Iranian Journal of Veterinary Research, University of Shiraz, Vol. 8, No. 2, Ser. No. 19, 2007

Effects of supplementary feeding on growth and carcass characteristics of fat-tailed lambs grazing cereal stubble

Izadifard, J. and Zamiri, M. J.*

Department of Animal Sciences, College of Agriculture, University of Shiraz, Shiraz, Iran

***Correspondence:** M. J. Zamiri, Department of Animal Sciences, College of Agriculture, University of Shiraz, Shiraz, Iran. E-mail: zamiri@shirazu.ac.ir

(Received 12 Sept 2005; revised version 30 Nov 2005; accepted 4 Jan 2006)

Summary

Despite a shortage of animal feed in Iran, cereal stubble is often underutilized due to agro-economic reasons. On the other hand, lambs fed with a conventional fattening ration deposit a considerable amount of fat; therefore, this experiment was conducted aimed at better utilization of cereal stubble and reducing the fat content of lamb carcasses. Fat-tailed Mehraban and Ghezel ram lambs were put on four feeding systems (FS) for 100 days. Animals in one group (FS1) were lot-fed with a conventional fattening ration (4% of the mean body weight) consisting of 50% ground barley and 50% chopped alfalfa hay. FS2, FS3 and FS4 animals grazed stubbles, and in the evening, received 2% of their body weights either ground barley (FS2), a mixture (50:50 DM basis) of ground barley and alfalfa hay (FS3), or ground alfalfa hay (FS4). Daily gain, slaughter weight, and tail weight were greatest ($P<0.05$) for FS1, lowest for FS4, and intermediate for FS2 and FS3. Stubble-fed lambs had lower subcutaneous fat depth and cavity fat. The sum weight of lean in primal cuts was lower in FS4 as compared with other groups, but the lean weight as a percentage of carcass weight was lowest in SF1. Similar pattern was found for the dissected fat from the primal cuts. The weight of soft tissues was highest in SF1 and lowest in SF4, but its percentage in carcass showed a reverse pattern. Stubble feeding with some supplementary feed resulted in less fat deposition in fat-tailed lambs as compared with the conventional fattening ration, and was more economical in terms of unit live weight gain. Due to the feed shortage in Iran, stubble grazing should be encouraged in lieu of the current practice of burning the residues on the farm.

Key words: Fat-tailed sheep, Stubble feeding, Growth, Carcass

Introduction

Wheat and barley, and to some extent maize, are the most important crops in Iran. Despite a shortage of animal feed in Iran, a large proportion of the crop stubble is either burned or returned to the soil at the time of plowing. Unfortunately, the ministry of agriculture also encourages the burning of the crop residues. In Iran, as in other countries (see Landau *et al*., 2000), cereal stubble is often underutilized due to agro-economic reasons. Composition and nutritional value of the stubble are affected by several factors (Landau *et al*., 2000); however, stubble is low in nitrogen, available carbohydrates, and digestibility (Dann and Coombe, 1987), making it less suitable to meet the nutrient requirements of high producing ruminants (Aitchinson, 1988). Several researches have been conduced on the ewe response to supplementation during stubble grazing (e. g., Rowe, 1986; Aitchinson, 1988; Outmani *et al*., 1991; Caballero *et al*., 1992; Brand *et al*., 2000). Some studies have been concerned with the effect of supplementary feeding on young lamb performance grazing wheat stubble (Rowe *et al*., 1989) or maize stover (Undi *et al*., 2001). In Iran, male feeder lambs are usually kept on natural pasture or crop residues for 3-4 months after weaning, and from the start of autumn, they are lot-fed with a fattening ration for a period of about 100 days. These animals are heavy at the time of slaughter but contain a considerable amount of fat, and therefore, the consumers have to pay a higher price for procuring leaner meat. We hypothesized that daily grazing on stubbles, followed by supplementary feeding at the end of the day may reduce feeding costs, and the fat content in fat-tailed Iranian lambs. Therefore, an experiment was conducted to compare the effects of three systems of supplementary feeding on feedlot performance and carcass characteristics of fat-tailed Ghezel and Mehraban lambs grazing wheat and barley stubbles. It is expected that leaner and cheaper meat is produced by optimizing the use of available stubbles.

