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Effect of supplementation of fenugreek (*Trigonella foenum -graecum* L.) seeds on feed intake, digestibility, N-balance and rumen environment of Nubian Goats

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Abstract

Twelve lactating Nubian goats, similar in body weight and age, were used in this experiment to assess the effects of supplementing concentrate ration with four levels of fenugreek seeds {0.0 % (T₀), 5 % (T₁), 10% (T₂) and 15% (T₃)} on feed intake, digestibility, N-balance and rumen environment. The goats were divided into four equal groups, consisting of 3 replicates of one animal each, using a completely randomized design. The animals were assigned to four iso-nitrogenous and iso-caloric concentrate rations. The experiment continued for 75 days; during it each animal was recorded dry matter intake daily, while urine samples, feces of individual animals were collected at the last week of the trial and the samples of rumen fluid were collected at the last day of the experimental period. The results showed that the dry matter intake, crude protein intake, nutrients digestibility of (DM, CP and OM) and nitrogen retention were significantly ($p < 0.05$) higher in goat fed fenugreek seeds diet compared to those fed the control diet. The pH, concentrations of NH₃-N and VFA of rumen fluid were slightly increased in treated groups than in the control group. This experiment concluded that supplementing goat's diets with fenugreek seeds had positive effects on DM and CP intake, DMD, CPD, OMD nitrogen retention.

Keywords: Fenugreek seeds, Feed intake, Digestibility and rumen environment

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1. Introduction

Sudan is predominantly an agricultural country with the largest livestock population in the Arab world and second to Ethiopia in Africa. The latest animal census estimated goat population as 38 million (MOAR, 2003). Despite this large population there is insufficient supply of milk and other animal products, this is mainly due to the poor genetic makeup of local breeds, lack of proper feeding, poor management and disease.

Feed additives are important materials that can improve feed efficiency and performance of lactating buffaloes (Salem and El-Mahdy, 2001). On the other hand, attempts to use the natural materials as alternative growth promoters such as medicinal plants are widely accepted, such as *Nigella sativa*, *Trigonella foenum* and *Lepidium sativium*.

Some studies on cows indicated that such plants seeds had favorable effects on nutrient digestibility, live weight and feed efficiency (Aboul-Fotouh et al., 1999; El-Saadany et al., 2001; Mohamed and El-Saidy, 2004 and Atta Elmnan and Mangara, 2012).

Medicinal and aromatic plants have been used for many years in human-nutrition as a spices and medical additives for animal to increase dietary energy utilization, improve the performance efficiency and as a new source of protein (Abdel El-Aal and Attia, 1993). In addition to that the medicinal plants can improve rumen activity and nutrient digestibility (El-Saadany et al., 1996; Allam et al., 1999; Aboul-Fotouh et al., 1999).

The objective of the present study was to evaluate the effect of fenugreek (*Trigonella foenum-graecum* L.) seeds supplemented at different levels on feed intake, digestibility, N-retention and rumen fermentation.

2. Materials and methods

2.1. Study area

This study was conducted at the small ruminant unit, Faculty of Animal production, Khartoum University, Department of Animal Nutrition, Sudan.

2.2. Experimental animals

Twelve Sudanese Nubian goats were purchased from Sheikh Abu zeid, a local livestock market in the vicinity of Omdurman. The criteria adopted for selection of does were as follows, matching body weight, age, breed and stage of pregnancy, to ensure homogenous groups. Following their arrival to experimental site, they were treated against internal and external parasites and ear tagged. The animals were housed in individual pens (1mx2m) partially shaded and offered basal diet and green roughages 3 times /week for ad libitum intake until parturition. Drinking water was freely available to the animals.

