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EFFECT OF DIETARY PROTECTED FAT AND ROUGHAGE LEVEL ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING-FINISHING LAMBS

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SUMMARY

Sixty male Barki lambs (age 8 month, weight 27.5 Kg) in six similar groups were fed diets containing 10 % or 30 % berseem hay with 0, 4 and 8% Ca -Soaps for 70 days. Feed intakes and body weight were weekly recorded. At the end of the experiment, three lambs from each group were slaughtered to study the effect of protected fat and roughage levels on carcass characteristics and mutton quality.

Increasing fat level in diet (P>0.05) increased total body weight gain and average daily gain (ADG). The 8% fat level improved feed conversion ratio (DM and DCP to gain ratio) by 6.4% and 14.3%, respectively. Lambs fed low roughage- high fat showed better body weight gain (16.76 kg); average daily gain (240g /day) and feed conversion ratio (4.5 DM intake/gain and 0.61 DCP intake/gain). Roughage level had no significant effect on body weight gain, average daily gain and feed conversion ratio.

Dietary fat level or roughage or their interaction had no significant effect on carcass weight and dressing percentage. Feeding rations containing protected fat had no significant effect on physical properties of meat except the increased (P<0.05) tenderness of the eye muscle of sheep fed 8% fat diets. Protected fat supplement (P<0.05) increased weights of omentum fat, intestinal fat, kidneys fat and total body and ether extract of eye muscle and liver but decreased (P<0.05) protein content of eye muscle. Feeding protected fat had no significant effect on fatty acid composition of eye muscle lipids, except the (P<0.05) higher lauric acid (C12:0) of 4% fat group.

Neither fat nor roughage level had significant effect on eye muscle area, eye muscle weight and physical composition of the best 9,10 and 11 th ribs (percentages of lean, fat and bone).

Results of chemical composition of whole 9, 10 and 11th ribs showed that feeding protected fat diets (P<0.05) increased DM and ether extract but decreased (P<0.05) CP percentages compared to the control (0% fat). Ash percentage was not significantly changed.

Feeding protected fat to growing lambs resulted in higher average daily gain and higher carcass fats, but it did not alter the percentage of unsaturated fatty acids in carcass fat. Roughage level had no significant effect on either the growth performance or carcass characteristics. (The greater intake of digestible energy by the lambs fed calcium soaps of palm oil may account for the higher average daily gains and fatter carcasses).

Keywords: sheep, calcium soaps, carcass characteristics, meat quality

INTRODUCTION

In ruminants, dietary unsaturated fatty acids are extensively biohydrogenated by ruminal microorganisms and the predominant class of fatty acids absorbed are saturated' FA; which favor synthesis of very-low-density lipoprotein (Byers and Schelling, 1988). Dietary modifications to reduce saturated fatty acids and/or increase polyunsaturated fatty acids in tissues therefore, more difficult to achieve in ruminants than in nonruminants. However, modifying tissue lipids can be achieved by feeding ruminants feedstuffs with ruminal escape characteristics (Solomon *et al*., 1991; Lough *et al*., 1992).

The objectives of this study were to examine the effects of high-forage diets without or with different levels of protected fat fed on performance and carcass characteristics of growing lambs.

MATERIALS AND METHODS

Sixty male Barki lambs aged 8 months and averaged 27.5 kg body weight were randomly divided into six similar groups, each of ten lambs. Lambs were fed at level of 3.5% DM of body weight for 70 days six diets containing 10 % or 30 % berseem hay as roughage (low and high roughage levels) and Ca -Soaps with three levels 0, 4 and 8% (low, medium and high fat) or (LF, MF and HF, respectively) of dietary DM. The experimental rations were almost iso-nitrogenous but not iso-energetic. Ingredient, chemical composition and nutritive value of the experimental rations are presented in Table 1.

Animals were weighed once a week before feeding at 8:00 hrs. Fresh water was available for free choice consumption. Feed intakes and body weight were weekly recorded.

Eighteen animals (three from each group) were slaughtered at the end of the experiment to study the effect of feeding protected fat and roughage level on carcass characteristics and mutton quality.

Slaughter technique

Animals were weighed after 12 hrs fasting, just before slaughtering. After complete bleeding, head, skin and feet were removed and weighed. Internal organs and offals (heart, lungs, liver, testes, spleen, kidneys and digestive tract) were removed and individually weighed. Body fats including tail, momentum, intestinal fat, kidney fat and scalpel separable fats were weighed and represented as a percentage of slaughter weight

The best ribs cut

The best 9,10 and 11^{th} ribs were removed and kept frozen in polyethylene bags for later physical and chemical analyses. Best ribs were dissected using scalpel into lean, fat and bone. Eye (*longissimus dorssi*) muscle area was measured in squared centimeters using planimeter (Henderson *et al*. 1966).

