Research Article

Efficiency of Feeding Sesban Hay as a Replacement for Clover Hay on Growth Performance and Semen Quality of Sheep

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Abstract | This study was conducted on forty male Ossimi sheep with an initial body weight of 19.04 ±0.48 kg post-weaning to puberty. We aimed to investigate the effects of substituting sesban (*Sesbania sesban*) hay instead of clover hay on feed intake, digestibility, growth performance, and semen quality. Animals were randomly divided into four groups and fed four different rations. Ration 1 (R_1) was the control (60% concentrate feed mixture + 40% clover hay). The remaining rations were supplemented with sesban hay by 10% (R_2), 20% (R_3), and 30% (R_4) as a replacement from the clover hay ratio in the control ration. Results showed that supplementation of sesban hay increased the nutritive value of digestible crude protein ($P < 0.0001$), ruminal pH, and NH_3-N values. Total dry matter intake tended insignificantly decrease with increasing levels from sesban hay. Final body weight, average daily gain, growth rate, and body weight gain did not affect by sesban supplementation. Supplementation of sesban hay improved feed conversion to digestible crude protein ($P < 0.002$). The replacement of clover hay 10, 20, and 30% ratios of sesban hay did not affect most of the puberty parameters and semen characteristics. Economic efficiency was noticeably higher with an increasing level of sesban hay. It concluded that partial replacement of up to 30% of clover hay by sesban hay has positive effects on some metabolic parameters, reflected improving the economic efficiency of growing Ossimi sheep without affecting their growth rate and semen quality.

Keywords | Ossimi sheep, Sesban hay, Clover hay, Growth, Semen quality

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INTRODUCTION

Nutrition is the main factor affecting the physiological state and metabolism in animals. In Egypt, there is a wide gap between the available green fodder and the requirements of farm animals. The shortage of forage supply during the summer season and poor quality of available are master determinants of the productivity of small ruminants (Solomon et al., 2010). Energy and protein are among the main factors affecting sheep productivity (McDonald et al., 2002).

Berseem (Egyptian clover) is high-quality forage due to its high concentration of nutrients, especially protein (15-25% DM), minerals (11-19%), and carotene (Feedipedia, 2016). During the winter, the surplus green clover is converted into Clover hay to overcome the lack of green forage. However, recently its price has risen significantly and has become an uneconomic component, especially with low-yielding animals such as sheep. Alleviate the problems associated with lack of protein supplementation due to availability and high cost; there was a need to search for alternative protein sources such as forage legume cowpea

(*Vigna unguiculata*). Nutritional supplements that farmers can produce on their farms, such as multipurpose forage trees of which sesban and *Acacia saligna* are among them can be easily grown on farm level and play a prominent role in supplementing the diet of growing lambs as an alternative to concentrated supplementation (Berhe, 2018). Also, several attempts have been made to introduce inexpensive, high-protein green forage such as sesban (El-Kholany et al., 2019).

Farghaly et al. (2022) reported that non-traditional fodder sources, such as Sesbania sesban or reed grass, can be used as alternatives to the frequently used alfalfa feed. Furthermore, these supplies have the potential to improve lamb meat quality and softness while maintaining acceptable meat and fatty color. Therefore, they recommended using Sisbanian grass or reed grass in sheep's rations as a way to combat the high prices or lack of traditional green fodder.

Previous studies indicated that the sesban plant contains a high level of crude protein (29 to 33% of DM) (Hossain et al., 2002; Pugalenth et al., 2004), So, the sesban as a legume, that has economic importance as fodder and source of protein in diets as reported by Pugalenthi et al. (2004). Mekoya et al. (2009) showed that taking sesban supplements improved the intake and digestibility of basal forages, thus increasing the live body weight and reproductive performance of goats and sheep. Furthermore, dried sesban supplements were comparable in their ability to provide nutrients to improve sheep productivity; dried Sesban can be used to replace the protein source of concentrated feed (Yirdaw, 2018). Another study concluded that treated or untreated sesban seeds can be safe and economical and have been successfully used as a source of feed protein to replace up to 30% of concentrate feed mixture in kids rations as it harmed on rumen fermentation parameters, blood components, and ration feeding values compared to control, by El-Kholany et al. (2016).

To comprehend the effects of adding hay of sesban to lamb's feeding programs that previously reviewed, a further long-term investigation there is a need. Therefore, we aimed was to explore the effects of the sesban hay supplementations in lambs' rations, beginning after weaning and continuing to reach puberty in the long term on the growth, digestibility, rumen activity, their nutritional and economic competence, and semen characteristics.

