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EFFECT OF DIFFERENT FAT SOURCES ON THE PERFORMANCE AND CARCASS TRAITS OF GROWING LAMBS

(With 7 Tables)

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تأثير مصادر مختلفة من الدهون علي الأداء وصفات الذبيحة في الحملان النامية

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تم استخدام عدد 18 من حملان الرحماني لدراسة تأثير مصادر مختلفة من الدهون علي كفاءة الأداء ومعاملات هضم العناصر الغذائية وقياسات الكرش وصفات الذبيحة في تجربة استغرقت ثلاثة شهور. قسمت الحيوانات إلي ثلاث مجموعات تحتوي كل منها علي 6 حملان. تم تغذية المجموعة الأولي علي عليقة ضابطة (لا تحتوي علي دهون) بينما غذيت المجموعة الثانية والثالثة علي عليقة تحتوي علي 4٪ من الدهن الجاف و 4٪ الشحوم الحيوانية علي التوالى. احتوت كل العلائق علي طاقة هضم (3 ميجاكالوري/كجم عليقة) وبروتين خام (14.71٪) تفي باحتياجات الحملان في هذا العمر طبقا لجداول ان ار سى (1985) الخاصة بالأغنام وقد اثبتت النتائج وجود فروق معنوية في كل من وزن الجسم وكمية الأكل ومعدل التحويل الغذائي بين المجموعات المختبرة وقد سجلت المجموعة المغذاة علي 4٪ دهن جاف أعلي زيادة في وزن الجسم مع أحسن معدل تحويل غذائي. معدلات هضم العناصر الغذائية كانت أفضل في المجموعة المغذاة علي 4٪ دهن جاف مقارنة بالمجموعات الاخري. انخفض معنويا محتوي الكرش من الامونيا والأحماض الدهنية الطيارة بينما زاد معدل تصافي الذبيحة في الحملان المغذاة علي علائق تحتوي علي الدهون مقارنة بالمجموعة الضابطة. من هذه الدراسة نستنتج أن إضافة الدهن الجاف بنسبة 4٪ في علائق حملان الرحماني كان الافضل في كفاءة الأداء وهضم المواد الغذائية وصفات الذبيحة.

SUMMARY

Eighteen Rahmani lambs (initial body weight 30±1.3 kg and 5-6 months old) were used to determine the effect of different dietary fat sources on the performance, digestion coefficient of nutrients, ruminal parameters and carcass traits in a three months experiment. The animals were allotted into three groups, 6 animals per each. The animals of the first group were fed the control diet (without fat supplementation), while the

animals of the second and third groups were fed diets containing 4% dried fat and 4% tallow, respectively. All experimental diets were formulated to provide the recommended levels of digestible energy (3.0 Mcal/kg diet) and crude protein (14.71 %) according to NRC publication (1985) for sheep. There were a significant ($P<0.05$) differences in the average daily gain, daily feed intake (g/head/day), and feed conversion between the different experimental groups. Lambs fed ration contained 4% dried fat recorded the highest value in daily gain and the best feed conversion. The digestion coefficients of dry matter, crude protein, crude fibre and ether extract as well as the nutritive value (DCP and TDN) were significantly ($P<0.05$) higher for ration containing 4% dried fat followed by ration containing 4% tallow compared to the control one. Ruminal pH values were significantly higher ($P<0.05$) in lambs fed diet with 4% dried fat**.** Ruminal ammonia nitrogen and total volatile fatty acids concentrations were significantly ($P<0.05$) decreased with supplementation of fat compared to the control one. Dressing percentages were increased significantly ($P<0.05$) by feeding supplemental fat compared to the control group. It could be concluded that, lambs fed diet with 4% dried fat recorded the best performance and the highest digestibility and carcass traits.

***Key words**: Fat, performance, Carcass traits, lambs*

INTRODUCTION

Energy and protein are the two major limiting nutrients that affect the production potential of both small and large ruminants, owing to shortage of dry roughages, concentrates and green fodders (Anonymous, 2001). Productivity of ruminants can be enhanced by strategic supplementation with energy and protein rich feedstuffs (Preston and Leng, 1987). Interest in the use of fats as source of energy for ruminants is increasing in the tropics owing to their high energy density and low heat increment. Due to their high energy value, fat supplements may contribute to meeting the energy requirements of animals; furthermore, it may be cheaper in some circumstances to provide energy as fat rather than carbohydrates (Doreau and Chilliard, 1997). Fats may be added in the form of oil seeds, animals and vegetable fats to provide unsaturated and saturated fatty acids and ruminally protected fatty acids and the currently recommended maximum fat supplementation for ruminants is 6-7% of dry matter (El-Banna, 1999).