2.3. Treatments and experimental design

Animals were assigned randomly to one of four different treatments with three animals per treatment, following the completely randomized design. All the diets formulated to be iso-nitrogenous and iso-caloric (Table 1), the animals on the different treatments received a same quality ingredient of basal diet (sorghum, groundnut cake, sesame cake, wheat bran, molasses, limestone and sodium chloride) supplemented with different levels of fenugreek seed (Table 2) to meet the daily requirement of lactating goats (NRC, 1981), the diets used in the experiment were:

- Basal diet +0 % of fenugreek seeds (T₀).
- Basal diet +5 % of fenugreek seeds (T₁).
- Basal diet +10 % of fenugreek seeds (T₂).
- Basal diet +15 % of fenugreek seeds (T₃).

2.4. Parameters measured

The parameters measured were dry matter intake (DMI), digestibility, N-retention and rumen environment.

2.5. Rumen Environment Study

For determination of ruminal ammonia-N (NH₃-N) and volatile fatty acid (VFA) concentration, ruminal fluid samples were delivered through esophageal stomach tube at 0, 2, 4 and 6 hrs after morning meal on the last days of the experimental period. Rumen fluid samples were strained through double layer cheesecloth and pH was immediately measured with pH meter, then the samples were acidified with three drops of concentrated H₂SO₄ and kept frozen for further analysis at -20 °C.

2.6. Chemical analysis

Feed samples and feces were analyzed for dry matter (DM), Crude proteins (CP), crude fiber (CF), ether extract (EE) and ash by method of AOAC (1990). Nitrogen free extract (NFE) was calculated by difference. NDF was determined according to Van Soest and Robertson (1980). Total NH₃-N and VFA were analyzed following the method described by Abdulrazak and Fujihara (1999).

2.7. Statistical analysis

Data were subjected to analysis of variance (ANOVA) for completely randomized design, using a computer program known as statistix^{8.0}. The comparison among means was analyzed by the least significant difference (LSD) test.

3. Results

3.1. Effect of treatments on feed intake

The effect of supplemented different levels of fenugreek seeds 0% (T_0) or 5% (T_1), 10 % (T_2) and 15 % (T_3) to concentrate ration on feed intake (DM and CP) was illustrated in Table 4. The result showed that there was a significant difference ($P < 0.05$) between experimental animal groups fed control diet and that fed a different level of fenugreek seed on Dry Matter Intake (DMI) and Crude Protein Intake (CPI). Control group (T_0) gave the lowest intake of DM and CP while highest intake of DM and CP were recorded by (T_3). Within supplemented groups there was no significant difference ($P > 0.05$) on (DMI) and (CPI). However, there was slightly increment in DMI and CPI with the increased level of fenugreek seeds.

Table 1. Calculated chemical analysis of supplementation fenugreek seeds

Ingredient%	T_0	T_1	T_2	T_3
CP %	14.59	15.25	15.96	15.48
ME(Mj/Kg)	11.00	11.30	11.43	11.71
Ca%	0.49	0.48	0.48	0.42

(T_0) Basal diet +0 % of Fenugreek seeds, (T_1) Basal diet+5 % of Fenugreek seeds, (T_2) Basal diet +10 % of Fenugreek seeds and (T_3) Basal diet +15 % of Fenugreek seeds.

Table 2. Ingredient (%) composition of supplementation fenugreek seeds

Ingredient %	T_0	T_1	T_2	T_3
Sorghum	55	53	50	51
Groundnut cake	5	5	5	3
Sesame cake	5	5	5	3
Wheat bran	14	11	9	7
Molasses	20	20	20	20
Fenugreek seeds	0.0	5	10	15
Limestone	0.5	0.5	0.5	0.5
Nacl	0.5	0.5	0.5	0.5
Total	100	100	100	100

(T_0) Basal diet +0 % of Fenugreek seeds, (T_1) Basal diet+5 % of Fenugreek seeds, (T_2) Basal diet +10 % of Fenugreek seeds and (T_3) Basal diet +15 % of Fenugreek seeds.

3.2. Effect of treatments on digestibility

The digestibility of {Dry Matter (DMD), Crude Protein (CPD) and Organic Matter (OMD)} significantly higher ($P<0.05$) for animal fed on 10 % and 15 % fenugreek seeds than those fed on 5% and control diet, Table 4.