MATERIALS AND METHODS

Experimental animals, their management and rations

This study was carried out at Sids Experimental Station, Beni-Suef Governorate during September to February 2020-2021. Forty male of Ossimi sheep ear-tagged for identification, beginning after weaning with an initial body weight of 19.04±0.48 kg, and continuing to reach puberty were used in this study, animals were quarantined for 15 days to follow any disease incidence, injected albendazole, ivermectin against internal, and external parasites respectively. Animals were randomly divided into four groups (each group, ten heads), based on their initial body weight, to feed on four ratios, to study the effect of using Sesban hay as a replacement for Egyptian clover hay.

Ration$_1$ (R_1) was the control, where animals received ration consisting of 60 % concentrate feed mixture (CFM) +40% clover hay, the calculated nutrient requirements were according to NRC (1985), the remaining rations involved supplementation of Sesban hay at 10% (R_2), 20% (R_3), and 30% (R_4) as replaced from the clover hay ratio in the R_1 ratio, daily rations were divided into two equal portions, at 8 am and 4 pm, water was available all time, and feed residuals were collected and weighed daily. The experimental animals were weighted every two weeks, and the growth experiments lasted 120 days.

Digestibility, feed intake, feed conversion, body weight change, and chemical analysis

Before the commencement of the actual feeding, were conducted the digestibility trials to evaluate the experimental four rations (R_1, R_2, R_3, and R_4) using 12 mature Ossimi rams (three/ each), 2-3 years, and an average weight of 40 kg. Rams housed in metabolic cages were individual. The preliminary period was 15 days and a collection period was five days, followed by three days of rumen studies. Average daily intake of forage was measured based on the differences between the feed provided and the remaining during the feeding. The initial body weight was calculated by averaging two successive weights, and the subsequent weight was taken after a 15-day interval.

Calculated feed conversion as the amount of DM, TDN, and DCP required to produce one kg weight gain, the chemical composition of representative samples of CFM, clover hay, and sesban hay and feces according to AOAC (1985) procedures were determined. Table 1 showed the chemical composition of CFM, clover hay, sesban hay, and experimental rations.

Blood samples

Blood samples were collected biweekly *via* the jugular vein into sterile tubes before feeding in the morning from each animal till the end of the growing lambs' trial, blood samples were centrifuged at 4500 rpm. for 20 min, to get the serum. Serum total protein and albumin were determined by a colorimetric method described by Cannon (1974), serum globulin by the difference between all proteins and albumin as calculated. Serum glucose was measured calorimetrically according to Howanitz and Howanitz (1984). Aspartate

aminotransferase (AST) and alanine aminotransferase (ALT) were determined as described by Young (2000). The quantified of urea-N and cholesterol concentrations in blood serum by using kits of Spinreact, S.A.U. Ctra. Santa Coloma, 7 E-17176 Sant Esteve de Bas (GI), Spain using a spectrophotometer. Testosterone concentration measured by the method of Jaffe and Behrman (1974) that assessed total testosterone concentration using Coat-A-count 125I radioimmunoassay (RIA) kits purchased from diagnostic products corporation, Los Angles, California, 90045, USA. Triiodothyronine (T3) and Thyroxin (T4) by radioimmunoassay procedures according to Chopra et al. (1971) and Irvin and Standeven (1968), respectively by using kits purchased from diagnostic products corporation, United States.

Table 1: Chemical composition of feedstuff and experimental rations fed to Ossimi growing lambs as DM basis (%).

Items	CFM	CH	SH	Experimental rations			
				R_1	R_2	R_3	R_4
DM	90.14	90.07	22.82	90.11	83.39	76.66	69.94
OM	94.15	97.37	92.87	95.44	94.99	94.54	94.09
CP	15.55	11.19	18.95	13.81	14.58	15.36	16.13
EE	2.89	1.71	2.66	2.42	2.51	2.61	2.70
CF	11.55	35.58	31.18	21.16	20.72	20.28	19.84
NDF	40.10	47.75	56.81	43.16	44.07	44.97	45.88
ADF	13.92	38.04	43.95	23.57	24.16	24.75	25.34
NFE	64.16	48.89	40.08	58.05	57.17	56.29	55.41
Ash	5.85	2.63	7.13	4.56	5.01	5.46	5.91

CFM: Concentrate feed mixture used in formulating the experimental rations contained 24% Cotton seed meal; 40% Wheat bran; 30% Yellow Corn 1.5% Lime stone; 1% Sodium chloride, 0.5% vitamins and mineral mixture and 3% Molasses; CH: Clover hay; SH: S. Sesban hay; DM: dry matter; OM: organic matter; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; R_1: control ration consisted of 60 % CFM+ 40% Clover hay; R_2: consisted of 60 % CFM+ 30 % Clover hay+10% SH; R_3: consisted of 60 % CFM+ 20% Clover hay+20% SH; R_4: consisted of 60% CFM+ 10% Clover hay+30% SH.