Chemical composition

Samples of eye muscle lean, liver and heart were dried and analyzed for DM, EE and ash (A.O.A.C., 1984) while CP percentage was calculated by difference (O'Mary *et al*. 1979). Ether extract of lean was used for fatty acid analysis using gas liquid chromatography technique (Mason and Waller, 1964).

Table 1. Ingredient, chemical composition and nutritive value of the experimental rations

Item	10 % roughage			30 % roughage		
	Calcium soap, %			Calcium soap, %		
	0	4	8	0	4	8
Feed ingredient, %						
Concentrate mix.	89.7	85.2	81.7	73.5	70.2	66.9
Berseem hay	10.3	10.6	10.3	26.5	25.6	25.1
Protected fat	0	4.2	8.0	0	4.2	8.0
Chemical analysis, %						
DM	89.32	89.52	89.48	90.68	91.06	91.45
DM composition%						
OM	94.18	93.62	93.04	93.20	92.66	92.14
CP	19.38	19.07	18.81	19.09	18.75	17.35
EE	2.90	6.37	9.84	2.65	6.12	9.59
CF	5.22	5.27	5.16	9.65	9.61	9.91
NFE	66.68	62.91	59.23	61.81	58.18	55.29
Ash	5.82	6.38	6.96	6.80	7.34	7.86
Nutritive value						
DE Mcal/ kg DM *	3.291	3.531	3.638	3.061	3.338	3.470
TDN % *	74.16	80.19	79.64	69.01	76.68	77.62
DCP % *	14.11	13.88	13.48	13.08	13.48	11.96

Concentrate mix., composed of 60% yellow corn, 20% soybean meal, 17% wheat bran, 0.8% sodium chloride, 1.2% limestone and 1% minerals.
* Were determined from digestion trial.

Physical characteristics

pH value

Samples of 2 g of eye muscle lean in 100 ml distilled water were shaken for 10 minutes. The pH was measured in filtrate using Orion Research (model 201) digital pH meter (Aitken *et al*. 1962)

Water holding capacity

Water holding capacity (WHC) % was determined by weighing about 0.3 g of eye muscle on filter paper between two glass cover (20 x 20 cm x 6 mm) under pressure of one kg for 10 minutes. Water holding capacity was estimated as weight difference percentage (Grau and Hamm, 1957).

Cooking loss %

Samples of lean were cut into (2 x 1 x 1 cm) cubes, weighed and boiled in saline solution (9 g sodium chloride / liter distillated water) for 30 minutes. Cooking loss was calculated as weight difference percentage.

Tenderness

Samples which were previously used in cooking loss determination were used to measure tenderness by using 50 lb. Warner-Bratzler Shear Force (Grau and Hamm, 1957).

Statistical analysis

Collected data were subjected to statistical analyzed as two factor factorial analysis of variance (Snedecor and Cochran, 1984). Duncan's Multiple Range Test (Duncan, 1955) was used to separate means when the dietary treatment effect was significant according to the following model:

$Y_{ijk} = \mu + F_i + R_j + (FR)_{ij} + e_{ijk}$

Where:

Y_{ijk} = Observation

μ = Overall mean.

F_i = Effect of dietary fat level for i = 1- 3
1 = No fat, 2 =4% fat and 3 = 8% fat

R_j = Effect of roughage levels for j =1-2,
1=10% hay and 2= 30% hay.

$(FR)_{ij}$ = the FxR interaction

e_{ijk} = the experimental error.

RESULTS AND DISCUSSION

Daily dry matter and nutrient intakes during the 70-day experimental period are shown in Table 2. The mean values of concentrate intake by lambs fed high roughage level ranged from 754 to 762 g /day, while, it ranged from 874 to 912 g/day for lambs fed low roughage diets. On the other hand, roughage intake ranged from 275 to 285 g /h /day for high roughage level but it ranged from 105 to 111 g /h /day for lambs fed low roughage level.

Digestible energy (DE) and TDN intakes were ($P<0.05$) higher for protected fat supplemented group than the control (no added fat). Interaction between roughage and fat was not significant on DE and TDN intakes. These results were in agreement with those found by El-Bedawy (1995) that TDN intake increased by fat addition in sheep diets.

No significant differences ($P>0.05$) in digestible crude protein (DCP) intake among the experimental groups were detected. Bendary *et al*. (1994); El-Bedawy *et al*. (1996b) and El-Bedawy *et al*. (2004a) reported that fat addition had no significant effect on DCP intake.