3.3. Effect of treatments on N retention

The results in Table 4 showed the effect of fenugreek seeds levels on N retention. N retention increased significantly ($p<0.05$) in supplemented groups than control group. Higher N intake and N retention were observed in treated groups.

3.4. Effect of treatments on rumen fermentation study

The mean values of pH, VFA and NH₃-N in the rumen liquor were shown in Table 5. The result showed a significant difference ($p<0.05$) in rumen pH and concentration of NH₃-N between treated and control diets. Within treated diets there were no significant difference ($p<0.05$) in pH and concentration of NH₃-N in the rumen liquor. The concentration of VFA showed a significant difference ($p<0.05$) between un-supplemented and supplemented groups. Among supplemented groups there was a significant difference ($P< 0.05$) between T₁ and T₃ on VFA concentration which increased with increasing fenugreek seeds level.

Table 3. Effect of supplementation different level of fenugreek seeds on feed intake and digestibility

	Items	T ₀	T ₁	T ₂	T ₃	SEM
Feed intake (g/day)	DM	621.73 ^b	955.00 ^a	1089.30 ^a	1178.00 ^a	88.59
	CP	96.75 ^b	139.33 ^a	158.93 ^a	171.88 ^a	12.67
Digestibility (%)	DM	79.51 ^b	80.50 ^b	88.72 ^a	89.13 ^a	1.24
	CP	73.97 ^b	76.39 ^b	86.43 ^a	86.68 ^a	2.34
	OM	76.98 ^b	79.56 ^b	88.19 ^a	89.68 ^a	1.20
	NDF	76.93 ^a	67.48 ^b	65.52 ^{bc}	61.49 ^c	1.33

(T₀) Basal diet +0 % of Fenugreek seeds, (T₁) Basal diet+5 % of Fenugreek seeds, (T₂) Basal diet +10 % of Fenugreek seeds and (T₃) Basal diet +15 % of Fenugreek seeds. (DM) Dry Matter, (CP) Crude protein, (OM) Organic Matter, (NDF) Neutral Detergent Fiber. (SEM) Stander Error of Mean. ^{a-c} Mean with different superscripts in the same raw were significantly different ($P<0.05$).

4. Discussion

The present study indicated that there was increase in DMI and CPI among groups offered diet supplemented with varying levels of fenugreek seeds than that one offered control diet. These results agree with those

reported by Petit et al., (1993) and Abo El-Nor (1999) who found that (DM) Intake was increased when lactating buffaloes fed different levels of fenugreek seeds. Tomar et al., (1996) found that the fenugreek seed stimulates feed intake in dairy cattle, resulting in a significant increase in milk production. Ismail (2000) who fed growing Barki lambs fenugreek seeds and found that DM intake increased gradually as the level of fenugreek seed increased. The increased of DMI and CPI among groups fed diet supplemented with varying levels of fenugreek seeds than that one fed control diet, firstly may be due to the saponins content in fenugreek seeds, which increased feed intake. Petit et al. (1993) reported isolated steroidal saponin fraction of fenugreek seeds increase feed intake and motivation to eat in normal rats. Secondly, the boosting effect of fenugreek seeds supplementation might also be attributed to the fact that fenugreek seeds increase the appetite for food (Borca et al., 2000). Although Abo El-Nor (1999) suggested that fenugreek seeds may have an effect on hypothalamus gland to stimulate hunger center in the brain and increase the desire for eating.

Table 4. Effect of supplementation different level of fenugreek seeds on N-retention

Items	T0	T1	T2	T3	SEM
N-intake (g/ day)	22.25 ^d	28.42 ^c	34.64 ^b	41.44 ^a	0.08
N-excretion					
Fecal N	4.89 ^d	6.30 ^c	9.02 ^b	10.74 ^a	0.06
Urinary N	6.61 ^c	7.89 ^b	7.58 ^b	8.64 ^a	0.14
N-retention (g/day)	10.75 ^c	14.23 ^{bc}	18.04 ^{ab}	22.06 ^a	1.54
N-retention %	48.32	50.07	52.08	53.23	

(T₀) Basal diet +0 % of Fenugreek seeds, (T₁) Basal diet+5 % of Fenugreek seeds, (T₂) Basal diet +10 % of Fenugreek seeds and (T₃) Basal diet +15 % of Fenugreek seeds.(SEM) Stander Error of Means. ^{a-b} Means with different superscripts in the same row were significantly different (P<0.05).