Ruminal parameters

Rumen fluid samples were taken from 12 rams (3 / each) using a stomach tube at 0 times (before feeding), 3 hours, and 6 hours post-feeding. The samples filter through three layers of surgical gauze without squeezing. Then immediately, ruminal pH was determined by a digital pH meter and rumen ammonia-N according to Conway (1957), and total volatile fatty acids (TVFA's) were measured by the steam distillation method as described by Warner (1964).

Sexual performance and seminal characteristics

Lambs were tested daily for libido from 8:00 am to 9:00 am until puberty. Two ewes in estrus were placed in two pens (one ewe/pen) a third similar pen separating and two test pens used stood of the observer. Ewes kept unrestrained in the pens. The evaluation for each lamb was accomplished individually and randomly by exposing it to the two ewes for 20 min on each test day. The remaining lambs were placed about 20 yards away with visual barriers between them and the test pens. Each pen using for test lambs of all groups on each test day. They included bouts of scrotal circumference, reaction time, and latency period as follow:

Scrotal circumference (SC) evaluate by using a flexible tape around the widest point of the testes (maximum circumference of the paired testes), *Reaction time* (RT) estimation in minutes from time introducing ewe to the ram until the ram starts to mount and ejaculate and *The Latency period* (LP) estimation in minutes after ejaculation to return activity, these observations estimate by Kridli and Al-Yacoub (2006).

Known as the puberty age, the first age of the first collected ejaculate contains motile sperm. After first mounting with erection, lambs were trained for semen collection, sexually stimulated by allowing two false mounts, especially before the first ejaculation. A false mountain, followed by two minutes of self-control, then another false mountain followed by another two minutes of self-control that ended with ejaculation (Almquist and Hale, 1973).

Semen was collected using an artificial vagina. The temperature adjusted in the inner liner-rubber sleeve of the artificial vagina to be 41-43°C at the time of collection. Clean inner liner and graduated collecting tube were used for each collected. Lubrication of the inner sleeve is performing white sterile vaseline with a sterling rod. After collection, semen of each ejaculate was transferred immediately to the laboratory where ejaculate volume was measured directly in milliliters to the nearest 0.1 ml using a transparent graduated plastic tube. Spermatozoa characteristics are evaluated by two successful ejaculates separately, obtained as described by Salisbury et al. (1978).

Evaluation of the percentage of sperm motility, a drop of semen was examined under the low power, (x10) of a microscope using a heated slide set at 37°C, progressive motility estimating in a percentage (%) score, the number of spermatozoa/ ml of semen was determined using a hemocytometer. Total, motile sperm output/ ejaculate, and semen index mathematically calculated.

Economic efficiency

To simple economical evaluated calculated for the tested rations. The price of one kg live weight gain of sheep was 50 LE, and the cost of one ton of concentrate feed mixture,

Clover hay, and Sesban hay was 4600, 2500, and 300 LE, respectively. The return estimate by using the following equations:

Total revenue/head (LE) = Total body gain × 50, assuming that the selling price of each Kg gain was LE (50).
Net revenue /rabbit (LE) = Total revenue / h -Total feed cost/h.
Economic efficiency = Net revenue /h (LE)/ Total feed cost/ h (LE)

Statistical analysis

Data were expressed as means (±S.E.), and statistical analyses were performed with the General Linear Model (GLM) of SAS (2002). Duncan's New Multiple Range Test of the same SAS program was applied to determine significant differences among all tested treatments.The model in statistical analysis was:

$$Yij = \mu + Gi + eij$$

Where; Yij = an observation; μ = overall means; Gi = effect of treatment (i = R1, R2, R3 and R4); eij = random error

RESULTS AND DISCUSSION

Chemical composition of feedstuff and experimental rations

Table 1 showed that the chemical composition of sesban hay contains higher levels of crude protein (CP), fat (EE), and lower crude fiber (CF) content compared to clover hay. But the NDF in sesban hay were lower than the clover hay. Similarly, CP, NDF, and ADF content of experimental rations that involved sesban hay (R_2, R_3, and R_4) were higher than R_1. However, CF content was decreased either in sesban hay or rations that included sesban hay (R_2, R_3, and R_4) compared to clover hay and R_1.

Table 2: Bodyweight gain, feed intake, feed conversion and economic efficiency of Ossimi growing lambs fed experimental rations.