Data in Table 3 showed that mean effects of dietary treatments on body weight gain, average daily gain and feed conversion ratio were not significant ($p>0.05$). However, increasing fat level tended to increase total weight gain and average daily gain (ADG). Contradicting responses in ADG to fat feeding were reported. However, Cameron and Hougue (1968); Zinn (1989); White *et al*. (1992); Pinosa *et al*. (1992); Huffman *et al*. (1992); Maiga *et al*. (1995); Chrzaszcz *et al*. (1995) and Wettestein *et al*. (1999) found that added fat to the diet had no significant effect or decreased average daily gain. El- Bedawy *et al*. (1996b); Zinn and Plascencia (1996) and

Plascencia *et al*. (1999) reported that body weight gain and average daily gain increased by fat supplement.

Table 2. Daily dry matter, energy and nutrient intakes by the experimental groups

Item	10% roughage diets			30% roughage diets			SEM
	0	4	8	0	4	8	
Av. body weight (kg)	34.6	34.8	35.9	34.5	34.8	35.2	1.0
Concentrate mix. (g)	912	874	882	762	754	758	33
Berseem hay (g)	105	109	111	275	275	285	10
Protected fat (g)	0	43	87	0	45	90	2
Dry matter							
g /day	1017	1026	1080	1037	1074	1133	44.0
g / kg $W^{0.75}$	71.30	71.61	73.67	72.80	74.90	78.48	3.06
Kg/100 kg BW	2.94	2.95	3.01	3.00	3.08	3.22	0.13
DE (Mcal)							
Mcal/ day	2.93^{b}	2.99^{b}	3.52^{ab}	2.71^{b}	3.26^{ab}	3.90^{a}	0.21
Mcal/100 kg BW	8.5^{b}	8.6^{b}	9.8^{ab}	7.9^{b}	9.4^{ab}	11.1^{a}	0.6
Kcal/ Kg $W^{0.75}$	205^{b}	209^{b}	240^{ab}	190^{b}	227^{ab}	270^{a}	15
TDN							
g/day	755^{bc}	823^{ab}	860^{a}	716^{c}	823^{ab}	879^{a}	33.5
g / kg $W^{0.75}$	52.9^{bc}	57.4^{abc}	58.7^{ab}	50.3^{c}	57.4^{abc}	60.9^{a}	2.30
Kg/100 kg BW	2.18^{bc}	2.37^{ab}	2.40^{ab}	2.07^{c}	2.36^{ab}	2.50^{a}	0.09
DCP							
g /day	143	142	146	136	145	136	6
g / kg $W^{0.75}$	10.0	9.9	10.0	9.6	10.1	9.4	0.4
g/100 kg BW	413	408	407	394	416	387	2

[a,b,c] Means in the same row having different superscripts ($P<0.05$) differ.

Table 3. Main effects of dietary treatments on body weight gain and feed conversion of the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
Initial weight, kg	27.5	27.5	27.5	0.5	27.5	27.5	0.4
Final weight, kg	41.6	42.1	43.5	0.9	42.6	42.2	0.8
Gain, kg	14.1	14.6	16.0	0.7	15.1	14.7	0.6
ADG, g /day	202	209	229	10	217	210	10
Feed conversion ratio (kg / kg gain)							
Dry matter	5.32	5.17	5.00	0.25	5.00	5.32	0.21
TDN	3.80	4.05	3.93	0.19	3.90	3.96	0.15
DCP	0.72	0.71	0.63	0.03	0.69	0.68	0.03

Feeding 8% fat containing rations insignificantly improved feed conversion ratio (DM and DCP to gain ratio) by 6.4% and 14.3% , respectively, but decreased TDN conversion ratio by 3.4%. These results might be related to the increase in energy intake of fat supplemented groups, which had not met by parallel increase in ADG and/or the possible change in body composition. Christie (1981) reported that dietary fat tended to promote body fat deposition with limited change in ADG.

Feeding high roughage level had no significant effect on body weight gain, average daily gain and feed conversion ratio. Bartle *et al.* (1994) and Zinn and Plascencia (1996) found that feeding high forage level (30% alfalfa hay) insignificantly decreased (P>0.05) final live body weight, body weight gain, average daily gain and feed efficiency compared to low roughage level (10% alfalfa hay) .

Data in Table 4 showed that there were no interaction between roughage level and supplemental fat (FXR) on growth performance of the experimental groups, but lambs fed low roughage- high fat showed the highest values of body weight gain (16.8 kg); average daily gain (240g /day) and feed conversion ratio (4.5 DM intake/gain and 0.61 DCP intake/gain). Bartle *et al*. (1994) and Zinn and Plascencia (1996) found that there were no interactions between forage level and supplemental fat on body weight gain, average daily gain and feed efficiency.

