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Effect of Two Beta-Adrenergic Agonists on Performance and Carcass Composition of an Iranian Native Breed of Sheep

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Abstract : The effects of terbutaline (T), metaproterenol (M) and low energy diet (LE) on growth performance and carcass composition were evaluated in 72 Moghani culled ewes. T and M each one at the doses of 0, 5, 10 and 20 mg/ kg DM (C, T5, T10, T20, M5, M10 and M20 respectively) were added to the diet (ME: 2.9 MJ/Kg DM) of seven groups of 63 culled ewes and the other group was fed on LE (ME: 2.5 MJ/Kg DM) for the final 8 wk of the fattening period. T10 and M20 increased ($p<0.05$) final and cold carcass weights of ewes. LE ewes had lower daily dry matter intake than controls (1126 vs. 1500 g/day). Except for T5 and LE, all beta-adrenergic treated groups showed improved ($p<0.05$) of food conversion efficiency of 17.6% to 26.9% compared with controls. Increased ($p<0.05$) carcass efficiency was obtained by M5, M10 and M20 relative to controls (49.94%, 50.07% and 50.64% vs. 46.31%). Total carcass protein was higher ($p<0.05$) for ewes receiving the M20. Ewes treated with T20, M5, M10, M20 and LE had lower ($p<0.05$) fat-tail weight than controls (3.64, 3.55, 3.54, 3.52 and 3.99 kg vs. 4.52 kg). Blood urea concentration was reduced by LE treatment 12.5% and 23.8% on days 60 and 90 respectively. Results indicated that metaproterenol causes a repartitioning of nutrients resulting in improved feed conversion, increased carcass meat and lowered weight of-fat tail. Metaproterenol was more effective on feedlot parameters and carcass characteristics than terbutaline and low energy diet.

Key words: Metaproterenol, terbutaline, carcass, ewes

Introduction

Excessive deposition of fat is a major problem of the livestock industry today. The problem of extra fat especially in Iranian fat-tailed breeds of sheep is more prominent. Fattening of culled ewes is a common practice in Iran and since the majority of their gain in fattening period relates to fat, improving the quality of carcasses will be of great benefits to producers and consumers' health.

Phenethanolamine leanness-enhancing repartitioning agents have been studied in livestock species for more than two decades. Some beta-adrenergic agonists have been shown to decrease fat deposition and increase muscle accretion in thin-tailed sheep carcass (Baker *et al.*, 1984; Beermann *et al.*, 1986a, b, 1987; Hamby *et al.*, 1986; Kim *et al.*, 1987; Koohmaraie and Shackelford, 1991; Koohmaraie *et al.*, 1996; Li *et al.*, 2000). The results of feeding repartitioning agents include consistently reduced fat accretion accompanied by an increase in muscle mass. Any proposed mechanism must begin with the possibility of direct effects of the agonists on skeletal muscle and adipocyte ß-A receptors. ß-A agonists causes modification of metabolite concentrations and adipocytes (Mersmann, 1998; Beermann, 2002; Mersmann, 2002). Few experiments have been conducted with fully developed animals. So far, no studies have been reported the effects of oral administration of terbutaline and metaproterenol on feedlot parameters and carcass composition of ewes. This paper describes the effect of metaproterenol and terbutaline, chosen for low price and availability on feedlot parameters and carcass composition, in culled Moghani ewes and also compares their effects with those of a low energy diet.