Items	Experimental rations				±SE	P. value
	R_1	R_2	R_3	R_4		
Bodyweight gain						
Initial weight, kg	19.17	19.00	19.00	19.00	0.48	0.9927
Final weight, kg	43.50	43.00	42.33	42.00	0.71	0.4585
Total body gain, kg	24.33	24.00	23.33	23.00	0.62	0.4268
Avg. daily gain, g/day[3]	202.75	200.00	194.44	191.67	5.17	0.4264
Growth rate (%)	126.92	126.32	122.79	121.05	4.90	0.8336
% Change	----	-1.80	-4.55	-5.90		
Survival rate (%)	100	100	100	100		
Feed intake						
CFM / h / d, kg	0.703	0.694	0.683	0.680	0.01	0.6689
CH / h / d, kg	0.469[a]	0.347[b]	0.229[c]	0.113[d]	0.01	0.0001
SH / h / d, kg	0.000[d]	0.116[c]	0.229[b]	0.341[a]	0.003	0.0001
TDMI / h / d, kg	1.172	1.157	1.141	1.134	0.02	0.6452
TDN / h / d, kg	0.857[a]	0.830[ab]	0.806[b]	0.796[b]	0.02	0.0160
DCP / h / d, kg	0.126[c]	0.131[bc]	0.134[b]	0.139[a]	0.002	0.0013
Feed conversion (FC)						
FC (TDMI/ kg gain)[1]	5.781	5.785	5.868	5.916	0.17	0.8743
FC (TDN/ kg gain)	4.229	4.150	4.145	4.155	0.12	0.7803
FC (DCP/ kg gain)	0.620[c]	0.653[bc]	0.688[ab]	0.727[a]	0.02	0.0024
Economic efficiency (EE)						
Price / kg diet (LE)	3.76	3.54	3.32	3.10		
Total Feed cost / h / 120d, LE	528.81[a]	491.49[b]	454.57[c]	421.85[d]	10.13	0.0001
Total revenue / h, LE[2]	1216.50	1200.00	1166.50	1150.00	31.02	0.4266
Net return / h, LE[3]	687.69	708.51	711.93	728.15	29.31	0.8148
Economic efficiency[4]	1.30[c]	1.44[bc]	1.57[ab]	1.73[a]	0.07	0.0021
Relative EE%	100.00	110.77	120.77	133.08		

[a and b]: Means within each row with different superscripts are significantly different (P<0.05). TDMI: Total dry matter intake; CFM: concentrate feed mixture; CH: Clover hay; SH= Sesban hay. Based on prices in the Egyptian market during the experimental period (2020) were 4600, 2500, and 300 LE/ton for concentrate feed mixture, Clover hay, and Sesban hay, respectively. [1]Feed conversion= Total DM intake / kg gain. [2]Total revenue/head (LE) = Total body gain × 50, assuming that the selling price of each Kg gain was LE (50). [3]Net revenue/rabbit (LE) = Total revenue/ h -Total feed cost/h. [4]Economic efficiency = Net revenue /h (LE)/ Total feed cost/ h (LE).

Feed intake, nutrient intake, feed conversion, body weight gain, and economic efficiency

Values of feed intake, nutrient intake, feed conversion, body weight gain, and economic efficiency, are shown in Table 2. Daily feed intake as TDMI/ h/ d tended to insignificantly decrease (being 1.172, 1.157, 1.141, and 1.134 kg) with increasing levels of Sesban hay (0, 10, 20, and 30%) in sheep rations (R_1, R_2, R_3, and R_4) , respectively. Feed intake as TDN/ h/ d also significant (P<0.01) decreased with increasing levels of sesban hay (being 0.857, 0.830, 0.792, and 0.781kg, respectively). The opposite trend observing with feed intake as DCP /h /d tended to significantly (P<0.001) increase with increasing levels of sesban hay (being 0.126, 0.131, 0.134, and 0.139 kg, respectively).

Final body weight, average daily gain, growth rate, were insignificant (P>0.05) decreased with supplementation level increased. Feed conversion as TDMI/ kg gain, TDN/ kg gain, and DCP/ kg gain followed the same trend of final body weight except with DCP/ kg gain differences were significant.

Economic efficiency was noticeably higher (1.30, 1.44, 1.57, and 1.73%) with increasing sesban hay levels (0, 10, 20, and 30 % from CH) in sheep's rations R_1, R_2, R_3, and R_4, respectively. Relative EE of sheep's rations which included the different ratios of sesban hay (R_2, R_3, and R_4), was gradually increased by 10.77, 20.77, and 33.08, respectively, compared to R_1.