Table 4. Effect of protected fat and roughage level on body weight gain and feed conversion of the experimental groups

Item	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
No., of animals	10	10	10	10	10	10	
Initial weight, kg	27.5	27.5	27.5	27.5	27.5	27.5	0.8
Final weight, kg	41.7	42.1	44.3	41.6	42.2	42.8	1.3
Gain, kg	14.2	14.6	16.8	14.1	14.7	15.3	1.0
ADG, kg /day	203	209	240	201	210	219	10
Feed conversion ratio (kg / kg gain)							
Dry matter	5.01	4.91	4.50	5.16	5.11	5.17	0.35
TDN	3.72	4.93	3.58	3.56	3.92	4.01	0.27
DCP	0.70	0.68	0.61	0.68	0.69	0.62	0.05

Increasing dietary fat level had no significant effect on carcass weight and dressing percentage (Table 5). These results were in agreement with those found by Zinn and Plascencia (1996); and Kerley's (2002) which found that supplemental fat had no significant effect on carcass weight and dressing percentage. However, Mc Cartor and Smith (1978); Zinn (1992) and Bendary *et al*. (1994) found that hot carcass weight and dressing percentage increased by feeding fat containing rations. On the other hand, Ngidi *et al*. (1990) recorded that hot carcass weight linearly decreased with increasing calcium soaps of long-chain fatty acids level from 2% to 6% in the diet fed to crossbred steers.

Roughage level had no significant effect (P>0.05) on carcass weight and dressing percentage. These results were in agreement with data obtained by Zinn and Plascencia (1996) that roughage level had no significant effect or decreased carcass weight and dressing percentage.

Data in table 6 showed that there were no interactions between roughage level and supplemental fat level (FXR) on slaughter weight, carcass weight and dressing percentage.

Table 5. Main effects of dietary treatments on carcass weight and dressing Percentage of the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
Slaughter weight, kg (SW)	41.98	39.43	41.88	0.72	41.16	41.04	0.72
Carcass weight, (kg)	19.48	18.67	19.85	0.39	19.51	19.15	0.35
Dressing percentage	46.39	47.40	47.39	0.73	47.45	46.67	0.59

Table 6. Carcass weight and dressing percentage of the experimental groups

Item	Low roughage			High roughage			SEM
	HF	MF	HF	LF	MF	HF	
Slaughter weight, kg	42.97	39.50	41.00	41.00	39.37	42.77	0.92
Carcass weight, kg	20.07	18.82	19.65	18.88	18.52	20.05	0.50
Dressing percentage	46.71	47.65	47.93	46.05	47.04	46.88	1.11

Physical properties as pH, water holding capacity, cooking loss % and tenderness of the eye muscle of the experimental groups were presented in Table 7. Feeding protected fat containing rations had no significant effect on physical properties of meat, except increased ($P<0.05$) tenderness of the eye muscle of sheep fed 8% fat diets. El-Bedawy *et al* (1996a) reported higher pH of the muscle extraction for fat supplemented group being 6.00 compared with 5.78 for the control. However, El-Bedawy *et al.* (2004b) showed that fat supplementation had no significant effect on pH, cooking loss percentage, expressible fluid percentage and fiber diameter.

Roughage level had no significant effect on physical characteristics of the eye muscle of the experimental lamb groups. Data in Table 8 showed that there were no interactions between roughage and supplementary fat levels on pH values and water holding capacity. While there was significant interaction on cooking loss and tenderness, increasing protected fat with low roughage level increased the tenderness of eye muscle.

Table 7. Main effects of dietary treatments on physical characteristics of the *Longissimus dorsi* muscle for the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
pH	5.69	5.70	5.69	0.01	5.69	5.68	0.01
Water holding capacity	18.6	19.1	17.7	1.1	18.4	18.6	0.9
Cooking loss	42.6^{a}	39.0^{b}	41.6^{a}	0.8	41.8	40.3	0.9
Tenderness	3.45^{b}	3.53^{ab}	3.66^{a}	0.02	3.57	3.52	0.03

^{a,b} Means within each treatment having different superscripts ($P<0.05$) differ

Protected fat supplement ($P<0.05$) increased ether extract content of eye muscle and liver but decreased ($P<0.05$) protein content of muscle. Ash content of muscle was lower for the 8% fat level (Table 9). El-Bedawy (1989); Bendary *et al*. (1994); El- Bedawy *et al*. (1996a); El-Bedawy *et al.* (2004b); Abdelhamid *et al*. (2003) and El- Kholy *et al*. (2003) found that feeding fat containing diets for goat, sheep and calves had no significant effect on chemical composition of eye muscle but Abo-Donia *et al*. (2003) found that addition of 5% calcium salts of soap-stock in Ossimi lamb rations ($P<0.05$) increased DM, EE and ash content of the eye muscle.

