* forage.

Item	**0M**	**200M**	**400M**	**SEM**	**Sig. level**
Dry matter	571.9	563.6	582.5	30.62	NS
Organic matter	597.9	594.1	615.7	38.64	NS
Crude protein	681.2	674.6	676.5	11.03	NS
Digestable organic matter (DOMD)	54.74	54.30	56.18	2.483	NS

SEM= Standard error of mean, NS= No significant difference (P>0.05)

In this study the digestibility of nutrients (DM, CP and OM) was comparable in all the dietary treatments. Similar results were observed by Singh et al. (2002). However, CP digestibility in this study was not significantly different between dietary treatments, but these values are still higher than the range 45.5- 47.7%, reported in other studies by (Mabrouk et al., 2010) and Singh et al. (2002), when using 60:40 roughage concentrate ratio diets. However, Gantalapiedra-Hijar et al. (2009) and Ramos et al. (2009) reported similar values to those in our study for CP digestibility (63-82% and 72-74 % respectively), for diets containing roughage: concentrate ratio of 70:30; suggesting better utilization of protein by ruminant at higher inclusion rate of medium quality forages; which corroborate the results of this study.

The utilization of feed energy is shown in table 4, which indicates that the Moringa supplemented feed energy, was equally used ,for the combined maintenance and growth functions, as may be inferred from AFRC (1990) suggested calculations.

Table 4: Utilization of metabolizable energy for growth by lambs fed concentrate, alfalfa mixture supplemented with *Moringa oleifera* shoots.

Item	**Treatments**			**SEM**	**Sig. level**
	0M	**200M**	**400M**		
Mean body weight (kg)	33.75	34.65	35.70	-	-
Metabolic body weight ($w^{0.75}$)	14.00	14.28	14.60	-	-
Daily gain (g/d)	146.8	163.6	161.3	16.83	NS
ME intake (MJ/day)	12.27	12.32	13.46	-	-
DM intake (kg/d)	1.329	1.323	1.442	-	-
Calculated ME for maintenance (MJ/)[1]	6.986	7.126	7.285	-	-
Energy concentration	9.23	9.31	9.33	-	-

(M/D) MJ/kg DM					
Metabolizability of feed $(q_m)^2$	0.50	0.51	0.51	-	-
Feeding value[2]	1.76	1.73	1.85	-	-
ME remaining for growth (MJ)	5.284	5.194	6.175	-	-
Efficiency of metabolizable energy use for gain(kg)3	0.396	0.404	0.404	-	-
Calculated Net energy value of gain (MJ NE/d)	2.092	2.098	2.495	-	-
Combined efficiency of ME use for maintenance and growth (kmp) [4]	0.557	0.565	0.542	-	-

SEM= Standard error of mean, NS= No significant difference (P>0.05)

[1] El Khidir et al. (1988), Sheep maintenance requirement=0.499 MJ/kg $w^{0.75}$

[2] McDonald et al. (2011). q_m= (M/D)/GE.

3 ARC (1980), k_g= 0.78 q_m+ 0.006.

4AFRC (1993). kmp = (NEm + NEg) / (NEm/km + NEg/kg).

Conclusion

It can be concluded that *Moringa oleifera* shoots fed at 200 or 400 g daily levels of supplementation, could be advised as a good and safe supplement in alfalfa -based diets for growing lambs.

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