Materials and Methods

The experiment was carried out at the Animal Research Station, College of Agriculture, University of Shiraz. Seventy-seven 8-month-old Ghezel and Mehraban rams were randomly allotted to four feeding systems (FS; 18 to 20 rams per FS and 9 to 10 rams per breed per FS) to receive either of the four diets for 100 days, plus a 10-day adaptation period. Mean live weights of the lambs in various groups were not significantly different (Table 1). Animals in one group (FS1) were kept in a barn during the experiment and fed with a conventional fattening ration (4% of the mean body weight) consisting of 50% ground barley and 50% chopped alfalfa hay. This ration contained 13.5% crude protein (CP; Kjeldahl determination) and 2.6 Mcal metabolizable energy (ME; calculated) per kg dry matter. Animals in the remaining groups were allowed to graze stubbles daily from 8:00-11:30 and 13:00-17:00, and in the evening they received their supplementary feed in the barn as follows: FS2: ground barley (13% CP and 3.1 Mcal ME per kg DM) at 2% body weight; FS3: mixture of ground barley and chopped alfalfa hay (as in FS1) at 2% body weight and FS4: chopped alfalfa hay (14% CP and 1.95 Mcal ME per kg DM) at 2% body weight.

The animals were weighed at 20-day intervals and their supplementary feed was adjusted accordingly. The sheep in groups FS2, FS3 and FS4 grazed each stubble lot (eight lambs per hectare) as one flock and were turned to an ungrazed lot after 10 days. The animals were vaccinated against enterotoxemia and received a deworming medication at the start of the experiment. Salt licks and water were freely available.

At the end of the experiment, the feed and water were removed for 16 hrs after which the lambs were weighed and slaughtered according to the local practices (Zamiri and Izadifard, 1995). Cavity fat (cardiac, renal, pelvic and gastrointestinal) was removed and weighed. Cold carcass weight was determined after 24 hrs at 4°C, and the tail was removed and weighed. Fat depth over carcass was measured at the cross section of the 12th and 13th thoracic ribs at 4 points and the values were averaged as a measure of subcutaneous fat depth (SCFD). Cross sectional area of the eye muscle (*Longissimus dorsi* muscle) was measured on both sides of the carcass between the 12th and 13th ribs. The cross section of the eye muscle was traced on a nylon sheath and the area was then measured by using a planimeter (Tamaya Digitising Area-Meter, Tamaya Technics, Japan).

The right side of the carcasses of 40 lambs (randomly selected) was cut into the leg, shoulder, back, neck and flaps (five lambs per FS per breed). The cuts were dissected into bone and meat. Meat from the right side of the carcass (excluding the tail fat) was minced and mixed thoroughly, and samples were kept at -20°C until analyzed for dry matter, ether extract (crude fat), nitrogen contents (expressed as crude protein) and ash contents (AOAC, 1975).

Data were analyzed by using the GLM procedure of the SAS for windows program on a personal computer (SAS, 1996). The effects of breed, feeding system, and their interactions were included in the model. Initial live weight was used as the covariate for analysis of data. Means were compared by using the Duncan's multiple range test (P = 0.05). Percentage data were transformed into arcsine $\sqrt{X}$ before analysis. Mean and standard deviation of original data are reported in the paper.

Results

Effect of feeding system on various measurements is shown in Tables 1 to 4.

Breed effect was not significant for most measurements. Average daily gain was higher in Ghezel than in Mehraban (Table 1). Ghezel sheep had significantly heavier leg and shoulder than Mehraban (Table 3). Bone weight and its proportion relative to carcass weight were also higher in Ghezel (Table 4). Breed by feeding system interaction was not significant for any of the measurements ($P>0.05$).

Initial body weight was not significantly different amongst feeding systems (FS), but slaughter weight (Table 1) was highest ($P<0.05$) for FS1 (conventional fattening ration), lowest for FS4 (stubble + alfalfa hay), and intermediate for FS2 (stubble + barley) and FS3 (stubble + barley/alfalfa hay). Similar patterns were noticed for daily gain and carcass weight (Table 1). The weight of tailless carcass was not affected by the feeding system, but its pattern of changes when expressed as a percentage of cold carcass weight, was opposite to those of slaughter and carcass weights (Table 1).