Table 8. Physical characteristics of the *longissimus dorsi* muscle for the experimental groups

Item	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
pH value	5.69	5.70	5.69	5.68	5.69	5.69	0.01
Water holding capacity	18.7	19.0	17.4	18.6	19.2	17.9	1.6
Cooking loss	42.1[b]	38.8[c]	44.6[a]	43.1[ab]	39.3[c]	38.6[c]	0.76
Tenderness	3.47[cd]	3.55[bc]	3.69[a]	3.40[d]	3.50[c]	3.62[ab]	0.02

[a,b] Means in the same row having different superscripts (P<0.05) differ.

Roughage level showed no significant effect on chemical composition of eye muscle, liver and heart. Data in Table 10 showed significant (P<0.05) roughage fat interaction on DM and ash percentages of eye muscle. Lambs those fed low roughage- high fat showed the highest values of EE but lowest ash contents.

Table 9. Main effects of dietary treatments on chemical composition of muscle, liver and heart for the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
Eye muscle							
DM	31.85	34.08	33.69	1.17	33.58	32.83	1.01
CP	70.29[a]	63.30[b]	60.45[b]	2.20	63.75	65.62	2.27
Ether extract	26.39b	33.89a	36.72a	2.43	33.25	31.41	2.40
Ash	3.32	2.81	2.83	0.18	3.00	2.97	0.16
Liver							
DM	30.43	29.98	30.45	0.48	29.99	30.58	0.40
CP	83.20	81.90	80.91	0.79	82.91	81.10	0.64
Ether extract	11.54[b]	13.08[a]	14.08[a]	0.65	12.27	13.76	0.61
Ash	5.26	5.02	4.66	0.39	4.82	5.14	0.34
Heart							
DM	28.36	27.77	26.94	1.32	28.02	27.35	1.07
CP	57.91	54.42	60.55	3.93	56.02	59.25	3.19
Ether extract	38.45	41.90	34.16	4.09	39.66	36.67	3.38
Ash	3.64[b]	3.68[b]	5.29[a]	0.37	4.32	4.08	0.40

[a,b] Means within each treatment having different superscripts (P<0.05) differ.

Main effects of dietary treatments on total body fats are shown in Table 11. Feeding protected fat (P<0.05) increased weights of omentum fat, intestinal fat, kidneys fat and total body fat. These results were in agreement with those found for sheep (El- Bedawy, 1989) and for steers (Haaland *et al*., 1981; Zinn, 1992, White *et al*., 1992 and Bartle *et al*., 1994 and Zinn and Plascencia, 1996) and for growing-finishing bulls El-Bedawy *et al*. (2004b). However, Teixeira *et al*. (1989); Ngidi *et al*. (1990) and Bock *et al*. (1991) found that fat supplementation had no significant effect on kidneys fat percentage.

No significant differences in the percentage of total body fat weights to slaughter weight of sheep fed either low or high roughage rations. Bartle *et al*. (1994) and Zinn and Plascencia (1996) found that dietary forage level did not increase or sometimes decreased fat thickness, KPH and carcass fats.

Table 10. Chemical composition of muscle, liver and heart for the experimental groups

Item	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
Eye muscle							
DM	31.72	33.35	35.67	31.99	34.80	31.70	1.52
CP	70.19[a]	66.27a[b]	54.79[c]	70.39[a]	60.31b[c]	66.13[ab]	2.07
Ether extract	26.35[c]	30.71[bc]	42.68[a]	26.42[c]	37.08[ab]	30.75[bc]	2.24
Ash	3.46	3.02	2.53	3.19	2.61	3.12	0.20
Liver							
DM	29.12[b]	30.48[ab]	30.38[ab]	31.73[a]	29.48[b]	30.52[ab]	0.47
CP	82.92[a]	83.00[a]	82.81[a]	83.48[a]	80.80[ab]	79.01[b]	0.66
Ether extract	11.12[b]	12.86[b]	12.82[b]	11.95[b]	13.30[b]	16.04[a]	0.70
Ash	5.96[a]	4.14[b]	4.37[b]	4.57[ab]	5.90[a]	4.95[ab]	0.36
Heart							
DM	29.30	27.44	27.33	27.42	28.10	26.54	1.97
CP	56.84	55.687	55.53	58.98	53.18	65.57	5.58
Ether extract	40.06	40.37	38.56	36.83	43.42	29.76	5.86
Ash	3.10[b]	3.95[b]	5.91[a]	4.19[b]	3.40[b]	4.67[ab]	0.42

[a,b,c] Means in the same row having different superscripts ($P<0.05$) differ

Data in Table 12 showed that there were no forage- fat interaction on body fat weights. Zinn and Plascencia (1996) reported similar results for steers fed calcium soap.

