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Effect of Feeding with Some *Atriplex* Species in Complete Diet on Meat Quality and Carcass Characteristics of Najdi Ram Lambs

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ABSTRACT

Thirty six Najdi ram lambs (average weight 23 kg) were equally and randomly allotted to four dietary groups with three replicates per group. The diets comprised a whole mixed control diet containing hay (C) and three diets, namely *Atriplex halimus* (H), *A. lecucoclada* (L) and both types of *Atriplex* (H+L), where types of *Atriplex* was incorporated to replace the hay alfalfa in control diet. After 70 days of feeding, 24 lambs were randomly selected, fasted for 18 h and slaughtered. Results indicated that diets containing *A. lecucoclada* (L) and *Atriplex* (H+L) were significantly ($P<0.05$) lower in warm and cold carcass weights than control diet. Dressing percentage, longissimus dorsi muscle area, body wall thickness, fat thickness, soft tissue and bone ratio were not significantly affected compared to the control. Fat percentage differed significantly ($p<0.05$) with *Atriplex* diet. Chemical composition of soft tissue was not affected by replacing *Atriplex* with hay in the diets. There were no significant differences for pH, meat color and taste panel between control diet and *Atriplex* supplemented diets. Results indicated that *Atriplex* can replace alfalfa hay, commonly used roughage in Saudi Arabia.

Key Words: *Atriplex*; Meat quality; Carcass characteristics; Najdi lambs

INTRODUCTION

Atriplex species can be planted in saline water, have low water requirement and can play an important role in semiarid environments in many areas of the world. The plant can be utilized as a main or secondary source of feed in periods when the availability of conventional forage is low (Alicata *et al*., 2002). *Atriplex* species remain green even during droughts and maintain a relatively high crude protein content throughout the year (Weston *et al*., 1970; Devendra, 1989). Feeding *Atriplex* is therefore a feasible solution to minimize the problem of feed shortage especially in arid and semiarid regions. Most of these plants have low energy content (Hassan *et al*., 1979a); for this reason and to increase the utilization of these plants, animals should be given an energy supplement such as barley grains (Shawket & Ahmed, 2001) or some concentrate ingredients as complete or mixed rations.

There are a number of reports in literature detailing the growth performance of sheep fed on *Atriplex* (Wilson, 1966; Abou El-Nasr *et al*., 1996; Ben Salem *et al*., 2002). By contrast, few reports have been published on carcass characteristics and meat quality of lambs fed *Atriplex* spp. either alone or supplemented with other sources of nutrition. Hopkins and Nicholson (1999) reported that feeding *Atriplex* spp. to lambs had no effects on tenderness, juiciness or overall acceptability.

Finishing lambs on *Atriplex* either supplemented with hay or grains did not present any apparent meat quality problems compared to Lucerne feed lambs (Aganga *et al*., 2003). There are no previous studies using *Atriplex* as a complete diet in sheep. The present study was therefore, undertaken to evaluate the effect of feeding two types of *Atriplex* spp. as complete diets on carcass characteristics and meat quality of Najdi ram lambs.

MATERIALS AND METHODS

Animals and management. Thirty six Najdi ram lambs (average weight 23 kg) were used to evaluate the effect of feeding two types of *Atriplex* species (*Atriplex halimus & A. lecucoclada*) on carcass characteristics and meat quality. Prior to the experiment, lambs were treated for internal and external parasites and vaccinated against entero-toxemias. The animal were divided by weight and randomly allotted to four treatment groups with nine lambs per group. The lambs of each group were equally divided into three replicates, each of which being housed in a separate concrete floored pen in an open sided building. The lambs were fed on four diets (Table I). The experiment lasted 70 days to determine feed intake, daily gain and feed conversion ratio in previous stage. At the conclusion of this feeding experiment, 24 lambs (two rams per replicate) were randomly selected and slaughtered.

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Slaughter procedures. Lambs were fasted for 18 h shrink and slaughtered in a commercial abattoir. Live body weight and hot carcass weight were obtained for all lambs at the time of slaughter; the carcasses were chilled for 24 h and the following measurements were obtained: cold carcass, head, legs, lungs, hide, heart, liver, kidney, stomach, longissimus area, fat thickness and body wall thickness. The 9-11th rib joints were separated from the right side of each carcass and physically separated into bone and soft tissues. The soft tissues were ground through a 4 mm plate, mixed and ground again. During the second grinding three 10-20 gm sub-samples were taken from each carcass and placed in plastic bags and stored at - 20°C for chemical analysis.