The present study showed that there was increased in nutrients digestibility of (DM, CP and OM) in supplemented groups than control. This results agree with (Abo El-Nor et al., 2007) who found that there was an improvement in digestibility co-efficient of lactating buffaloes fed different levels of fenugreek seeds. The improvement in digestibility could be justified on the basis of that fenugreek seeds contain saponins

which stimulate anaerobic fermentation of organic matter that improve efficiency of utilization of nutrients (Abo El-Nor et al., 2007). In addition fenugreek seeds increased bacterial number in the rumen of lactating cows (Valdez et al., 1986; Ali et al., 2005). The results revealed that NDF digestibility decreased in treated diet compared to control diets may be explained by Lu and Jorgensen (1987) who observed that saponins impaired fiber digestion in the rumen. Moreover, saponins may decrease cellulolytic bacteria rather than amylolytic bacteria (Wang et al., 1998; Wang et al., 2000).

Table 5. Effect of supplementation different level of fenugreek seeds on rumen fermentation

Items	T ₀	T ₁	T ₂	T ₃	SEM
pH	6.22 ^b	6.25 ^a	6.30 ^a	6.36 ^a	0.24
VFA(m mol/dl)	5.90 ^c	6.59 ^b	6.76 ^{ab}	7.00 ^a	0.10
NH ₃ -N(mg/dl)	5.61 ^b	8.59 ^a	9.05 ^a	9.54 ^a	0.69

(T₀) Basal diet +0% of Fenugreek seeds, (T₁) Basal diet +5% of Fenugreek seeds, (T₂) Basal diet +10% of Fenugreek seeds and (T₃) Basal diet +15% of Fenugreek seeds. (VFA) Volatile Fatty Acid. (SEM) Stander Error of Mean. ^{a-b} Means with different superscripts in the same raw were significantly different ($p < 0.05$).

Maximum increase in N intake was observed in treated diet followed by the control diet. The magnitude of increase was consistent with feed intake of the diet supplemented with fenugreek seeds. The N retention and N losses increased in animal fed on supplemented diets. This result agree with (Badamana et al., 1990; Badamana and Sutton 1992) who found that in lactating goats the largest increase in nitrogen losses associated with increasing intake of dietary nitrogen.

PH values among treatments ranged from (6.22— 6.36). However pH was similar among treatments and the values were quite stable at (6.22—6.36), which was within the range (pH 6.0—7.0) considered for optimal microbial digestion of fiber and protein (Wanapat and Cherdthong, 2009).

Ruminal NH₃-N ranged from (5.61—9.54mg/dl), were lower in animal fed the control diet, whereas it was increased with increasing fenugreek seeds levels to the treated diet. Wanapat et al., (2008) reported that ruminal NH₃-N concentration increased linearly with increasing supplemental rumen degradable protein (RDP) levels. The increase of NH₃-N in the present study may due to the fenugreek seeds and concentrate ration contain a high level of RDP, which leads to a high ruminal NH₃-N. Or may be due to the diets contains a high digestible crude protein sources resulting in an increase in NH₃-N concentration. This result is in agreement with (Ngyuen et al., 2001).

Total VFA for supplemented diet increased with increase fenugreek seed levels. Also the groups with higher digestibility showed higher values of VFA. This is presumably because VFA was the end product of rumen fermentation and more the VFA produced with the increase in feed intake. These result in agreement

with (Ngyuen et al, 2001) who found that the groups with higher nutrients digestibility (DM, CP) showed higher values of VFA.

5. Conclusion

As a conclusion, supplementing goat's diets with medicinal plants seeds (Fenugreek seeds) had positive effect on intake of DM, CP, DMD, CPD and OMD.

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