Digestibility and feeding values

The experimental rations are present in Table 3, which apparent digestibility of DM, OM, CP, CF, NFE, NDF, and ADF in Ossimi sheep rams fed. Apparent digestibility of OM, CP, EE, CF, and ADF for sheep fed R_1 and R_2 were significantly similar which higher (P<0.01) than those feed on R_3 and R_4. The apparent digestibility of DM and NFE was insignificantly different among experimental rations. The first ration (R_1) recorded the highest value of NDF digestibility, then significantly (P<0.01) decreased gradually with R_2, R_3, and R_4. The same trend of OM, CP, EE, CF, and ADF digestibility, was obtained with feeding value as TDN. On the other hand, the DCP value was high in the experimental rations involving Sesban hay (R_2, R_3, and R_4), compared to the R_1. The ratio of DCP recorded in R4 then gradually decreased with decreasing Sesban hay percent (R_3 and R_2), while R_1 without Sesban hay recorded the lowest one.

Rumen fermentation parameters

Table 4 presented the rumen fluid parameters affected by dietary the experimental rations. The pH values increased with dietary Sesban hay (R_2, R_3, and R_4) compared to the R_1. The differences among the experiment ratios were significant at 3 hours post-feeding but insignificant at 0 and 6 hours post-feeding. The NH_3-N values were significantly (P<0.05) increased with dietary Sesban hay (R_2, R_3, and R_4) compared to the R_1 at 0, 3, and 6 hours post-feeding. There is an insignificantly increase in total volatile fatty acids (TVF's) with dietary Sesban hay (R_2, R_3, and R_4) compared to the R_1.

Table 3: Digestibility coefficients and nutrient values of Ossimi rams fed experimental rations.

Items	Experimental rations				±SE	P. value
	R_1	R_2	R_3	R_4		
Digestibility coefficient, %						
DM	83.28	82.53	82.71	82.61	0.57	0.7866
OM	73.98^{a}	72.82^{ab}	71.09^{b}	71.25^{b}	0.58	0.0120
CP	77.65^{a}	77.46^{a}	76.35^{b}	76.18^{b}	0.14	0.0001
EE	84.53^{a}	84.42^{a}	81.89^{b}	81.07^{b}	0.74	0.0121
CF	67.21^{a}	65.58^{a}	62.16^{b}	61.12^{b}	1.32	0.0001
NFE	75.14	73.61	73.71	73.78	0.85	0.5569
NDF	62.21^{a}	60.25^{b}	56.39^{c}	54.25^{d}	0.47	0.0001
ADF	52.45^{a}	51.13^{a}	47.49^{b}	46.49^{b}	0.50	0.0001
Nutrient values, %						
TDN	73.16^{a}	71.74^{ab}	70.63^{b}	70.23^{b}	0.54	0.0003
DCP	10.72^{d}	11.30^{c}	11.73^{b}	12.29^{a}	0.02	0.0001

$^{a-d}$: Means within each row with different superscripts are significantly different (P<0.05).

Table 4: Effect of experimental rations on rumen fermentation parameters of Ossimi rams.

Rumen liquid parameters	Time of samples	Experimental rations				±SE	P. value
		R_1	R_2	R_3	R_4		
pH	Zero time	6.16	6.25	6.24	6.22	0.04	0.3477
	After 3hr	6.08^{c}	6.15^{b}	6.21^{ab}	6.23^{a}	0.02	0.0003
	After 6hr	6.43	6.62	6.43	6.46	0.11	0.6202
NH_3-N (mg /100 ml)	Zero time	11.89^{c}	16.87^{b}	17.19^{b}	21.20^{a}	0.77	0.0001
	After 3hr	16.83^{c}	19.85^{b}	20.51^{ab}	23.17^{a}	0.96	0.0048
	After 6hr	15.08^{c}	17.24^{bc}	18.49^{b}	21.54^{a}	0.79	0.0008
Total volatile fatty acids (ml eq/100 ml)	Zero time	9.79	10.74	10.72	11.43	0.71	0.4630
	After 3hr	9.41	10.31	10.13	10.18	0.60	0.7125
	After 6hr	9.81	11.33	11.66	11.73	0.69	0.2166

$^{a-c}$: Means within each row with different superscripts are significantly different (P<0.05).

Table 5: Blood serum constituents of Ossimi ram-lambs fed experimental rations.