Table 11. Main effects of dietary treatments on total body fat weights and percentages to the slaughter weight (SW) of the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
Omentum fat (kg)	0.34[b]	0.46[b]	0.68[a]	0.07	0.51	0.48	0.08
% of SW	0.80[b]	1.17[b]	1.63[a]	0.16	1.24	1.17	0.19
Intestinal fat (kg)	0.50[b]	0.70[a]	0.76[a]	0.05	0.62	0.68	0.07
% of SW	1.18[b]	1.78[a]	1.81[a]	0.13	1.53	1.65	0.16
Kidneys fat (kg)	0.22[b]	0.23b	0.33[a]	0.03	0.22	0.29	0.03
% of SW	0.52[b]	0.57b	0.79[a]	0.08	0.53	0.71	0.07
Tail fat (kg)	1.05	1.29	1.42	0.13	1.35	1.15	0.12
% of SW	2.49	3.26	3.40	0.30	3.28	2.82	0.28
Total body fat (kg)	2.11[b]	2.68[a]	3.19[a]	0.13	2.70	2.60	0.19
% of SW	4.99[b]	6.78[a]	7.63[a]	0.34	6.58	6.35	0.47

[a,b] Means within each treatment having different superscripts ($P<0.05$) differ.

Table 12. Total body fat weights and percentages to the slaughter weight (SW) of the experimental groups

Item	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
Omentum fat (kg)	0.36	0.45	0.71	0.32	0.47	0.65	0.10
% of SW	0.83	1.15	1.74	0.78	1.20	1.52	0.24
Intestinal fat (kg)	0.53[ab]	0.64[ab]	0.70[ab]	0.46[b]	0.76[a]	0.82[a]	0.07
% of SW	1.23[ab]	1.63[ab]	1.72[ab]	1.13[b]	1.93[a]	1.90[a]	0.18
Kidneys fat (kg)	0.22[b]	0.17[b]	0.28[ab]	0.22[b]	0.28[ab]	0.38[a]	0.04
% of SW	0.51[b]	0.42[b]	0.67[ab]	0.53[b]	0.71[ab]	0.90[a]	0.10
Tail fat (kg)	1.15	1.23	1.67	0.94	1.35	1.17	0.17
% of SW	2.67	3.11	4.05	2.30	3.42	2.75	0.38
Total body fat (kg)	2.26[cd]	2.49[bc]	3.36[a]	1.94[d]	2.86[ab]	3.02[ab]	0.16
% of SW	5.24[cd]	6.31[bc]	8.18[a]	4.74[d]	7.26[ab]	7.07[ab]	0.39

[a,b,c] Means in the same row having different superscripts ($P<0.05$) differ

Feeding 4% or 8% protected fat containing rations had no significant effect on fatty acid composition of muscle lipids except the ($P<0.05$) higher lauric acid (C12:0) of 4% fat group. Ilian *et al*. (1988); El- Bedawy *et al*. (1996a) and Eweedah *et al*. (1997) found that feeding lambs or bulls fat containing diets had no significant effect on fatty acid composition of eye muscle and carcass lipids. However, Abo- Donia *et al*. (2003) found that feeding 5% Ca- Soap containing diets to Ossimi male lambs or buffalo calves slightly increased Oleic acid (C18: 1), Linoleic acid (C18: 2) and Linolenic acid (C18: 3). Roughage level showed no significant effect on fatty acid composition of muscle lipids of the experimental groups (Table 13).

Table 13. Main effects of dietary treatments on fatty acid composition of eye muscle lipids for the experimental groups

Fatty acid %	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
C8:0	0.21	0.22	0.19	0.02	0.20	0.21	0.02
C10:0	0.12	0.13	0.09	0.02	0.11	0.11	0.02
C12:0	3.09[b]	3.57[a]	2.95[b]	0.16	3.39	3.02	0.15
C14:0	0.68	0.54	0.49	0.06	0.63	0.51	0.05
C16:0	23.38	25.94	24.95	0.65	24.78	24.74	0.65
C18:0	0.19	0.28	0.63	0.10	0.35	0.38	0.13
C18:1	52.58	52.20	50.27	0.88	52.20	50.27	0.82
C18:2	4.70	4.46	4.21	0.18	4.63	4.29	0.15
C18:3	0.23	0.27	0.27	0.05	0.24	0.27	0.04
Other	14.82	12.39	15.95	1.14	13.47	16.20	1.06
Total saturated	27.67	30.68	29.30	0.68	29.46	28.97	0.74
Total unsaturated	72.33	69.32	70.70	0.68	70.54	71.03	0.74

[a,b] Means within each treatment having different superscripts ($P<0.05$) differ.

Data in Table 14 showed that there were significant roughage x fat interaction on Capric acid (C10: 0) and Myristic acid (C14: 0). While no interactions were detected on the other fatty acids. The effect of dietary fatty acid would not expected to be great on the fatty acid composition of lean of animals fed fat containing diets because of the biohydrogenation in rumen by rumen microbes (El-Meddah *et al.*1991; Wu and Palmquist 1991; Wu *et al*. 1991; Ferlay *et al*.1993 and Doreau *et al*. 1993).

