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Effect of Fat Source on Performance of Fattening Lambs

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Abstract: Thirty six Barki male lambs were divided into 4 groups to determine the effect of fat source on performance of fattening lambs. In a growth trial, lambs were fed four experimental rations *ad lib* for 126 days. A digestibility trial was carried out at the end of the growth trial. The control ration (T1) contains no fat while the second, third and fourth rations (T2, T3 and T4) contained 4% tallow, grease or cotton seed oil, respectively. The results showed higher ($P<0.05$) digestion coefficient and nutritive values in oil supplemented group in all nutrients compared with T2 and T3, while the control group recorded the lowest values. Concerning the rumen liquor parameters, T1 recorded ($P<0.05$) more acidity pH, higher NH_3-N and TVF's concentration. On contrast, T4 had lower acidity pH, lower NH_3-N; however, T3 showed the lowest TVF's concentration. T4 retained ($P<0.05$) more dietary nitrogen compared with the other fat sources. Higher average daily gain, best feed efficiency and lower feed cost/kg gain were detected for T4.

Key words: Lambs · fattening · fat · digestibility · performance

INTRODUCTION

Fat supplementation can effectively increase the energy density of rations. Feeding fat has generally improved persistency of lactation, body condition and reproductive efficiency in dairy cows and body weight gain in fattening animals [1].

High levels of unsaturated fatty acids can decrease rumen fiber digestion (depended on ration composition). Urea addition can be improved the rumen fermentation by decrease the adverse effect of fat supplement [2].

When selecting a fat supplement to be incorporated in ruminant feeds, some orders must be considered, such as, forage program and supplemental nutrient needs, facility constraints on ingredient handling, storage and feeding, feeding-system constraints on palatability of adding fat, ruminal inertness and digestibility of fat supplement and/or cost of fat supplement [3].

The objective of this study was to investigate the source of fat (differ in saturation of fatty acids) and urea to be incorporated in the finishing diets of male lambs.

MATERIALS AND METHODS

Thirty six Barky male lambs with an average live body weight of 35.4 kg were randomly divided into four nutritional groups for 126 days fattening period. Each group was kept in a separated pen. Animals were usually offered their diets *ad lib*. Water and salt blocks were available freely to the animals and they were weighed every two weeks before the morning feeding.

Representative samples of offered rations and residuals were taken daily for DM determination. Feed intake was calculated on DM basis. The formula of the experimental rations is presented in Table 1 and its proximate analyses are shown in Table 2.

Digestion trials: Digestion trials were conducted to determine nutrients digestibility and N-balance for the 4 experimental rations. Sixteen animals (4 from each group) were kept in metabolic crates during 7 days adaptation period and 5 days for feces and urine collection.

Urine and feces collection: Urine was collected from each animal in glass containers with 100 ml of 10% sulfuric acid. Urine volume was measured daily and 10% of it was taken and kept in tight bottles until the end of collection period for nitrogen determination. Feces were daily collected in plastic bags, weighed and representative samples (usually 10%) were taken and kept in –20°C until the end of collection period for chemical determination.

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Table 1: Composition of experimental rations

	Rations			
Ingredients %	T_1	T_2	T_3	T_4
Yellow corn	29.00	20.00	20.00	20.00
Soybean meal	21.50	14.10	14.10	14.10
Bean straw	15.00	15.00	15.00	15.00
Peanut hulls	14.10	15.60	15.60	15.60
Cotton seed meal	10.00	10.00	10.00	10.00
Wheat bran	-	9.90	9.90	9.90
Olive seed meal	5.00	5.00	5.00	5.00
Molasses	5.00	5.00	5.00	5.00
Tallow	-	4.00	-	-
Grease	-	-	4.00	-
Cotton seed oil	-	-	-	4.00
Urea	-	1.00	1.00	1.00
Mineral mixture	0.10	0.10	0.10	0.10
Vitamins	0.30	0.30	0.30	0.30
TDN%	60.30	61.40	61.60	61.30
CP%	15.30	15.38	15.38	15.38
Price LE/Ton (2001)	503.95	531.25	501.25	533.25