Laboratory analysis. Samples of ground soft tissues were analyzed for moisture, ash, ether extract and crude protein according to AOAC (1990). Meat color was measured using Minolta Model CR-300 chromameter set on the L*, a*, b* system, where L* measures relative lightness, a* relative redness, b* relative yellowness and the average values were recorded. Surface pH of 3 different areas for each cut were measured directly using an electronic pH-meter equipped with combined pH surface electrode (Model MP 220, Mettler Toledo, USA) and the results were averaged and recorded.

For shear force and cooking loss, two steaks form each muscles were weighed and cooked using an electric oven (Hopart, Model ND 98, Troy, OH. USA) at 70ºC internal temperature. Steaks were turned over after reaching 40ºC. Internal temperature was monitored by Fisher alarm thermometer (Model No. 15-077-8B, Fisher Scientific, USA). After cooking, the steaks were allowed to equilibrate to room temperature (23ºC), then weighed and percentage of cooking loss were calculated (100 x $(w_i – w_f)/w_i$ where w_i was the initial weight of meat sample before cooking and w_f was its final weight after cooking. Three cores (1.27 cm diameter) were removed from each sample paralleled to the muscle fiber axis and sheared perpendicular to this axis using an Instron 4411 equipped with a Warner Bratzler shearing device. The crosshead speed was 100 mm min^{-1}.

For testing taste by a taste panel, meat samples were cooked similar to shear force samples. One cubic sample was presented to each of twelve panelists. The Juiciness, tenderness and overall palatability were performed by using 6 point scale (1 is very tender & 6 very tough). All of these traits were evaluated and their averages recorded.

Statistical analysis. Carcass characteristics data were statistically analyzed by ANOVA using GLM procedures (SAS, 1988). Duncan's multiple range tests was used to test for significant differences among means.

RESULTS AND DISCUSSION

Table II showed the effect of treatments on carcass characteristics. *Atriplex* (L) and *Atriplex* (H+L) were significantly ($p< 0.05$) lower in warm and cold carcass weights than the control. Dressing percentage was in the range of 52.95-51.89; the highest being recorded in control diet and the lowest values in the *Atriplex* L diet but no significant differences. Abdul Aziz *et al.* (2001) found that dressing percentage was significantly improved with the inclusion of halophytic silage with non conventional energy supplements in the fattening diet. Lambs feed *Atriplex* (L) were higher in longissimus muscle area than the other diets with no significant differences. Abdul Aziz *et al.* (2001) reported that eye muscle area was not significantly affected by introducing halophytic silage with non conventional energy source in the fattening diet. Thickness of body wall and fat did not show significant differences between different diets. Body wall thickness ranged between 16 mm to 15.33 mm, the highest value being recorded with *Atriplex* H, whereas fat thickness ranged between 6 mm to 7.33 mm

Table I. Composition of the experimental diets

Components	Experimental diets[1]			
	C	H	L	H + L
Hay	29.45	---	---	---
Atriplex halimus	---	29.03	---	14.51
A. lecucoclada	---	---	29.03	14.52
Barley	51.63	49.86	49.86	49.86
Corn	6.59	6.00	6.00	6.00
Soybean meal	9.06	12.75	12.75	12.75
Sodium bicarbonate	0.91	0.91	0.91	0.91
Dicalcium phosphate	0.36	0.36	0.36	0.36
Limestone	0.91	0.91	0.91	0.91
Trace minerals[2]	0.18	0.18	0.18	0.18
Salt	0.91	---	---	---
TDN*	72.12	67.52	68.18	67.36
DCP*	11.45	11.51	12.23	11.82

[1] C = control diet, H = *A. halimus*, L = *A. lecucoclada*,
H+L = Atriplex halimus + Atriplex lecucoclada
[2] Contained per kg: $COSO_4$, 0.30g, $CuSO_4$, 20.1g, $FeSO_4$, 10.0gm, ZnO_2, 50.0gm, $MnSO_4$, 40.2gm,
KI, 0.75gm, Nacl, 878.65gm, Vit A, 500.000Iu, Vit D, 500.000 Iu, Vit E, 10.000 Iu.
* These values were determined using sheep in digestibility trials.

Table II. Carcass characteristics and carcass traits of Najdi lambs fed experimental diets

Parameter	Experimental diets			
	C	H	L	H + L
Warm carcass wt (kg)	23.68^a	22.33^{ab}	21.29^b	21.94^b
Cold carcass wt (kg)	23.34^a	22.05^{ab}	21.01^b	21.68^b
Dressing (%)	52.95	52.27	51.89	52.72
Longissimus area (cm^2)	13.67	13.43	14.85	13.46
Body wall thickness (mm)	15.33	16.00	15.50	15.83
Fat thickness (mm)	7.33	6.83	6.17	6.00
Soft tissue: bone ratio*	2.92	3.46	2.82	3.26
Head**	9.95^{ab}	10.40^{ab}	10.63^a	9.87^b
Legs**	5.26	5.23	5.89	5.54
Hide**	19.14	18.73	20.52	18.75
Heart**	0.79	0.76	0.79	0.75
Liver**	3.35	3.52	3.37	3.09
Kidney**	0.58	0.66	0.63	0.59
Lungs **	2.47^b	2.76^a	2.69^{ab}	2.38^b
Stomach **	19.74	24.19	20.69	20.67