Table 14. Fatty acid composition of eye muscle lipids of the experimental groups

Fatty acid, %	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
C8:0	0.19	0.22	0.19	0.22	0.22	0.19	0.03
C10:0	0.08[bc]	0.12[ab]	0.12[ab]	0.16[a]	0.13[ab]	0.05[c]	0.02
C12:0	3.38[ab]	3.73[a]	3.05[ab]	2.81[b]	3.40[ab]	2.84[b]	0.19
C14:0	0.84[a]	0.49[b]	0.55[b]	0.52[b]	0.58[b]	0.43[b]	0.06
C16:0	22.57	25.96	25.80	24.19	25.92	24.09	0.83
C18:0	0.21	0.18	0.66	0.18	0.38	0.60	0.15
C18:1	52.93	52.73	50.94	52.23	51.67	49.67	1.25
C18:2	5.12	4.52	4.24	4.28	4.39	4.18	0.20
C18:3	0.14	0.30	0.29	0.32	0.24	0.26	0.07
Other	14.54	11.75	14.16	15.09	13.07	17.76	1.49
Total saturated	27.27	30.70	30.38	28.07	30.63	28.20	0.95
Total unsaturated	72.73	69.30	69.62	71.93	69.37	71.80	0.95

[a,b] Means in the same row having different superscripts ($P<0.05$) differ.

Data in Table 15 showed that neither fat nor roughage level had significant effect on eye muscle area, eye muscle weight and physical composition of the best ribs (percentages of lean, fat and bone). These results were in agreement with those found by El- Bedawy 1989; White *et al*. 1992; Zinn 1992; Bartle *et al*. 1994; Zinn and Plascencia 1996, El- Bedawy *et al*. 1996a and El-Bedawy *et al*. (2004b) that feeding fat containing diets to goat, sheep or steers had no significant effect on eye muscle area or physical composition of the best (9, 10 and 11) ribs. However, El- Kholy *et al*. (2003) found that 5% Ca-Soap supplement to buffalo calves ($P<0.05$) increased eye muscle area and lean percentage, lean: bone ratio and lean: fat ratio but ($P<0.05$) decreased fat and bone percentages. While, Abo- Donia *et al*. (2003) found that supplementation of 5% calcium salts of soap stock in Ossimi lamb diets ($P<0.05$) decreased lean but increased ($P<0.05$) fat percentages with no significant effect on bone percentage. Bartle *et al*. (1994) and Zinn and Plascencia (1996) found that increasing alfalfa hay level from 10 % to 30% in steer rations had no significant effect on eye muscle area.

Data in Table 16 showed no significant roughage x fat interaction on eye muscle area, eye muscle weight and physical composition (lean, fat and bone) of the best ribs. Lambs those fed high roughage- high fat diets recorded the highest values of fat percentage and the lowest value of lean percentages. Bartle *et al*. (1994) and Zinn and Plascencia (1996) found no significant forage x fat interaction on eye muscle area.

Results of chemical composition of whole 9, 10 and 11*th* ribs showed that feeding protected fat diets ($P<0.05$) increased DM and ether extract but decreased ($P<0.05$) CP percentages compared to the control (no added fat). While, ash percentage was not significantly changed (Table 15). However Ilian *et al*. (1988) found that addition of 5% fat into diets did not affect protein, fat and ash percentages of sheep carcass. Also, Zinn (1992) noticed that feeding finishing steers on 6% fat containing diets did not influence body composition. Roughage level had no significant effect on chemical composition of the best ribs.

There were no significant roughage x fat interactions on chemical composition of the best ribs. Lambs that fed low roughage- high fat diet recorded the highest value of ether extract percentage and the lowest value of crude protein percentage.

Table 15. Main effects of dietary treatments on physical and chemical composition of the best (9, 10 and 11th) ribs of the experimental groups

Item	Protected fat level			SEM	Roughage level		SEM
	LF	MF	HF		Low	High	
Eye muscle area (Cm^2)	21.3	21.2	20.4	1.2	20.5	21.5	1.0
Eye muscle weight (g)	120	108	128	7	125	166	5
Physical composition of the best ribs, %							
Lean	63.7	62.5	59.8	1.9	62.5	61.5	1.6
Fat	22.4	24.2	26.2	2.2	23.4	25.1	1.9
Bone	13.9	13.3	14.0	1.0	14.1	13.4	0.7
Chemical composition of the best ribs, %							
DM	44.2^b	46.7^a	47.6^a	0.9	46.6	45.8	0.9
DM composition, %							
CP	49.7^a	44.2^b	42.7^b	1.2	45.4	45.6	1.5
Ether extract	42.6^b	49.3^a	50.6^a	1.4	47.8	47.1	1.6
Ash	7.7	6.5	6.7	0.4	6.8	7.2	0.3

^{a,b} Means within each treatment having different superscripts ($P<0.05$) differ.