T_1: Control, T_2: 4% Tallow, T_3: 4% Grease, T_4: 4% Cotton seed oil

Table 2: Proximate analysis of experimental rations (DM basis) %

	Experiment rations			
Items	T_1	T_2	T_3	T_4
Dry matter (DM)%	91.09	91.63	92.00	91.49
Dry matter composition%				
Organic matter (OM)	92.91	92.95	92.89	92.80
Crude protein (CP)	15.47	15.60	15.28	15.82
Ether extract (EE)	3.94	6.27	6.39	6.02
Crude fiber (CF)	28.04	27.61	30.16	28.47
Nitrogen free extract (NFE)	45.46	43.47	41.06	42.49
Ash	7.09	7.05	7.11	7.20

T_1: Control, T_2: 4% Tallow, T_3: 4% Grease, T_4: 4% Cotton seed oil

Chemical analysis: Proximate analysis of feed and feces were determined according to A.O.A.C. [4].

Rumen liquor parameters: Rumen liquor samples were collected using stomach tube from experimental animals at 4 hours post feeding. Ruminal pH was immediately measured by the HANNA pH meter, model (HI 8424). Ruminal ammonia (NH_3-N) concentration was determined using micro diffusion technique of Conway [5]. Total volatile fatty acids (TVFA's) concentrations were determined by steam distillation as described by Warner [6].

Statistical analysis: Data collected were statistically analyzed using the general liner model of SAS[7]. Significant differences between means were tested by Duncan's multiple range tests [8].

RESULTS AND DISCUSSION

Chemical composition of experimental rations: Chemical composition of the experimental rations on dry matter basis in Table 2 showed that all tested rations had almost similar values except for EE which were higher in T2, T3 and T4 resulted from fat sources supplementation.

Nutrients digestibility: Data in Table 3 indicated that adding fat significantly ($P<0.05$) improved DM, CP and CF by (11, 7.1 and 54.8%), (5.5, 6.4 and 31.5) and (21.3, 14.9 and 87.2) for T2, T3 and T4,respectively compared with T1, however T2 and T4 improved OM digestibility by 9.3 and 18.3% respectively, compared with T1, while no significant deference between T1 and T3. Highest values of EE and NFE digestibility was observed for T4 compared with T1, while no significant differences between T1, T2 and T3. Highest values of TDN and DCP were observed with T4 and the lowest values were recorded by T1. No significant differences were noticed between T2 and T3.

Generally, adding fat to ruminant ration improved digestibility coefficients and nutritive value, these may be due to the effect of high energy of fat which converted efficiently to net energy and presence a source of ammonia (urea addition), which may be minimized the adverse effect of fat supplementation on rumen bacteria [9], this results accepted with Hederson [10] who reported that growth of some strains of important rumen bacteria could be strongly inhibited by the presence of long chain fatty acids and Abou Ward *et al.* [2] reported that urea supplementation leads to reduce the inhibition occurred in NH_3 production in the rumen, which usually observed with fat addition to the ruminant rations. Also, Abou Ward [3] found that lambs fed ration supplemented with 8% fat and 1.5% urea, showed an improvement, in

Table 3: Apparent digestion coefficients and nutritive values of the experimental rations%

	Treatments			
Items	Control T_1	4% tallow T_2	4% grease T_3	4% oil T_4
Apparent nutrients digestibility %				
DM	54.40±0.68^{d}	60.37±1.03^{b}	57.39±1.12^{c}	65.96±0.57^{a}
OM	57.19±0.62^{c}	62.50±1.17^{b}	59.29±1.27^{c}	67.63±0.38^{a}
CP	56.94±0.37^{c}	60.96±0.18^{b}	60.59±0.76^{b}	65.45±0.44^{a}
CF	24.16±1.98^{d}	37.40±1.77^{b}	31.77±1.96^{c}	45.23±0.93^{a}
EE	69.03±2.46^{b}	73.64±2.88^{ab}	75.65±2.16^{ab}	77.88±1.27^{a}
NFE	76.63±0.44^{b}	77.39±1.74^{b}	76.48±1.04^{b}	81.86±0.34^{a}
Nutritive values %(DM):				
TDN	56.54±0.68^{c}	63.87±0.94^{b}	61.11±1.32^{b}	68.57±0.49^{a}
DCP	8.81±0.06^{c}	9.51±0.03^{b}	9.26±0.12^{b}	10.35±0.07^{a}

a,b,c, Means with different small letters in the same row indicate significant difference (P<0.05).