* Physically separated tissues (Fat + Lean) from 9-11th rib joint.
** % from warm carcass weight.
Values in the same row with different letters differ significantly ($P<0.05$).

with the highest value being recorded in the control diet. Swingle *et al*. (1999) reported that carcass merit was not affected by the different *Atriplex* forages in lamb trials. Hopkins and Nicholson (1999) noted that hot carcass weight and longissimus muscle area were not affected by *Atriplex* diet on 18 months old cross breed wether lambs. Lambs fed *Atriplex* diets tended to be less fat and leaner than control but no significant differences were recorded. These results agree with Pearce (2006) who reported that sheep fed salt bush with barley had a tendency to have a higher lean and a lower fat content. Head, heart, liver, kidney and stomach were not significantly affected by *Atriplex* diets as compared to control diets, whereas the lung percentage was higher in *Atriplex* H fed groups (Table II).

Animals fed *Atriplex* diet L and H tended to be higher in moisture contents but the differences between these groups and the control was non-significant (Table III). This result agrees with Hopkins and Nicholson (1999). Animal fed *Atriplex* L showed significantly (P<0.05) lower fat percentage in comparison to these fed control diet. Pearce (2006) reported that sheep grazing saltbush with barley supplement or fed a dried saltbush and barley ration had a significantly lower fat content than sheep grazing the control pasture plot. The ultimate muscle pH for the different groups was in the range of 5.73 to 5.61. These results were comparable to studies of Judge *et al.* (1994) and Dhanda *et al*. (1999). Hopkins and Nicholson (1999) found that muscle pH was not affected by grazed whether on saltbush plus supplement or Lucerne. There was no significant difference between groups for color values (where L* indicates relative lightness, a* indicates relative redness & b* indicates relative yellowness). These results were supported by Hopkins and Nicholson (1999) who found that meat color was not affected in lambs grazing on saltbush plus supplement or Lucerne. Our results indicate that L* values ranged from 44.58 to 43.07. This is higher than that reported by Hopkins (1996), where L* values were below 34 and considered dark by consumers. Shorthose (1989) and Warner (1989) concluded that a decrease in L* value and increase in a* value indicating a darker muscle color.

Table III. Chemical composition, pH, color, share force and taste panel of Najdi ram lambs fed experimental diets

Parameter	Experimental diets			
	C	**H**	**L**	**H + L**
Moisture (%)*	48.01	49.13	49.12	47.04
Protein (%)*	14.15	14.28	15.50	14.53
Ether extract (%)*	37.89[a]	35.47[ab]	32.49[b]	36.79[ab]
Ash (%)*	0.83	0.84	0.89	0.91
pH	5.67	5.73	5.69	5.61
L* (lightness)	43.82	43.07	43.65	44.58
a* (redness)	16.68	16.39	16.58	16.87
b* (yellowness)	8.13	8.16	8.31	8.83
Share force (kg)	2.74[a]	2.47[ab]	2.83[a]	2.08[b]
Tenderness	2.58	2.53	2.95	2.37
Juiciness	3.16[ab]	3.10[ab]	3.38[a]	2.98[b]
Flavor	2.83[ab]	2.72[ab]	3.15[a]	2.54[b]
Over all acceptability	2.64	2.62	2.74	2.31
Cooking losses	23.79	21.62	25.44	24.09

* Chemical analysis of the physically separated soft tissues from 9-11[th] rib joint. Values in the same row with different letters differ significantly (P<0.05).

Shear force values ranged between 2.74 for control diet and 2.08 for *Atriplex* H+L (Table III). No significant differences were found between diets accept *Atriplex* H+L. Taste panel data did not differentiate between treatments in juiciness, flavor and over all acceptability compared to the control (Table III). These results are in agreement with the findings of Pearce (2006), who reported no differences in eating quality in sheep meat consuming saltbush under different feeding conditions. Hopkins and Nicholson (1999) reported that there were no effect of feeding *Atriplex* to lambs on tenderness, juiciness and overall acceptability. Similarly, Aganga *et al.* (2003) noted that finishing lambs on *Atriplex* and either supplemented with hay or grains did not present any apparent meat quality problems compared to Lucerne feed lambs.

CONCLUSION

Feeding *Atriplex* L or H as complete diets to growing sheep has no effect on carcasses characteristics and meat quality and can be replace the conventional forages.

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