Materials and Methods

In this study seventy two nonpregnant culled Moghani ewes, weighing 41±3.8 kg and approximately 6-7 years old were used. The experiment was conducted at the Kenebist farm of Astane Ghodse Razavi, which is located in Mashad. Moghani breed is well known as a moderate fat breed of sheep in Iran and is used for meat and carpet wool production. Ewes were housed in a well-ventilated closed barn in which they were randomly divided into 24 group pens (three ewes in each pen). A three month fattening schedule was arranged; in the first month animals were adapted to the treatment feeds. Then, sixty three ewes were administered T and M (0, 5, 10 and 20 mg/kg DM, designated C, M5, M10, M20, T5, T10 and T20, respectively) in a complete diet, in the

Table 1: Composition of diets

Ingredient (%)	Basal (control) diet	Low energy diet
Wheat straw	26	42
Barley	48	33
Wheat bran	11	9
Cottonseed meal	2.5	6
Dried sugar beet pulp	9	7.5
Cottonseed oil	1	---
Limestone	1.5	1.5
Vitamin premix	1	1
Chemical composition		
ME (MJ/Kg DM)	2.9	2.5
Crude protein (%)	12	12
Crude fiber (%)	16.2	22.3
Ca (%)	1	1
P (%)	0.7	0.6

second and third months of fattening period (nine ewes per treatment group). Other nine ewes were fed LE diet in two latter months of fattening period. The amount of fresh feeds offered daily at 08:00 h to each pen were adjusted daily to accommodate intake. Uneaten feeds were collected, weighed and discarded immediately before the next feeding. The feeds ingredients (balanced on the basis of ARC, 1994) and compositions are presented in Table 1. T and M powder (Iran Hormone Co.) were mixed with premix vitamin and thoroughly mixed with the basal diet. Salt licks and water were freely available. Animals were weighed at 30-day intervals. Feed and water were withdrawn for 12 h before weighing and slaughtering.

Individual blood samples were obtained from jugular vein at 0, 1, 3 and 5 hours after feeding on days 60 and 90. Samples were centrifuged at 1500×g for 20 min at 4 ^{o}C. Plasma was removed and stored at -20^{o}C pending analysis for glucose and urea. At the end of fattening period (day 91), four animals of each treatment were randomly slathered according to local practices and skinned. All the abdominal and thoracic organs were removed and carcass was prepared.

The hot carcasses were weighed immediately after dressing and removal of the offal parts. Weight of Cold Carcass (after 24 h), cavity fats (cardiac, renal, pelvic and gastrointestinal), meat and fat extracted from hot carcasses for all slathered animals were measured (Farid, 1989). By cutting between the 12th and 13th ribs of the back, the cross-section of the longissimus dorsi muscle (LD) was traced on paper, and then measured by digital planimeter. Fat-tail was removed, weighed and each cold carcass separated into two right and left side. Dissected fat and meat from the right side of carcass were completely minced. Minced meat and fat thoroughly mixed and a sample taken for determination of protein and fat (Association of Official Analytical Chemists 1975). The following plasma metabolites were quantified using kits from Zistshimi, Diagnostic Products (Tehran, Iran). Plasma glucose and urea concentrations were determined using an enzymatic, colorimetric-GOD-PAP and di-acetyl mono oxium procedures respectively. Data were analyzed using the GLM procedure of Statistical Analysis System Institute Inc (1996) and means were compared using Duncan's test (Steel and Torrie, 1981). Data related to feedlot and carcass parameters were adjusted by analysis of covariance using start weight and cold carcass weight as the covariate respectively.

Results

The effect of terbutaline, metaproterenol and low energy diet on the performance of ewes is summarized in Table 2. T10 and M20 significantly increased the final weight compared with controls (59.64 and 59.54 vs. 50.04 kg respectively). The highest and lowest amount of daily gain were observed in treatments contained metaproterenol and treatment, low energy diet respectively. Only low energy diet significantly decreased the dry matter intake compared with controls (1126 vs. 1500 g/day respectively). Except for LE, all treatments improved the feed conversion ($p < 0.05$) of course the change in T5 group was not significant. Table 3 summarizes the effect of terbutaline, metaproterenol and low energy diet on carcass characteristics and body composition. T10, M5 and M20 ewes had greater hot carcass weight than controls. Cold carcass weight also was affected by T10 and M20 (27.99 and 29.2 vs. 23.2 kg for controls). All doses of metaproterenol increased the carcass efficiency when compared with controls (49.94, 50.07 and 50.64 vs. 46.31 respectively). LD areas were greater in T20, M10 and M20 ewes than controls. M10 and M20 significantly increased the weight of meat dissected from carcass compared with controls (7.34 and 7.3 vs. 6.74); percentage of meat dissected from carcass only in M10 ewes was greater than controls. T, M and LE had no significant effect on fat weight of carcass excluding fat-tail, however, LE group had higher fat weight of carcass excluding fat-tail than M10 and all treatments of terbutaline. Cavity fat weight was not significantly different between treatment groups. T20, M5, M10, M20 and LE resulted in lower ($p<0.05$) weight of the fat-tail. Crude fat of carcass was not affected by treatments, however M20 group had more ($p<0.05$) carcass crude protein than controls. Effect of terbutaline, metaproterenol and low energy diet on blood metabolites is presented in Table 4. Blood glucose and urea were not influenced by beta-agonists, but LE reduced the blood urea.