Table 16. Physical and chemical composition of the whole best ribs of the experimental groups

Item	Low roughage			High roughage			SEM
	LF	MF	HF	LF	MF	HF	
Eye muscle area cm^2	20.8	18.6	22.0	21.9	23.8	18.9	1.3
Eye muscle weight, g	135	105	135	105	110	120	7
Physical composition of the best ribs, %							
Lean	64.1	60.8	62.5	63.2	64.2	57.0	2.5
Fat	21.7	26.5	22.0	23.1	21.9	30.5	2.7
Bone	14.2	12.7	15.5	13.7	13.9	12.5	1.2
Chemical composition of the best ribs, %							
DM	43.9^b	46.1^{ab}	49.7^a	44.5^b	47.3^{ab}	45.6^b	1.2
CP	50.1^a	45.4^{ab}	40.8^b	49.3^a	43.0^b	44.6^{ab}	1.7
Ether extract	42.2^c	48.8^{abc}	52.4^a	43.1^{bc}	49.7^{ab}	48.7^{abc}	1.9
Ash	7.7	5.8	6.8	7.7	7.3	6.7	0.5

^{a,b,c,d} Means in the same row having different superscripts $P<0.05$) differ.

Implications

Feeding diet containing dietary protected fat to growing lambs resulted in higher average daily gain and higher carcass fats but it did not alter the percentage of unsaturated fatty acid in carcass fat. Roughage level had no significant effect on either the growth performance or carcass characteristics The greater intake of digestible energy by the lambs fed calcium soaps of palm oil may account for the higher average daily gains and fatter carcasses.

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تأثير مستويى الدهن المحمى و مواد العلف الخشنة على النمو وصفات الذبيحة للأغنام النامية

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غذى ستون حمل برقى عمرها ٨ شهور و متوسط وزنها ٢٧.٥ كجم فى ٦ مجموعات متشابهة على علائق تحتوى مستويين من دريس البرسيم (١٠ و ٣٠ %) مع ثلاث مستويات من الدهن المحمى (صفر ، ٤% ، ٨%) لمدة سبعون يوما، سجل خلالها المأكول اليومي و الوزن الحي أسبوعيا وفى نهاية التجربة، ذبحت ثلاثة حملان من كل مجموعة لدراسة تأثير مستويات الدهن المحمى و المادة الخشنة على صفات الذبيحة و جودة اللحم.

أدت زيادة مستوى الدهن إلى زيادة غير معنوية فى النمو والزيادة اليومية فى وزن الجسم، حسن مستوى الدهن العالي (٨%) من الكفاءة التحويلية للطاقة بنسبة ٦.٤% و للبروتين ١٤.٣% . بينما لم يكن لمستوى المادة الخشنة أو التداخل بين الدهن و المادة الخشنة تأثيرا معنويا على النمو أو الكفاءة التحويلية.

لم يؤثر مستوى الدهن أو المادة الخشنة أو التداخل بينهما على وزن الذبيحة أو نسبة التصافي أو التركيب الطبيعي للحم ماعدا زيادة طراوة العضلات للأغنام المغذاة على علائق تحتوى على ٨% دهن محمى.

أدت إضافة الدهن المحمى إلى زيادة وزن الدهن الداخلى و دهن الجسم الكلى و مستخلص الأثير للعضلات و الكبد و خفضت من نسبة البروتين للعضلات بينما لم يتأثر تركيب الأحماض الدهنية فى ليبيدات العضلات ماعدا الزيادة المعنوية فى حمض اللوريك للمجموعة المغذاة على ٤% دهن.

لم يؤثر مستوى الدهن أو المادة الخشنة على مساحة أو وزن العضلة العينية أو تركيبها من اللحم و الدهن و العظم. أظهرت نتائج التحليل الكيماوى للأضلاع التاسع و العاشر و الحادى عشر أن التغذية العلائق المحتوية على الدهن زادت معنويا من نسبة المادة الجافة و مستخلص الأثير و قللت من البروتين الخام ولم تتأثر نسبة الرماد الخام.

ويمكن استنتاج أن إضافة الدهن المحمى لعلائق الحملان حسنت الزيادة اليومية فى الوزن و دهن الذبيحة، ولكنها لم تغير نسبة الأحماض الدهنية غير المشبعة فى دهن الذبائح بينما لم يسبب مستوى المادة الخشنة اختلافا معنويا فى النمو أو صفات الذبيحة وقد يرجع السبب فى زيادة النمو و دهن الذبيحة إلى زيادة الطاقة المهضومة للحيوانات المغذاة على الدهن المحمى.