Feeding of fat to ruminants at 5-6% level in the ration would maximize the efficiency of nutrient utilization (Coppock and Wilks, 1991). However, feeding of free or unprotected fats in excess of 3-4% results in reduction in microbial activity in the rumen and depresses the digestion of cellulose (Czerkawski *et al.*, 1966; Henderson, 1973). Jenkins and Palmquist (1984) and Schauff and Clark (1989) reported that protected fat in the form of calcium soap allows normal rumen fermentation and digestibility of nutrients. Feeding fat has generally improved the body weight gain in fattening animals (White *et al.*, 1992). When selecting a fat supplement to be incorporated in ruminant feeds, some orders must be considered such as forage programe 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 (Abou-Ward, 1992). The objective of the present study was to investigate the effect of fat sources on the performance, digestibility, ruminal parameters and carcass traits of lambs.

MATERIALS and METHODS

Animals:

Eighteen Rahmani lambs (initial body weight 30±1.3 kg and 5-6 months old) were randomly distributed into three groups (6 lambs /group). Each lamb was kept in a metabolic cage. A daily ration was offered to each animal in its respective feed trough and tap water was freely available.

Diets and measurements:

The animals of the first group were fed the control diet (without fat supplementation), while the animals of second and third groups were fed diets containing 4% dried fat and 4% tallow, respectively. The experimental rations were formulated to contain the recommended levels of digestible energy 3.00 Mcal/kg, crude protein 14.71% according to the NRC (1985) for sheep as shown in Tables 1 and 2. The experiment extended for 3 months. Data were recorded weekly concerning live weight and feed consumption for computing the average daily gain, average daily feed intake and feed conversion.

Table 1: Chemical composition and energy value of feed ingredients

Ingredients	DM	On dry matter, %							DE (Mcal/kg)
		CP	EE	CF	NFE	Ash	Ca	P	
White corn	89.0	10.0	4.0	2.4	81.4	2.2	0.03	0.31	3.53
Soybean meal	89.0	49.6	3.40	7.0	33.50	6.5	0.36	0.75	3.56
Wheat bran	89.0	18.0	4.0	11.0	62.60	4.4	0.12	1.32	3.08
Wheat straw	90.0	4.2	2.0	42.0	38.50	13.30	0.21	0.08	2.02
Dried fat*	96.3	4.7	60.0	3.3	11.0	21.0	2.75	0.42	6.20
Tallow	100	0.0	100	0.0	0.00	0.0	0.00	0.00	8.50
Limestone	90.0	0.0	0.00	0.0	0.00	100	38.0	0.00	0.00

DM: dry matter, CP: crude protein, EE: ether extract, CF: crude fibre, NFE: nitrogen free-extract; Ca: calcium, P: phosphorus

* Dried fat composed of: 30% cottonseed oil, 20% soybean oil, 10% sunflower oil, 10% palm oil, 29.98% wheat bran and 0.02% antioxidant (BHT).

Table 2: Composition (%) of the experimental rations

Item	Treatment		
	Control	4% dried fat	4% tallow
Ingredients:			
White corn	42.00	29.00	20.40
Soybean meal	13.10	14.10	15.00
Wheat bran	16.00	18.00	20.00
Wheat straw	27.00	33.30	38.80
Dried fat/Tallow	00.00	4.00	4.00
Limestone, ground	1.00	0.70	0.90
Common salt	0.50	0.50	0.50
Mineral mixture*	0.30	0.30	0.30
AD_3E**	0.10	0.10	0.10
Chemical composition:			
DM	88.48	88.83	88.31
CP	14.71	14.72	14.71
EE	3.25	5.43	6.91
CF	15.03	17.79	20.04
Ash	7.06	8.32	8.37
NFE	59.95	53.74	49.97
Calcium	0.52	0.53	0.50
Phosphorus	0.46	0.49	0.46
DE (Mcal/kg diet)	3.00	3.00	3.00

*Mineral mixture contain (g/kg): 40 Fe; 6.3 Mn; 44.9 Zn; 0.5 Cu; 0.4 I; 0.03 Se; 0.5 Co, 153.9 NaCl and 122.8 Mg.