Discussion

In this experiment, oral feeding of 10 and 20 mg/kg DM of metaproterenol increased final weight of culled ewes

Table 2: Effect of T[1], M[2] and LE[3] on performance of culled ewes

Item	C[4]	T5	T10	T20	M5	M10	M20	LE
Final weight (Kg)	50.04[b]	53.78[b]	59.64[a]	51.73[b]	53.43[b]	50.13[b]	59.54[a]	48.36[b]
Daily gain (g/day)	112[b]	119[b]	88[c]	76[c]	140[ab]	142[a]	142[a]	50[d]
Dry matter intake (g/day)	1500[a]	1500[a]	1465[a]	1417[a]	1465[a]	1400[a]	1400[a]	1126[b]
Feed conversion (dry matter intake/daily gain)	13.39[c]	12.60[c]	16.65[b]	18.64[b]	10.46[d]	9.86[d]	9.86[d]	22.52[a]

[a,b,c,d,e]Means in a row with similar superscripts do not differ ($p<0.05$).
[1, 2]T = terbutaline; T5 = basal diet with 5 mg/kg DM terbutaline; T10 = basal diet with 10 mg/kg DM terbutaline; T20 = basal diet with 20 mg/kg DM terbutaline; M = metaproterenol; M5 = basal diet with 5 mg/kg DM metaproterenol; M10 = basal diet with 10 mg/kg DM metaproterenol; M20 = basal diet with 20 mg/kg DM metaproterenol. [3]LE = Low energy diet (2.5 MJ kg/DM). [4]C = control (basal diet, 2.9 MJ kg/DM).

Table 3: Effect of T[1], M[2] and LE[3] on carcass characteristics of culled ewes

Item	C[4]	T5	T10	T20	M5	M10	M20	LE
Hot carcass (kg)	24.15[c]	26.44[bc]	28.73[ab]	25.51[c]	27.93[ab]	24.35[c]	30.86[a]	23.50[c]
Cold carcass (kg)	23.2[cd]	25.62[bc]	27.99[ab]	24.85[bcd]	26.67[abc]	23.95[cd]	29.20[a]	21.48[d]
Carcass efficiency	46.31[cd]	47.88[bc]	47.03[c]	48.24[bc]	49.94[ab]	50.07[ab]	50.64[a]	44.48[d]
LD area (cm^2)	10.87[d]	11.51[cd]	12.27[abcd]	13.23[abc]	11.77[bcd]	13.43[ab]	14.04[a]	12.55[abcd]
Carcass meat (Kg)	6.74[cd]	6.72[cd]	6.57[cd]	6.90[bc]	6.40[d]	7.43[a]	7.30[ab]	6.86[bc]
Carcass meat (%)	26.1[bc]	26.33[bc]	25.92[bc]	26.93[b]	25.01[c]	29.52[a]	26.96[b]	27.45[b]
Carcass fat (kg)	2.46[a]	2.08[a]	2.07[a]	2.08[a]	2.66[a]	1.53[a]	2.45[a]	2.81[a]
Carcass fat (%)	9.72[ab]	7.92[b]	8.13[b]	8.15[b]	10.18[ab]	8.21[b]	9.23[ab]	11.56[a]
Cavity fat (kg)	2.39[a]	2.33[a]	2.30[a]	2.85[a]	2.47[a]	2.78[a]	2.02[a]	2.54[a]
Fat-tail (kg)	4.52[a]	4.91[a]	4.52[a]	3.44[bc]	3.55[b]	3.54[bc]	3.52[bc]	2.99[c]
Carcass crude protein (%)	8.61[bcd]	9.04[bc]	9.68[abc]	8.51[cd]	9.46[abc]	8.19[d]	10.57[a]	9.77[ab]
Carcass crude fat (%)	17.01[a]	19.32[a]	19.84[a]	19.93[a]	22.02[a]	20.86[a]	20.96[a]	18.20[a]