Table 1: Effect of feeding system (FS) on daily gain and carcass weight of Ghezel and Mehraban sheep (mean ± SD)

					Hot carcass		Cold carcass		Cold carcass minus tail	
	n	Initial weight (kg)	Slaughter weight (kg)	Daily gain (g)	Weight (kg)	% of slaughter weight	Weight (kg)	% of slaughter weight	Weight (kg)	% of cold carcass weight
Feeding system										
FS1	19	33.5 ±5.5^{a}	56.0 ±5.1^{a}	225 ±34^{a}	28.9 ±2.9^{a}	51.6 ±1.8^{a}	28.2 ±2.8^{a}	50.3 ±1.9^{a}	23.3 ±2.3^{a}	82.6 ±2.2^{c}
FS2	20	34.9 ±6.2^{a}	53.6 ±7.6^{b}	186 ±50^{b}	26.7 ±4.1^{b}	49.7 ±1.6^{bc}	26.1 ±4.0^{b}	48.6 ±1.7^{bc}	22.2 ±3.2^{a}	85.5 ±2.5^{b}
FS3	18	33.6 ±6.2^{a}	52.7 ±5.8^{b}	190 ±38^{b}	26.7 ±3.9^{b}	50.6 ±3.2^{ab}	26.0 ±3.8^{b}	49.3 ±3.2^{ab}	22.2 ±3.2^{a}	85.4 ±2.1^{b}
FS4	20	33.6 ±5.9^{a}	49.5 ±6.5^{c}	159 ±29^{c}	24.1 ±3.6^{c}	48.5 ±2.5^{c}	23.5 ±3.5^{c}	47.4 ±2.4^{c}	20.6 ±3.0^{a}	87.8 ±2.4^{a}
Breed										
Ghezel	39	35.6 ±6.5^{a}	55.6 ±7.2^{a}	200 ±40^{a}	27.8 ±4.4^{a}	50.0 ±2.7^{a}	27.1 ±4.0^{a}	48.7 ±2.6^{a}	23.1 ±3.3^{a}	85.3 ±3.0^{a}
Mehraban	38	32.3 ±4.6^{b}	50.2 ±4.8^{b}	179 ±48^{b}	25.3 ±3.1^{a}	50.2 ±2.5^{a}	24.7 ±3.1^{a}	49.1 ±2.6^{a}	21.0 ±2.4^{a}	85.1 ±3.0^{a}
Overall	77	33.9 ±5.9	52.9 ±6.7	190 ±45	26.6 ±4.0	50.1 ±2.6	25.9 ±3.9	48.9 ±2.5	22.1 ±3.0	85.2 ±2.9

a, b, c: Within each column and for each subgroup, the means with common superscript(s) are not significantly different at p = 0.05 (Duncan's multiple range test). FS1: Conventional fattening ration at 4% live weight; FS2: Stubble grazing supplemented with ground barley at 2% live weight; FS3: Stubble grazing supplemented with ground barley and chopped alfalfa hay (50:50) at 2% live weight and FS4: Stubble grazing supplemented with chopped alfalfa hay at 2% live weight

Table 2: Effect of feeding system (FS) on subcutaneous fat depth (SCFD), cross sectional area of eye muscle, tail weight and cavity fat of Ghezel and Mehraban sheep (mean ± SD)

			Tail		Cavity fat (g)	
	SCFD (mm)	Eye muscle area (cm^2)	Weight (kg)	% of cold carcass weight	Weight (g)	% of slaughter weight
Feeding system						
FS1	4.6±1.5^{a}	26.8±2.5^{a}	4.9±0.9^{a}	17.4±2.2^{a}	1042±469^{a}	1.8±0.1^{a}
FS2	3.5±1.2^{b}	27.8±4.3^{a}	3.9±1.1^{b}	14.5±2.5^{b}	535±171^{b}	1.0±0.2^{b}
FS3	3.2±1.2^{b}	26.0±3.6^{a}	3.8±0.8^{b}	14.6±2.1^{b}	488±218^{b}	0.9±0.4^{b}
FS4	2.8±1.0^{b}	27.7±3.3^{a}	2.9±0.8^{c}	12.3±2.4^{c}	373±94^{b}	0.8±0.2^{b}
Breed						
Ghezel	3.4±1.3^{a}	27.6±3.5^{a}	4.0±1.2^{a}	14.7±3.0^{a}	608±386^{a}	1.1±0.6^{a}
Mehraban	3.6±1.4^{a}	26.6±3.5^{a}	3.7±1.0^{a}	14.9±3.0^{a}	605±364^{a}	1.2±0.7^{a}
Overall	3.5±1.4	27.1±3.5	3.9±1.1	14.8±2.9	607±373	1.1±0.6