** Vitamin AD_3E, Each g contains 20000 IU Vit. A; 2000 IU Vit.D3 and 400 IU Vit.E.

Digestibility trials:

At the end of the experiment, a digestion trial was conducted for 7 days to assess the digestibility of different dietary nutrients, in which the animals were fed a fixed weight of ration. Representative fecal samples were collected over the period of 7 days and were subjected to chemical analysis according to AOAC (1990).

Rumen liquor samples:

At the end of the experiment, rumen liquor was collected by stomach tube from each animal just before feeding in clean and sterile flask, then aliquots from the filtrate were used to determine the volatile fatty acids (VFAS) and ammonia concentrations. As soon as the rumen fluid samples were obtained, pH was immediately measured by pH meter. Total volatile fatty acids and ammonia concentrations were determined by gas-liquid chromatography (Intersmat, IGC 120 FB).

Carcass traits:

At the end of the experiment, three animals were selected from each treatment and starved for 24h; while water was provided ad-libitum. Live body weights at slaughter, dressed carcass, edible organs and body fat weights were recorded.

Economical efficiency:

Economical efficiency was calculated as the ratio between income (price of weight gain) and the cost of feed consumed.

Statistical analysis:

The data were subjected to statistical analysis (SAS, 1990). Duncan's (1955) multiple range test were utilized to detect differences among groups

RESULTS

The performance of lambs fed the different experimental rations is shown in Table 3. The feed intake was low in the experimental groups compared to the control group. The weight gain was increased by 38.58% and 12.64% in lambs fed on diets with 4% dried fat and 4% tallow, respectively in comparison with that of the control one. The feed conversion was better in the lams fed diet with 4% dried fat (5.95) followed by those fed on diet with 4% tallow (7.32) and the control one (8.96).

Table 3: Effect of fat source on the performance of lambs

Item	Treatment		
	Control	4% dried fat	4% tallow
Initial weight (kg)	30.15±1.20	30.44±1.35	30.25±1.10
Final weight (kg)	46.53±1.98 [b]	53.14±2.01 [a]	48.70±1.90 [b]
Total weight gain (kg)	16.38±1.02 [b]	22.70±1.10 [a]	18.45±1.05 [b]
Average daily gain (gm)	182.00±7.89 [b]	252.00±9.45 [a]	205.00±7.90 [b]
Average daily feed intake (Kg)	1.63±0.01 [a]	1.50±0.02	1.50±0.05 [b]
Feed conversion	8.96±0.90 [a]	5.95±0.75 [b]	7.32±0.80 [ab]

Figures in the same row having the same superscripts are not significantly different (P<0.05)

Data in Table 4 revealed that adding fat to the ration of lambs improved digestion coefficients of dry matter by 19.98 and 12.59%, crude protein (16.45 and 7.08%), crude fibre (78.84 and 51.98%), ether extract (10.44 and 6.65%) and nitrogen free-extract (1.44 and 6.63%) for rations with 4% dried fat and tallow respectively compared with control one. Highest values of digestible crude protein and total digestible nutrients were observed in groups fed on the rations containing 4% dried fat and 4% tallow respectively, compared with control one (9.88, 70.38; 9.08, 67.22 and 8.48, 62.37 respectively).