[a,b,c,d]Means in a row with similar superscripts do not differ ($p<0.05$)
[1,2]T = terbutaline; T5 = basal diet with 5 mg/kg DM terbutaline; T10 = basal diet with 10 mg/kg DM terbutaline; T20 = basal diet with 20 mg/kg DM terbutaline; M = metaproterenol; M5 = basal diet with 5 mg/kg DM metaproterenol; M10 = basal diet with 10 mg/kg DM metaproterenol; M20 = basal diet with 20 mg/kg DM metaproterenol. [3]LE = Low energy diet (2.5 MJ kg/DM). [4]C = control (basal diet, 2.9 MJ kg/DM).

19.2 and 19% respectively. These results are consistent with Zamiri and Izadifard (1995), Kim *et al.* (1987), Galbraith *et al.* (1997) and Koohmaraie (1991) who observed increased final weight in sheep treated with beta-agonists agents. Injecting the fat-tailed lambs with 5 mg/kg metaproterenol increased cold carcass weight (Zamiri and Izadifard, 1995). Feeding the lambs with 10 ppm cimaterol, increased body weight 29% compared with controls (Kim *et al.*, 1987). Treating the lambs with cimaterol and clenbuterol resulted in heavier carcasses and more meat than controls (Warris *et al.*, 1989). Differences in results may refer to differences in administrated dose of beta adrenergic agents, method and duration of administration, kind and age of animal. According to some reports, greater responses to the beta adrenergic agonists are observed in older and heavier animals (Vestergaard *et al.*, 1994 and Moody *et al.*, 2000). In mature animals, energy requirement for the growth is approximately 50 MJ/kg gain, and for young animals it is reduced to 25 MJ/kg gain. In young animals the distribution of energy from fat toward muscle, results in improved growth efficiency (Wood and Fisher, 1990). Feed intake was not affected by beta agonists, however, it was lower ($p<0.05$) for ewes were fed on low energy diet. Lower feed intake in LE group may result from more roughage in this diet compared with control diet. Dry matter intake was not changed by clenbuterol treatment in wether lambs (Bohorov *et al.*, 1987) .Similarly Galbraith *et al.* (1997) found no change of dry matter intake in beta-agonist treated lambs. All three doses of metaproterenol improved the feed conversion in comparison with controls, whereas, low energy diet had reverse effect which probably resulted from higher roughness and lower palatability. Kim *et al.* (1987) reported that adding 10 ppm cimaterol to a TMR in fattening lambs leaded to 14% improvement of feed conversion. Similarly improvement in feed conversion has been reported in lambs as a result of administration of beta-agonists (Galbraith *et al.*, 1997; Warriss, 1989). The energy efficiency for deposition of a weight unit of muscle is much higher than that of fat since muscle is composed of 70% water. This suggests that the successful repartitioning of energy from fat to muscle can lead to an improvement in animal growth rate and feed efficiency (Kim *et al.*, 1987). Metaproterenol increased carcass efficiency of ewes in comparison with controls (50% vs. 46.3% respectively). Galbraith *et al.* (1997) reported significant improvement due to the