a, b, c: Within each column and for each subgroup, the means with common superscript(s) are not significantly different at p = 0.05 (Duncan's multiple range test). FS1: Conventional fattening ration at 4% live weight; FS2: Stubble grazing supplemented with ground barley at 2% live weight; FS3: Stubble grazing supplemented with ground barley and chopped alfalfa hay (50:50) at 2% live weight and FS4: Stubble grazing supplemented with chopped alfalfa hay at 2% live weight

Table 3: Effect of feeding system (FS) on carcass cuts of Ghezel and Mehraban sheep (mean ± SD)

	Leg	Shoulder	Back	Flap	Neck
			Kg		
Feeding system					
FS1	3.60 ± 0.36[a]	2.26 ± 0.24[a]	2.41 ± 0.26[a]	2.68 ± 0.31[a]	0.78 ± 0.12[a]
FS2	3.37 ± 0.57[a]	2.25 ± 0.35[a]	2.34 ± 0.37[a]	2.44 ± 0.52[a]	0.76 ± 0.11[a]
FS3	3.53 ± 0.52[a]	2.22 ± 0.33[a]	2.35 ± 0.41[a]	2.39 ± 0.38[a]	0.74 ± 0.11[a]
FS4	3.25 ± 0.51[a]	2.04 ±0.29[b]	2.11 ± 0.41[a]	2.11 ± 0.38[a]	0.76 ± 0.15[a]
Breed					
Ghezel	3.65 ± 0.50[a]	2.33 ± 0.33[a]	2.44 ± 0.38[a]	2.49 ± 0.45[a]	0.78 ± 0.13[a]
Mehraban	3.21 ± 0.40[b]	2.04 ± 0.21[b]	2.16 ± 0.33[a]	2.32 ± 0.44[a]	0.73 ± 0.12[a]
Overall	3.43 ± 0.51	2.19 ± 0.31	2.30 ± 0.39	2.40 ± 0.45	0.76 ± 0.12
			% of cold carcass weight		
Feeding system					
FS1	25.5 ± 1.3[a]	16.0 ± 1.0[b]	17.1 ± 0.7[a]	19.0 ± 1.3[a]	5.5 ± 0.8[b]
FS2	25.9 ± 2.9[a]	17.3 ± 2.0[a]	18.0 ± 1.4[a]	18.7 ± 2.1[a]	5.8 ± 0.5[b]
FS3	27.1 ± 1.2[a]	17.1 ± 0.8[a]	18.0 ± 1.2[a]	18.4 ± 1.7[a]	5.7 ± 0.7[b]
FS4	27.7 ± 2.6[a]	17.4 ± 0.9[a]	17.9 ± 2.0[a]	17.9 ± 1.2[a]	6.4 ± 0.7[a]
Breed					
Ghezel	27.0 ± 1.7[a]	17.3 ± 1.6[a]	18.0 ± 1.2[a]	18.2 ± 1.4[a]	5.8 ± 0.7[a]
Mehraban	26.1 ± 2.7[b]	16.6 ± 1.0[b]	17.5 ± 1.6[a]	18.7 ± 1.9[a]	6.0 ± 0.8[a]
Overall	26.6 ± 2.3	17.0 ± 1.4	17.7 ± 1.4	18.5 ± 1.6	5.9 ± 0.7

a, b, c: Within each column and for each subgroup, the means with common superscript (s) are not significantly different at p = 0.05 (Duncan's multiple range test). FS1: Conventional fattening ration at 4% live weight; FS2: Stubble grazing supplemented with ground barley at 2% live weight; FS3: Stubble grazing supplemented with ground barley and chopped alfalfa hay (50:50) at 2% live weight and FS4: Stubble grazing supplemented with chopped alfalfa hay at 2% live weight