Items	Experimental rations				±SE	P. value
	R_1	R_2	R_3	R_4		
Total protein (g/dl)	6.59[c]	7.17[b]	7.22[b]	7.65[a]	0.11	0.0001
Albumin (g/dl)	3.46[c]	3.95[b]	4.05[b]	4.73[a]	0.07	0.0001
Globulin (g/dl)	3.13	3.22	3.17	2.92	0.17	0.6153
A/G ratio	1.11[b]	1.23[b]	1.28[b]	1.62[a]	0.12	0.0031
Glucose (mg/dl)	58.12	60.00	64.34	67.60	2.62	0.0836
Cholesterol (mg/dl)	96.29	105.25	103.15	107.37	3.63	0.1977
ALT (U/L)	48.01	46.00	45.00	46.75	1.53	0.1510
AST (U/L)	55.08	63.75	63.38	66.00	4.52	0.3700
Urea (mg/dl)	69.34	73.00	76.75	79.00	4.79	0.5195
T_3 (nmol/L)	2.51	2.40	2.35	2.30	0.08	0.3474
T_4 (nmol/L)	36.75	35.37	35.20	35.27	0.91	0.5915

[a-c]: Means within each row with different superscripts are significantly different (P<0.05).

Blood parameters

Data of blood serum parameters of male sheep fed different experimental ratios were presented in Table 5. The results indicated that total protein and albumin concentrations tended to increase significantly (P<0.05) with supplemented rations by Sesban hay (R_2, R_3, and R_4) compared to the R_1. There were no significant among experimental animals in globulin, glucose, cholesterol, and Urea, T_3, and T_4 concentrations. The parameters previously obtained using hepatic enzymes (ALT and AST) took the same direction.

Puberty and semen characteristics

Puberty parameters and male semen characteristics of sheep fed the experimental ratios summarized in Tables 6 and 7. The obtained data showed that the replacement of clover hay by 10, 20, and 30% ratios of sesban hay did not affect puberty parameters and semen characteristics except for the level of testosterone and live sperm count. On the other hand, the testosterone level increased significantly in two groups of male sheep fed R_1 and R_2 compared to the rest rations R_3 and R_4, also the ratios of live sperms increased in the same two rations compared to others.

The chemical composition of sesban hay and clover hay in this study showed that higher content of CP, EE, and lower CF in sesban hay than clover hay, which made sesban hay has nutritional and economic importance value compared

Table 6: Puberty parameters in Ossimi ram-lambs fed experimental rations.

Items	Experimental rations				±SE	P. value
	R_1	R_2	R_3	R_4		
Age (day)	222.67	224.50	223.83	223.67	1.79	0.9102
Bodyweight (kg)	40.67	40.50	39.93	39.33	1.36	0.8917
Testes circumference (cm)	19.67	19.33	19.17	19.17	0.69	0.9497
Urethral process (cm)	2.92	2.83	2.58	2.67	0.17	0.5239
Reaction time (min)	4.30	4.28	4.36	4.34	0.13	0.9671
Latency period (min)	13.62	13.51	13.58	13.66	0.29	0.9855
Testosterone level (ng/dl)	233.38[a]	225.53[a]	204.02[b]	204.48[b]	6.66	0.0078

[a-b]: Means within each row with different superscripts are significantly different (P<0.05).

Table 7: Some physical semen characteristics of pubertal ram-lambs fed experimental rations.

Semen characteristics	Experimental rations				±SE	P. value
	R1	R2	R3	R4		
Seminal volume (ml)	0.90	0.91	0.83	0.83	0.06	0.6732
Progressive motility (%)	79.67	78.33	77.50	75.83	1.33	0.2472
Sperm conc. /ml ($\times 10^9$)	1.53	1.39	1.43	1.43	0.09	0.6850
Sperm output/ej. ($\times 10^9$)	1.38	1.26	1.19	1.19	0.09	0.8810
Motile sperm/ml ($\times 10^9$)	1.22	1.09	1.11	1.08	0.06	0.4413
Motile sperm/ej. ($\times 10^9$)	1.10	0.99	0.92	0.90	0.05	0.3224
Live sperm (%)	82.17[a]	79.17[ab]	75.50[b]	75.00[b]	1.65	0.0167
Abnormality (%)	17.50	17.83	18.17	18.50	0.89	0.8729
Semen index[1]	9014.51	7844.13	6944.85	6750.20	574.79	0.1831

[a-b]: Means within each row with different superscripts are significantly different (P<0.05). [1]Semen index= Seminal volume (ml) × Progressive motility (%) × Sperm conc. /ml ($\times 10^9$) × Live sperm (%).

to clover hay. Therefore, sesban hay can be considered a source of protein and energy to supplement the deficiency in sheep rations (Sabra et al., 2010). Also, the chemical composition of sesban hay had a significant effect on the higher ratios of CP, EE, NDF, and ADF of the experimental supplemented with sesban hay (R_2, R_3, and R_4) compared to control, in contrast with CF content, these results harmony with those obtained by Tekliye et al. (2018).