Table 4: Effect of T[1], M[2] and LE[3] on blood metabolites of culled ewes

Item (mg/dl)	C[4]	T5	T10	T20	M5	M10	M20	LE
Glucose (Day 60)	45.73[a]	46.23[a]	44.78[a]	45.27[a]	45.58[a]	46.02[a]	46.05[a]	44.09[a]
Glucose (Day 90)	46.82[a]	43.27[a]	44.31[a]	44.59[a]	45.60[a]	45.49[a]	43.95[a]	43.08[a]
Urea (Day 60)	18.03[a]	17.76[a]	17.64[a]	17.46[a]	18.93[a]	18.77[a]	18.22[a]	15.76[b]
Urea (Day 90)	19.81[a]	18.84[a]	18.86[a]	18.62[a]	19.30[a]	19.75[a]	19.86[a]	15.08[b]

[a,b,c,d]Means in a row with similar superscripts do not differ ($p<0.05$)

[1,2]T= terbutaline; T5=basal diet with 5 mg/kg DM terbutaline; T10= basal diet with 10 mg/kg DM terbutaline; T20= basal diet with 20 mg/kg DM terbutaline; M=metaproterenol; M5= basal diet with 5 mg/kg DM metaproterenol; M10= basal diet with 10 mg/kg DM metaproterenol; M20= basal diet with 20 mg/kg DM metaproterenol. [3]LE= Low energy diet (2.5 MJ kg/DM). [4]C=control (basal diet, 2.9 MJ kg/DM).

presence of cimaterol for cold carcass weight as a proportion of live weight. M10 and M20 increased the weight of carcass meat by 10% and 8% respectively. Zamiri and Izadifard (1995) reported increased meat dissected from cold carcass but no change in LD area as a result of metaproterenol treatment in sheep. LD cross sectional area was increased ($p<0.05$) by T20, M10 and M20 approximately by 22%, 23% and 29% respectively. In a study by Warriss *et al.* (1989), 25% enhance of LD cross sectional area was obtained by clenbuterol and cimaterol treatment. Beermann *et al.* (1986a,b) reported 26% and 32% greater cross sectional area in cimaterol fed lambs at 7 and 12 wk.

None of beta-agonists had significant effect on the weight of cavity fat, however, all doses of metaproterenol, T20 and LE decreased the weight of fat-tail compared with controls (3.55, 3.54, 3.52, 3.44, and 2.99 kg, vs. 4.52 kg respectively). The result of this investigation concerning the effect of beta–agonist on cavity fat is in agreement with the reports of Galbraith *et al.* (1997) and Kim *et al.* (1987) but contradictory with the results reported by Koohmaraie (1992) and Warriss *et al.* (1989). The differences between results probably come from various breed, age and sex of animal. A significant reduction in the weight of fat-tail in metaproterenl-treated lambs was reported by Zamiri and Izadifard (1995).

None of treatments had significant effect on blood glucose content. Blood urea was decreased only by LE treatment. The absence of cottonseed oil in the LE probably is the main cause for this effect. Galbraith *et al.* (1997) obtained significant reductions on average in plasma urea and free fatty acids at day 9 and increases in plasma glucose concentrations at day 49 in wether sheep treated with cimaterol. In a study by Kim *et al.* (1987), significant increases in plasma concentrations of fatty acid and triglyceride with the feeding of 10 ppm cimaterol were observed.

Conclusions: Metaproterenol and terbutaline dramatically improved the feed efficiency of culled ewes, but low energy diet had an opposite effect on the feed efficiency probably because of less palatability in comparison with control diet. Oral administration of metaproterenol significantly enhanced the carcass efficiency of ewes. According to the results of feed conversion rate and percentage of carcass crude protein, oral administration of 20 mg/kg.DM metaproterenol results in the best efficiency rate of fattening culled Moghani ewes.

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Abbreviations: T, terbutaline; M, metaproterenol; LE, low energy diet; DM, dry matter; ME, metabolizable energy; LD, longissimus dorsi