Table 4: Effect of feeding system (FS) on lean meat, dissected fat and bone in primal cuts (leg, shoulder, back) and in half carcass of Ghezel and Mehraban Sheep (mean ± SD)

	Primal cuts			Half carcass	
	Lean meat	Dissected fat	Bone	Soft tissue minus tail	Bone
			kg		
Feeding system					
FS1	5.79 ± 0.57[a]	0.66 ± 0.21[a]	1.73 ± 0.33[a]	9.23 ± 1.20[a]	3.87 ± 0.58[a]
FS2	5.67 ± 0.95[a]	0.39 ± 0.16[b]	1.68 ± 0.32[a]	8.39 ± 1.30[c]	3.84 ± 0.65[ab]
FS3	5.85 ± 0.83[a]	0.58 ± 0.35[ab]	1.70 ± 0.27[a]	8.67 ± 1.35[b]	3.85 ± 0.62[ab]
FS4	5.39 ± 0.84[a]	0.37 ± 0.23[b]	1.63 ± 0.25[a]	7.90 ± 1.38[d]	3.60 ± 0.53[b]
Breed					
Ghezel	5.90 ± 0.89[a]	0.50 ± 0.28[a]	1.82 ± 0.28[a]	8.86 ± 1.50[a]	4.06 ± 0.60[a]
Mehraban	5.38 ± 0.55[a]	0.49 ± 0.27[a]	1.52 ± 0.19[b]	8.16 ± 1.08[a]	3.45 ± 0.33[b]
Overall	5.70 ± 0.79	0.50 ± 0.27	1.68 ± 0.28	8.55 ± 1.35	3.78 ± 0.58
			% of cold carcass weight		
Feeding system					
FS1	41.5 ± 2.2[b]	4.7 ± 1.4[a]	12.3 ± 1.9[b]	65.9 ± 2.1[a]	13.8 ± 1.3[b]
FS2	45.5 ± 2.7[a]	3.0 ± 1.2[a]	13.5 ± 1.3[ab]	67.9 ± 2.3[a]	15.4 ± 1.6[a]
FS3	46.0 ± 1.6[a]	4.7 ± 3.4[a]	13.3 ± 0.9[ab]	67.3 ± 1.9[a]	15.1 ± 1.0[a]
FS4	46.7 ± 1.8[a]	3.2 ± 1.8[a]	14.2 ± 2.0[a]	68.2 ± 2.5[a]	15.6 ± 1.2[a]
Breed					
Ghezel	44.9 ± 3.1[a]	3.84 ± 2.4[a]	13.8 ± 1.3[a]	67.0 ± 2.1[a]	15.4 ± 1.3[a]
Mehraban	44.8 ± 2.8[a]	4.00 ± 1.9[a]	12.7 ± 2.0[b]	67.6 ± 2.6[a]	14.4 ± 1.3[b]
Overall	44.8 ± 2.9	3.90 ± 2.20	13.3 ± 1.7	67.3 ± 2.3	15.0 ± 1.4

a, b, c: Within each column and for each subgroup, the means with common superscript (s) are not significantly different at p = 0.05 (Duncan's multiple range test). FS1: Conventional fattening ration at 4% live weight; FS2: Stubble grazing supplemented with ground barley at 2% live weight; FS3: Stubble grazing supplemented with ground barley and chopped alfalfa hay (50:50) at 2% live weight and FS4: Stubble grazing supplemented with chopped alfalfa hay at 2% live weight

Changes in tail weight (Table 2) were similar to the slaughter weight (Table 1).