Table 4: Effect of fat source on nutrients digestibility and nutritive value

Item	Treatment		
	Control	4% dried fat	4% tallow
Digestion coefficient (%):			
Dry matter	52.76±1.05 [c]	63.30±0.98 [a]	59.40±0.97 [b]
Crude protein	57.62±0.70 [c]	67.10±0.86 [a]	61.70±0.95 [b]
Crude fibre	25.80±1.03 [c]	46.14±1.10 [a]	39.21±1.05 [b]
Ether extract	68.12±1.97 [b]	75.23±2.01 [a]	72.65±1.65 [ab]
Nitrogen free-extract	75.12±0.38 [b]	80.20±0.68 [b]	78.00±0.75 [a]
Nutritive value (%):			
Digestible crude protein	8.48±0.05 [b]	9.88±0.08 [a]	9.08±0.04 [ab]
Total digestible nutrients	62.37±1.10 [b]	70.38±1.50 [a]	67.22±1.25 [a]

Figures in the same row having the same superscripts are not significantly different (P<0.05)

Rumen parameters of lambs fed on different experimental rations were presented in table 5. Ruminal pH was higher in groups fed on

rations containing 4 % dried fat and tallow (6.23 and 6.08, respectively) compared to the control one (5.77). Ruminal ammonia nitrogen and volatile fatty acid concentrations were decreased in lambs fed on rations containing 4% dried fat and 4% tallow compared with the control one (4.35, 13.05; 4.76, 12.25 and 7.12, 15.20 respectively).

Table 5: Effect of fat source on the ruminal parameters

Item	Treatment		
	Control	4% dried fat	4% tallow
pH	5.77±0.02 [b]	6.23±0.01 [a]	6.08±0.08 [a]
NH3-N mg/100ml	7.12±0.35 [a]	4.35±0.60 [b]	4.76±0.45 [b]
TVFAs mg/100ml	15.20±0.56 [a]	13.05±0.70 [b]	12.25±0.40 [b]

Figures in the same row having the same superscripts are not significantly different (P<0.05)

The carcass traits of lambs fed on the experimental rations were shown in Table 6. The dressing percentage was increased by 11.74 and 10.83 % in lambs fed on diets supplemented with 4 % dried fat and 4 % tallow, respectively in comparison with those fed on the control diet. Fat deposition was increased in the abdomen, pelvic and kidney of lambs fed on fat supplemented diets.

Table 6: Effect of fat source on the carcass traits of lambs

Item	Treatment		
	Control	4% dried fat	4% tallow
Pre-slaughter weight (kg)	40.98±2.50 [b]	47.15±2.35 [a]	41.85±2.20 [b]
Dressed carcass wt. (kg)	22.58±1.22 [b]	29.03±1.50 [a]	25.56±1.35 [b]
Dressing (%)	55.10±0.01 [b]	61.57±0.04 [a]	61.07±0.02 [a]
Heart (%)	0.80±0.03	0.85±0.02	0.83±0.05
Kidneys (%)	0.51±0.07	0.55±0.03	0.54±0.01
Liver (%)	2.50±0.20	2.81±0.10	2.79±0.30
Lungs (%)	2.21±0.15	2.23±0.35	2.20±0.18
Abdominal fat (kg)	1.28±0.10 [b]	1.35±0.25 [a]	1.32±0.13 [a]
Pelvic fat (kg)	0.33±0.01 [b]	0.39±0.03 [a]	0.37±0.02 [a]
Perinephric fat (kg)	0.42±0.06 [b]	0.48±0.01 [a]	0.46±0.05 [a]
Pericardial fat (kg)	0.27±0.02 [b]	0.30±0.05 [a]	0.31±0.01 [a]

Figures in the same row having the same superscripts are not significantly different (P<0.05)

Economical evaluation:

As presented in Table 7, feed costs (LE) of live body gain and economic feed efficiency were calculated. The diet contained 4% dried fat showed to be superior in economic feed efficiency (127.23%) compared to that contained 4% tallow (111.89%) and control one (89.47%).

Table 7: Economical evaluation of experimental rations

Items	Treatment		
	Control	4% dried fat	4% tallow
Total feed cost (L.E)	173.11	199.80	174.15
Body weight gain (Kg)	16.38	22.70	18.45
Price of body weight gain (L.E)	328	454	369
Net revenue (L.E)	154.89	254.20	194.85
Economic feed efficiency (%)	89.47	127.23	111.89
Relative economic feed efficiency (%)	100	142.2	125.05

DISCUSSION

Growth performance:

A significant difference ($P<0.05$) in the daily feed intake (g/head/day) was recorded between the lambs fed the different experimental rations as shown in Table 3, a result which are in line with the finding of Son *et al.* (2000), Khattab *et al.* (2001) and Montgomery *et al.* (2005) they found a negative effects of fat supplementation on dry matter intake of animals. There was a significant ($P<0.05$) difference in the average daily gain between the different experimental groups and the lambs fed ration contained 4% dried fat recorded the highest value. Similar results were obtained by Plascencia *et al.* (1999). However, Clary *et al.* (1993) found that 4% tallow tended to increase the average daily gain. On contrast, El-Bedawy *et al.* (1996) reported that addition of fat did not affect average daily gain. There was a significant ($P<0.05$) difference in the feed conversion between experimental groups as the animal group fed 4% dried fat recorded the best feed conversion followed by that fed 4% tallow. These results were in agreement with those found by Bock *et al.* (1991); Brandt *et al.* (1992); Moustafa *et al.* (1995) and Hutchison *et al.* (2006) who reported the improved feed conversion to the significant intensification of energy of fat diets.

Digestion coefficient of nutrients:

The present findings indicated a significant (P<0.05) differences in the digestion coefficients of nutrients between different experimental groups. The digestion coefficients of dry matter, crude protein, crude fibre and ether extract as well as the nutritive values (DCP and TDN) were significantly (P<0.05) higher for the ration containing 4% dried fat followed by that containing 4% tallow compared to the control one. Generally, adding fat to the ruminant ration improved the digestion coefficients of nutrients and nutritive values; these might be due to the effect of high energy of fat which is converted efficiently to net energy (Abou-Ward *et al.,* 2008). The results are in accordance with those of Bayourthe *et al.* (1993) who reported that digestion coefficient of nutrients was increased with supplemented fat. Hussein *et al.* (1995) reported that, addition of fat to the diet of sheep had a significant effect on the digestion coefficient of dry matter and crude protein. It has been noted in previous studies that, the inclusion of lipid into the diet increased the digestibility of fat (Jenkins and Palmquist, 1984; Bayourthe *et al.,* 1993 and Sayed *et al.,* 2003). The higher digestibility of fat associated with fat supplementation might be due to the higher digestibility of the supplementary fat and in line the smaller effect of endogenous lipid excretion on apparent fat digestibility (Abel *et al.,* 1988 and Ryanto, 1989).

Ruminal parameters:

Ruminal pH was significantly (P<0.05) higher in group fed on 4% dried fat followed by that fed on 4% tallow and lowest pH value was found in control group. Similar results were reported by Benchaar *et al.* (2007). However, Abdullah *et al.* (2000) found that ruminal pH was not affected by different sources of fat supplementation. Ruminal ammonia nitrogen concentration was significantly (P<005) decreased with supplementation of fat compared to the control one. Similar results were reported by Nangia and Sharma (1994) and Onetti *et al.* (2001). The reduction in ruminal ammonia concentration when fat is included in the diet has been associated with reduced numbers of protozoa (Ikwuegbu and Sutton, 1982; Broudiscou *et al.,* 1994) and decreased recycling of microbial nitrogen. On contrast, Tjardes *et al.* (1998) found that ruminal ammonia nitrogen was not affected by adding fat to the diets.

Total volatile fatty acids (VFAs) concentrations were significantly (P<0.05) decreased with supplementation of fat in comparison with the control. This result was consistent with that reported by El-Bedawy (1995) who found that feeding ration supplemented with oil led to decrease in the concentration of VFAs.

Abdullah *et al.* (2000) found that TVFAs were not affected by addition of fat.

Carcass traits:

Dressing percentages were increased significantly ($P<0.05$) by feeding supplemental fat. This result coincides with that reported by previous studies (Brandt *et al.*, 1988$_{a, b}$; Zinn, 1989; Plascencia *et al.*, 1999; Felton and Kerley, 2004 and Nelson *et al.*, 2004). The increased dressing percentage was likely due in part to increased internal cavity (kidney, pelvic) fat, which commonly occurs with supplemental fat feeding (Brandt *et al.*, 1988 $_{a, b}$ and Zinn, 1988, 1989).

Economical evaluation:

Lambs fed diet with 4% dried fat achieved the highest values in net revenue and economical feed efficiency compared to lambs fed diet with 4 % tallow or the control ones.

From the present study, it can be concluded that, addition of dried fat to the lamb diets recorded higher performance, nutrient digestibility, ruminal parameters and carcass characteristics than tallow.

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