Table 4: Effect of feeding experimental rations on ruminal pH, NH_3-N and TVFA's concentrations of fattening lambs (4hrs. post feeding)

Items	T_1 Control	T_2 Tallow	T_3 Grease	T_4 Oil
pH	5.85±0.04^c	6.24±0.02^a	6.04±0.05^b	6.38±0.08^a
NH_3-N mg/100ml	6.00±0.23^a	3.80±0.45^b	4.80±0.67^{ab}	3.20±0.65^b
TVFA's mg/100 ml	16.78±0.59^a	13.28±0.12^b	11.83±0.64^b	14.03±1.02^b

a, b & c values with different letters on the same row differ at (P<0.05)

digestibility more than lambs fed rations containing fat without urea. The results agreement with that obtained by Bayourthe *et al.* [11] who reported that digestibilities were increased with supplemented fat, while Benchaar *et al.* [12] recorded that no changes attributable to the administration of oils were observed for nutrients digestibility, end products of ruminal fermentation and microbial counts, this is may due to the ration composition.

Rumen parameters: Rumen parameters for lambs fed the experimental rations are presented in Table 4.

Ruminal pH at 4 hours post feeding were higher (P<0.05) in T4 followed by T2, but without significant differences between them and lowest pH value was noticed in T1, however T3 had intermediate value. The same results were reported by Benchaar *et al.* [12]. These results were in contrast with data reported by Ikwuegbu and Sutton [13] who noticed that rumen pH was slightly lowered with oil supplemented diets and without significant effects. However, Abdullah *et al.* [14] found that ruminal pH was not affected by different sources of fat supplementation.

Ruminal ammonia nitrogen (NH_3-N) concentration decreased in T2, T3 and T4 with supplementation fats without significant differences among them compared with T1. Similar results were reported by Nangia and Sharma [15]. And contrast with those reported by Bunting *et al.* [16] who noticed that the addition of fat increased the concentration of NH_3-N. On the other hand, Tjardes *et al.* [17] found that ruminal NH_3-N concentration was not affected by adding fat to the diets.

Total volatile fatty acids (TVFA's) concentration decreased (P<0.05) in T2, T3 and T4 without significant differences among them compared with T1. Similar results were reported by El-Bedawy [18] who found that, feeding 5% unprotected oil ration led to decrease the concentration of TVFA's before and after feeding. These results were in contrast with those reported by Abdullah *et al.* [14] who found that TVFA's were not affected by fat supplementation.

Table 5: Nitrogen balance for lambs given experimental rations

	Treatments			
Items	T_1	T_2	T_3	T_4
Nitrogen intake, g/h/day	43.07	43.68	42.78	44.04
Fecal nitrogen, g/h/day	18.55±0.16^a	17.05±0.08^b	16.86±0.34^b	15.22±0.21^c
Urinary nitrogen, g/h/day	14.15±0.57	14.07±0.40	13.57±0.57	14.38±0.16
Nitrogen balance, g/h/day	10.37±0.45^c	12.56±0.43^b	12.35±0.25^b	14.44±0.28^a

a, b, & c Means with different superscripts on the same row are significant (P<0.05)

Nitrogen utilization: Table 5 presented nitrogen utilization of lambs fed the experimental rations. Data obtained pointed out insignificant differences among groups in nitrogen intake.

Regarding the nitrogen retention (NR), highest value (P<0.05) was observed by T4, while the lower value was obtained by T1, however animals in T2 and T3 had an intermediate values, without significant difference.

Animal performance: Data in Table 6 presented the performance of lambs fed different experimental rations.

Similar daily dry matter intake (DMI) values were shown by lambs fed the different experimental rations. Similar result was reported by White *et al.* [1] whom fed calves diets based on ground corn (65%) supplemented with stabilized animal-vegetable blended at 0, 2.5, or 5%, Benchaar *et al.* [12] and Mosley *et al.* [19] whom fed cows diet supplemented with oils, while El-Bedawy *et al.* [20] pointed that significant increase in DMI for fat supplemented diets. On the contrary, numerous information regarding the negative effects of fat supplementation on animals DMI were reported by Son *et al.* [21] and Khattab *et al.* [22].

Concerning the average daily gain (ADG) the highest value was recorded by T4 followed by T2 and T3 without significant differences among them. No significant differences were noticed between the T1and both T2 and T3. Similar results were reported by Plascencia *et al.*[23]. However, Clary *et al.*[24] stated that 4% tallow tended to increase ADG. On contrast, El-Bedawy *et al.* [20] revealed that, supplemental fat did not affect average daily gain.