Amongst various cuts, only the weight of shoulder was significantly affected by the feeding system (Table 3); FS4 had a lighter shoulder as compared with other groups. Shoulder weight relative to cold carcass weight was smallest in FS1, and neck weight as a percentage of cold carcass weight was highest in FS4 (Table 3). Total weight of lean in primal cuts (leg, shoulder, and back) was not significantly affected by the feeding system, but FS1 had a proportionally less lean in the cold carcass (Table 4). The FS4 diet resulted in lower weights of soft tissues (de-boned meat, excluding the tail) and dissected fat from the primal cuts, but relative to the cold carcass weight, these values were not significantly different amongst the feeding systems (Table 4). Whereas the total weight of bone in primal cuts was not affected by the feeding system, relative to the weight of carcass it was larger in FS4 sheep (Table 4). The total weight of bone in the carcass of FS4 sheep was significantly lower than in FS1.

Subcutaneous fat depth, cavity fat and cavity fat as a percentage of slaughter weight were greater in FS1 as compared to other groups (Table 2). Cross sectional area of eye muscle (Table 2) and the chemical composition (data not shown) of meat (moisture, crude protein, crude fat, and ash percentages) were not affected (on fresh or dry matter basis) by the feeding system.

Discussion

In Iran, fattening lambs are usually fed with a mixture of roughage and grains (mainly barley) for 100 to 120 days. This type of ration results in the accumulation of undesirable amount of fat around the internal organs and also in the fat-tail, which is sold at a very low price mainly for soap production. The price per kg live weight is the same regardless of the degree of fatness; therefore, feed-lot operators and processors are not concerned with meat quality, and the cost of excess fat production has to be borne by the consumers, who are now demanding a leaner product.

The sheep which grazed stubbles and received some supplementary feed produced less trimmed (separated) fat (both absolute and relative) as compared with those receiving the conventional fattening ration. This was especially more noticeable with the ration containing alfalfa hay as the supplementary feed. Barley, either alone or in combination with alfalfa hay resulted in more fat production. Trimmed fat was minced with the meat for determination of the chemical composition, and this might be a reason for the lack of a significant effect of the feeding system on crude fat content. It is likely that intramuscular fat would have also been higher in fatter sheep. Thus, raising lambs on stubble could result in the production of meat that contains less fat.

Smaller final weights of lambs on stubble and alfalfa hay was compensated for by the heavier tails and higher amounts of fat dissected from the internal organs (cavity fat) and cuts in sheep receiving barley as a supplementary feed. Inclusion of barley grains in the diet tended to increase the amount of fat.

Cereal stubbles may supply more than 20% of the annual energy requirement of the sheep in some areas (Perevolotsky and Landau, 1988). In spite of the quantity produced, cereal stubble is underutilized for several reasons. The stubble used in the present experiment was a byproduct of mechanical harvesting and its composition was not known. However, other studies have shown that stubble may comprise up to 40% of wheat biomass, and fallen grains could represent about 2% of the total biomass following mechanical harvesting (Landau *et al.*, 2000). According to Rosilio *et al.* (1991) stubble is partitioned into small, delicate-mostly from leaf-parts (43%) and rougher-mostly from stem parts (57%) that differ in crude protein and metabolizable energy. In studies carried out in Syria (Rihani *et al.*, 1991), head, leaf and stem components represented 4, 54 and 42% of the biomass, respectively. A study in the Mediterranean part of Australia showed that the leaf:stem ratio ranged between 0.41: 0.46 to 0.20:0.71, the rest being composed of dust and weeds (Wales *et al.*, 1990). Chemical composition of stubble is affected by many factors, including the cultivar, harvesting method and climate. The proportion and digestibility of each component determine the intake and ultimate feeding value of stubble (Landau *et al.*, 2000). When productive sheep are kept on depleted stubble, or the stocking rate is high, supplementation is needed to prevent body condition loss. Interaction between supplemental feeding and cereal stubble do not seem to have been investigated, but the results of studies with low-quality roughages such as straw indicate that small amounts of degradable protein stimulate consumption, whereas small amounts of starchy energy supplementation have negligible effect (see Landau *et al.*, 2000).

The absolute values of most carcass measurements were highest for FS1, intermediate for FS2 and FS3, and lowest for FS4. There were practically no differences between FS2 and FS3 for performance measurements.