Total DM and TDN intake decreased in supplement groups with sesban hay compared to the control. These results may be due to its content of some anti-nutritional factors, which have undesirable influences on intake, and digestion may tend to decrease after a long period of feeding. This agreement with Mekoya et al. (2009) who reported that there was a decrease in the feed intake for pregnant ewes fed sesban. Also, They indicated that despite the fact that sesban had moderate quantities of tannins, the positive benefits of intake and digestion may wane over a prolonged feeding period, the same trend was observed by El-Kholany et al. (2013) with using of sesban seeds in rations of growing Zaraibi kids.

On the other hand, Topps (1997) reported that if the level of sesban supplementation was < 30–40% of the DM consumption, the animal will consume more of the basal diet, in contrast with our obtained results, wich may be attributed to nutrient value , the amount of supplement, and ratio provided to the animals (Tekliye et al., 2018). Furthermore, increasing dietary supplementation of sesban hay leads to higher intakes of NDF, and ADF attributed to fiber content supplements may influence dry matter intake (Tekliye et al., 2018).

DM intake, like DCP, raised significantly ($P<0.001$) with an elevating ratio of sesban hay, which might be attributed to the substitution impact of sesban, and its high nutritional content of CP. Amelioration in CP intake may be due to sesban supplemented ration, which may have provided the appropriate rumen environment, leading to increased basal roughage fermentation and thus the rate of microbial protein production and digestion increased. The CP intake in this investigation was higher than the published values, which varied from 54.23 to 111.98 g/day and 53.26 to 62.97 g/ day reported by Worku et al. (2015) and Gulilat and Walelign (2017), respectively.

The obtained results indicated that values of feed conversion calculated as DM and TDN intake/ kg gain were similar to the experimental rations. However, values of feed conversion based on crude protein were better with two supplemented rations with 20 and 30% of sesban hay (R_3 and R_4) compared with other rations control and 10% of sesban hay (R_1 and R_2), as shown in Table 2. El-Kholany et al. (2013) stated the effect of using sesban seeds at levels 0, 10, 20, and 30% in goat ratios during the growing period and found that the values of feed conversion expressed as DCP intake /kg gain was better in kids consumed sesban seeds diets compared with control.

Disparities in growth rate and feed conversion reported in the present study are generally consistent with similar differences in DM and nutrient consumption. These results agree with those obtained by Mekoya et al. (2009), who indicated that during animals pregnancy supplemented with sesban were not significantly higher in daily body weight gain than those of control.

Economic efficiency values revealed that R_4 had the highest economic feed efficiency, followed by R_3 then R_2, and lasted R_1. Thus, the net return increases with sesban hay rations (R_2, R_3, and R_4, respectively) compared with R_1 shown in Table 2, this positive effect of sesban hay on economic efficiency observe by El-Kholany et al. (2013, 2016). Economic efficiency improved as a result of using sesban seeds at levels 10, 20, and 30% in diets of growing male kids, and lactating Zaraibi goats, respectively. The same trend with results obtained by Tekliye et al. (2018) indicated that sheep ration supplemented with the highest level of dried sesban leaves was more advantageous given the net return and marginal rate of return at the end of the feeding trial.

Apparent digestibility of OM, CP, EE, CF, and ADF for sheep fed R_1 and R_2 were significantly similar and better ($P<0.01$) than those feed on R_3 and R_4. Results showed that supplementation of Sesban with 10% in R_2 did not affect the digestibility of OM, CP, EE, CF, and ADF. At the same time, a decrease occurred in the digestibility of NDF. However, increasing the ratio of supplemented sesban hay in R_3 and R_4 (20 and 30%) decreased the digestibility of all previous values. This result may be related to the supplementation of high ratio of sesban hay, which contains anti-nutritional components such as tannins and saponins that may limit its digestibility (Woldemeskel et al., 2001; Solomon, 2002).

Previous studies were in contrary with the present study, reported that no significant difference in the apparent digestibility of the same parameters among the supplemented and control treatments, which could be an attribute of the types of supplement used (Mekuriaw et al., 2012). The differences were not statistically significant between all rations in digestion coefficients for both DM and NFE for the experimental rations. This result agrees with those obtained by Soliman and Haggag (2002).

The minimum pH and the maximum NH_3-N values were recorded at 3hrs. post-feeding, as shown in Table 4. The

same trend was obtained by El-Emam et al. (2014) and El-Kholany et al. (2016) found that the pH value of each group fed on sesban hay was significantly higher than control at 3hrs. post-feeding and insignificantly higher at 0 and 6hrs. post-feeding. These results may be related to high fiber content (ADF and NDF), as shown in Table 1, which may have influenced on increased salivation of these nutrients during digestion by sheep consequently, the increased pH in sheep fed the rations supplemented with sesban hay compared to the control. However, the obtained pH values after feeding ranged from 6.08 to 6.66. These values are within the normal ranges for normal functions in the rumen (5.5 to 7.3) as recorded by Hungate (1966). The pH values are affected by various factors such as drinking water, rumen ammonia, and VFAs (Zaki, 2015). The effect of the experimental rations on ammonia-N concentrations was significant at 0, 3, and 6hrs. post-feeding and were significant within each sampling time. Ruminal NH_3-N concentration after feeding tends to increase because of used sesban hay, especially with R_3 and R_4.