Results of feed efficiency in terms of kg DMI/kg gain showed that the best feed efficiency (P<0.05) recorded by T4 followed by T3 or T2 and without significant difference among them compared with T1. These results were confirmed by the findings of Bock *et al.*[25] on sheep fed

Table 6:Effect of dietary fat source on the fattening performance of male lambs

	Treatment			
Items	T_1 Control	T_2 Tallow	T_3 Grease	T_4 Oil
Initial L.B.W(kg	36.56±1.66	36.44±1.58	36.44±1.64	36.39±1.83
Final L.B.W.(kg	59.13±2.98^{b}	61.39±2.25^{a}	61.44±1.41^{a}	64.39±2.83^{a}
Total gain(kg)	22.57±1.59^{b}	24.95±1.79^{ab}	25.00±0.97^{ab}	28.00±2.01^{a}
Average daily gain (g)	179.00±12.64^{b}	198.00±14.17^{ab}	198.00±7.72^{ab}	222.00±15.91^{a}
Feed intake				
DMI kg/h/day	1.74±0.03	1.75±0.02	1.75±0.03	1.74±0.01
TDNI g/h/day	984	1118	1069	1193
DCPI g/h/day	153	166	162	180
Feed efficiency				
Kg DMI/kg gain	9.72±0.86^{a}	8.84±0.73^{ab}	8.84±0.36^{ab}	7.84±0.61^{b}
Kg TDNI/kg gain	5.50±0.49	5.65±0.47	5.40±0.22	5.37±0.42
Kg DCPI/kg gain	0.85±0.08	0.84±0.07	0.82±0.34	0.81±0.06

a & b values with different letters on the same row differ at ($P< 0.05$)

Table 7: Economical evaluation for lambs fed different experimental rations

	Rations			
Items	T_1	T_2	T_3	T_4
Feed cost LE/ton	503.95	531.025	501.25	533.25
Feed cost LE/kg	0.50*	0.53*	0.50*	0.53*
Feed intake (kg/h/day)	1.74	1.75	1.75	1.74
Daily feed cost (L.E/h/day)	0.87	0.93	0.88	0.92
Kg DMI/kg gain	9.72	8.84	8.84	7.84
Feed cost/kg gain (L.E)	4.86	4.69	4.42	4.16
Net profit/kg gain (L.E)	6.14	6.31	6.58	6.84

*Based on the current prices of 2001, price/kg gain = L.E 11.00

3.5% tallow or soybean oil soap stock; Hutchison *et al.* [26] on steers fed diets containing 4% tallow or 4% grease and Brandt *et al.*[27] with steers supplemented with yellow grease and Moustafa *et al.* [28] on palm oil, who referred the improved feed efficiency to the significant intensification of energy of fat diets.

The improvement in lamb's performance in T4, T2 and T3 may be due to urea supplementation provided to meet microbial requirements from ammonia to synthesize its needs of microbial protein. On the other hand, fat supplementation prevented microorganisms to attack true proteins in the basal ration and this protein had an opportunity to by pass into the lower tract. Ensuring adequate NH_3-N in the rumen to supply the majority of N for microbial growth is the first priority in optimizing fermentative digestion of forage [3]. Also, Abou Ward, [29] showed that addition of fat, reduced NH_3 in the rumen, particularly with higher levels which need more N supplement. For this reason, urea in combination with fat might have increased NH_3 production in the rumen which enhanced microorganism's activity and this was consequently reflected on lamb's performance.

Economical evaluation: Feeding cost and net profit above feeding cost are shown in Table 7, T4 had the lowest Feeding cost followed by T3, T2 and T1 being 4.16, 4.40, 4.66 and 4.86 L.E/kg gain respectively, net profit values had higher for T4 followed by T3, T2 and T1 being 6.84, 6.60, 6.34 and 6.14 L.E/kg gain respectively based on the difference between feed costs and current selling price/kg gain.

CONCLUSION

It could be recommended to utilize 4% cotton seed oil in finishing rations of local lambs, however, type of ingredients formulated in the ration must be taken in consideration *i.e.* roughages type and levels (not more than 30%), in addition to grain percentages which might not exceeded more than 20%. It was recommended as the proper level, since nutrients digestibilities, DMI and rations palatability were not negatively affected at such level.

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