Average daily gain (ADG) of the lambs receiving the conventional fattening ration was greater than the stubble-fed lambs. Previous studies (Ely *et al.*, 1979; Arnold and Meyer, 1988; Murphy *et al.*, 1994) reported that ADG was higher for the lambs placed immediately in drylot as compared with those that grazed forages. The ADG of FS2 (186 g per day) and FS3 (190 g per day) lambs over 100 days in the present experiment is comparable with the ADG of Hampshire × Targhee lambs (180 g per day) that grazed ryegrass for 42 days and were then fed with a 100% concentrate diet until they reached a target weight of 48 kg after 113 days (Murphy *et al.*, 1994). It seems that the stubble grazed during this experiment had an acceptable quality; even though the lambs grazing the stubble and receiving a daily allowance of alfalfa hay (2% live weight) had a slightly lower ADG (160 g per day).

In the present work, chemical composition of soft tissues (excluding the tail fat) was not significantly affected by the feeding system, although in FS4 sheep the crude protein content was 1% greater, and the crude fat content was about 1.5% smaller than in FS1. Murphy *et al.* (1994) reported a similar chemical composition among lambs placed directly in the feedlot and lambs allowed to graze ryegrass for 42 days before drylot placement; however, Arnold and Meyer (1988) found reduced carcass fatness when lambs grazed pasture to a weight of 41 kg before drylot placement. Such discrepancies may be due to the method of pasture grazing (Murphy *et al.*, 1994). Reduction of body fat in the lambs receiving stubble and alfalfa (FS4) may be due to lower energy intake and reduced growth rate. Source of energy available may also influence carcass composition. Ruminal fermentation of forages leads to a relatively higher acetate:propionate ratio, but grains decrease this ratio (Maynard *et al.*, 1979). Increased propionate results in an increased insulin secretion which stimulates protein and fat synthesis (Bines and Hart, 1982; Weekes, 1986).

In general, the protein content was higher but the fat content was considerably lower than their corresponding values in the lean reported by Murphy *et al.* (1994). This is probably a breed difference indicating a better quality of meat in these breeds as compared with the crossbred lambs used in that experiment. However, in these fat-tailed sheep, the mean weight of the tail fat in various feeding groups was 3 to 5 kg (12 to 17% of the cold carcass weight). Tail fat is no longer in demand in Iran as a foodstuff, and is used mainly for soap production, and in smaller amounts as supplemental fat for animal feeding.

The amount of bone in the side was lower in FS4 than in FS1 indicating an effect on bone development. However, Murphy *et al.* (1994) did not find a significant effect of the feeding systems on skeletal tissue development. This difference could be attributed to the breeds or the systems of feeding; the amount of minerals received from grazed stubble and the supplementary feed may not have been sufficient for optimum bone development.

In our experiment, sheep grazing stubble had a significantly lower subcutaneous fat. Although Murphy *et al.* (1994) did not find a significant effect of the finishing system on backfat thickness in Hampshire × Targhee lambs, Arnold and Meyer (1988) found smaller backfat thickness in whiteface lambs but not in blackface lambs due to feeding pasture before drylot placement. Together these findings give support to the notion that breed differences may influence the effects of finishing system.

Under the conditions of the present

research, stubble grazing and provision of supplementary feed to fat-tailed lambs resulted in the reduction of dissected fat and production of leaner carcasses. Although final weight and ADG were lower compared with the lambs fattened on a conventional fattening ration, but it allows better utilization of feedstuff in Iran which is facing a shortage of livestock feed. The predicted duration of feeding required to gain as much as FS1 group (22.5 kg) in 100 days, was 121, 118 and 142 days for FS2, FS3 and FS4, respectively (22.5 divided by the ADG of each group in kg); however, the calculated net profit per kg live weight, expressed as the percentage of FS1 was 152%, 158%, and 104% for FS2, FS3 and FS4, respectively; the cost of stubble was included in the calculations.

Acknowledgements

We would like to thank the staff of the Animal Research Station, and the technicians of the Animal Science Department for their cooperation during the conduct of this experiment.

References

Aitchinson, E (1988). Cereal straw and stubble as sheep feed. J. Agric. West Aust., 29: 96-101.

Arnold, AM and Meyer, HH (1988). Effect of gender, time of castration, genotype and feeding regimen on lamb growth and carcass fatness. J. Anim. Sci., 66: 2468-2475.