This result may be associated with high content of CP in supplemented rations with sesban hay which is considered a protein source. Generally, ammonia level depends on CP in the ratios and degradability degree CP in the rumen (Zaki, 2015). Nearly similar values of NH_3-N of sesban were reported by Ibrahim et al. (2008) with goats. The present finding is in agreement with those reported by El-Kholany et al. (2013) who observed also some noticeable and positive effects on ruminal protein as a result to using sesban seeds in ration's goats. Moreover, the effect of using sesban hay on ruminal total volatile fatty acids (VFA's) was not significant as shown in Table 4. In at the same time, rumen total VFA's concentrations during the all hours (3 and 6hrs.) post-feeding were not significant. The same trend was obtained by Zaki (2015).

The values of some serum variables showed significant differences between the four levels of globulin, glucose, cholesterol, urea, AST, ALT, T_3, and T_4 concentrations. Total protein concentrations in the blood (TP) and albumin of the control ratio decreased significantly than the supplementary rations (R_2, R_3 and R_4) by sesban hay. In the same line, the highest TP values recording, albumin with R_4 (7.65 and 4.73), then R_3 (7.22 and 4.05), followed by R_2 (7.17 and 3.95), respectively, and the lowest values recorded (6.59 and 3.46). The obtained values are within the normal range reported by Kaneko (1989) for healthy goats and in line with the findings of (Sabra et al., 2010; El-Kholany et al., 2013, 2016) with using sesban plant in Baladi sheep, sesban seeds in kids and lactating Zaraibi Goats rations, respectively.

The data obtained in Tables 6 and 7 showed that adding 10, 20, and 30% of sesban hay did not affect pubertal parameters and semen characteristics except for testosterone level and the number of live sperms. Feeding animals supplemented with sesban hay showed a significant ($P<0.01$) increase in testosterone level and live sperm count in two groups of male sheep feed R_1 and R_2 compared to the rest rations supplemented with R_3 and R_4, respectively. In addition, there was no any adverse effect on puberty parameters and semen characteristics as a result of partial replacement of up to 30% of clover hay by sesban hay. These results are similar to those obtained by Mekoya et al. (2009) who concluded that found of sesban up to 30% in the diet of sheep as a supplement before mating improved some of the puberty parameters, semen characteristics, and during the period of pregnancy while, other some parameters did not show statistically significant differences without showing negative effects.

CONCLUSIONS AND RECOMMENDATIONS

Our study concluded that Sesban hay as an unconventional forage source and safe source of protein can be used in rations of lambs (up to 30%) as alternatives to the clover hay without any adverse influences on the growth performance. It had a positive role in some metabolic parameters, such as improving the nutritional value, feed conversion, and some rumen parameters. In addition, there was no any adverse effect on the blood profile, growth rate, pubertal parameters, semen characteristics, and general health. The improvements reflect enhanced economic efficiency. This had the greatest impact on increasing the economic return of ossimi sheep supplemented with sesban hay. Finally, it can be recommended to cultivate sesban plant during summer in Egypt to substitute clover (The winter crop).

NOVELTY STATEMENT

Looking to find high quality and cheap nutritional roughage to feed sheep instead of the expensive traditional roughage in all seasons of the year.

AUTHOR'S CONTRIBUTION

Abd El-Moniem Ali S. Mahgoub conceived the presented idea and carried out the experiments, collected and cured the data. **Ahmed Mohamed Abd El-Hafee z** developed the theory, has revised the experimental design, and wrote the manuscript with input and support from all authors. **Mahmoud Yassin Mohamed** has planned the study, performed the experimental procedures, cured the data, performed the data analysis, prepared and revised the manuscript. **Al-Moataz Bellah Mahfouz Shaarawy** worked out almost all of the technical details, and per-

formed the numerical calculations for the suggested experiment. **Mohamed Ibrahim Nassar** supervised the experimental procedures, revision the manuscript and paraphrase some paragraphs. All authors discussed the results, provided critical feedback, helped shape the research, and contributed to the final manuscript.

Ethics statement

All research procedures were carried out in compliance with the standards set forth guidelines for the care and use of experimental animals by the Animal Ethics Committee of APRI, ARC, Egypt.

Conflict of interest

The authors have declared no conflict of interest.

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