AOAC (1975). *Official methods of analysis*. 12th. Edn., Association of Official Analytical Chemists, Washington DC., PP: 129-136.

Bines, JA and Hart, IC (1982). Metabolic limits to milk production, especially role of growth hormone and insulin. J. Dairy Sci., 65: 1375-1389.

Brand, TS; Frank, F; Durand, A and Coetzee, J (2000). The intake and nutritional status of sheep grazing wheat stubble. Small Ruminant Res., 35: 29-38.

Caballero, R; Rioperez, J; Fernandez, E; Arauzo, M and Hernaiz, PJ (1992). Performance of Manchega ewes grazing cereal stubbles and cultivated pastures. Small Ruminant Res., 79: 315-329.

Dann, RP and Coombe, JB (1987). Utilization of fodder crops and crop residues. In: Wheeler, LW; Pearson, CG and Robards, GE (Eds.), *Temperate pastures, their production, use and management*. Australia, Australian Wool Corporation. P: 517.

Ely, DG; Glenn, BP; Mahyuddin, M; Kemp, JD; Thrift, FA and Deweese, WP (1979). Drylot vs pasture: early-weaned lamb performance to two slaughter weights. J. Anim. Sci., 48: 32-37.

Landau, S; Prevolotsky, A; Bonfil, D; Barkai, D and Silanikove, N (2000). Utilization of low quality resources by small ruminants in Mediterranean agro-pastoral systems: the case of browse and aftermath cereal stubble. Livest. Prod. Sci., 64: 39-49.

Maynard, LA; Loosli, JK; Hintz, HF and Warner, RG (1979). *Animal nutrition*. 7th. Edn., New York, McGraw-Hill Co., PP: 26-29.

Murphy, TA; Loerch, SC; McClure, KE and Solomon, MB (1994). Effect of grain or pasture finishing systems on carcass composition and tissue accretion rates of lambs. J. Anim. Sci., 72: 3138-3144.

Outmani, A; Luginbuhl, JP; Guessous, F and Johnson, WL (1991). Utilization of wheat stubble pastures by gestational sheep. Small Ruminant Res., 4: 257-267.

Rowe, JB (1986). Supplementary feed for sheep. J. Agric. West Aust., 27: 100-102.

Perevolotsky, A and Landau, S (1988). *Improving sheep farming in the Negev Bedouin sector: the bedouin model farm at lehavim*. A Joint Publication of ARO, Ministry of Agriculture (Beer Sheva) and the Jewish Agency (Negev). P: 77.

Rihani, S; Treacher, TT; Goodchild, AV and Owen, E (1991). Nutritive value of barley stubble. Annual Report 1990/91. ICARDA, Aleppo (Syria). PP: 158-162.

Rosilio, I; Barkai, D and Landau, S (1991). The contribution of wheat stubble to sheep nutrition in the Northern Negev. Hanoked 31, 27-30 (in Hebrew; cited in Landau *et al*., 2000).

Rowe, JB; Brown, G; Ralph, IG; Ferguson, J and Wallace, JF (1989). Supplementary feeding of young Merino sheep, grazing wheat stubble, with different amounts of lupine, oat or barley grain. Aust. J. Exp. Agric., 29: 29-35.

SAS, (1996). SAS System for Windows, Release 6.12, SAS Inst. Inc., Cary, NC, USA.

Undi, M; Kawonga, KVC and Musendo, RM (2001). Nutritive value of maize stover/pasture legume mixtures as dry season supplementation for sheep. Small Ruminant Res., 40: 261-267.

Wales, WJ; Doyle, PT and Pearse, GR (1990). The feeding value of cereal straws for sheep.

I. Wheat straws. Anim. Feed Sci. Technol., 29: 1-14.

Weekes, TEC (1986). Insulin and growth. In: Buttery, PJ; Haynes, NB and Lindsay, DB (Eds.), *Control and manipulation of animal growth*. Butterworths, London. P: 187.

Zamiri, MJ and Izadifard, J (1995). Effects of metaproterenol, a beta-adrenergic agonist, on feedlot performance and body composition of two fat-tailed sheep. Small Ruminant Res., 18: 263-271.