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Restructuring of Carcasses of Cull Ewe by Dietary Incorporation of Rumen Protected Fat during Pre Slaughter Fattening

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ABSTRACT

The objective of the present study was to restructure the carcass of cull ewes by incorporating rumen protected fats in the diet. Thirty cull ewes (>6 years old, BW 29.2±0.90 kg) were equally divided into 3 groups of 10 each. The animals were fed 0 (T_1), 2 (T_2) and 4% (T_3) rumen protected fat with adlib roughage and concentrate in cafeteria system for 90 days before slaughter. Pre-slaughter and hot carcass weights of ewes at the end of 90 days for T_1, T_2 and T_3 groups were 32.6, 15.71; 38.33, 18.4 and 37.05, 19.4 kg, respectively. Dressing yield (on ELW) in T_1, T_2 and T_3 groups was 55.16, 56.28 and 59.37%. It was significantly ($p<0.05$) higher in T_3 than T_1 and T_2 groups. The different primal cuts viz., leg, loin, rack, neck and shoulder and breast and fore shank for T_1, T_2 and T_3 groups contained 57.45, 52.11 and 58.01% lean; 13.62, 21.55 and 17.92% fat and 26.41, 23.21 and 19.91% bone, respectively. The loin eye area was 11.94 in T_1, 15.56 in T_2 and 15.72 cm^2 in T_3 and it was significantly ($p<0.05$) higher in T_3 than T_2 and T_1. The cooking losses and water holding capacity were 35.76 and 83.36 in T_1, 30.67 and 88.39 in T_2 and 31.10 and 86.48% in T_3, respectively. The shear force values of mutton for T_1, T_2 and T_3 groups were 3.66, 5.03 and 3.63 kg cm^{-2}, respectively. The present study suggested that supplementation of rumen protected fat at 4.00% level in cull ewe's diet increased pre-slaughter weights and carcass yield but did not improve meat quality.

Key words: Spent ewes, rice bran oil, calcium salts, carcass traits, mutton, physicochemical quality

INTRODUCTION

In ruminants, rumen microorganisms hydrogenate a substantial proportion of dietary Polyunsaturated Fatty Acid (PUFA), resulting in high levels of Saturated Fatty Acid (SFA) for absorption and deposition in muscle tissues (Sinclair *et al*., 2005). One-way to overcome rumen degradation is to protect the dietary lipid from microbial action. Various processes like hydrogenation, conversion to Calcium (Ca) salt, prilling and encapsulation commonly used to modify lipid and minimize or even eliminate changes of fermentation in the rumen when fat is added to the ration.

Inclusion of fat in the ruminant diets increases the caloric density without reducing fibre content, thus increase energy intake and efficiency of energy utilization (Jenkins and Jenny, 1992). Similarly, Reddy *et al*. (2003) reported that inclusion of calcium soap of palm oil at 10% in the diet improved the nutrient utilization without affecting the Dry Matter Intake (DMI) of straw-based diets in sheep.

Small amount of lipid containing supplements and protein improved production responses and were beneficial in producing carcasses with more lean compared with carcasses from lambs fed a low quality hay diet (Ponnampalam *et al.*, 2005). Incorporation of protected fat in the diet improves feed efficiency in fattening lambs and growth potential economically without affecting carcass quality (Dutta *et al.*, 2008). Use of protected fat in culled ewe rations is largely unexplored. The present study was therefore conducted to restructure the carcass of cull ewes by incorporating rumen protected fats.

MATERIALS AND METHODS

The study was conducted at Central Sheep and Wool Research Institute, Avikanagar, Rajasthan, India during the year 2010. The raw material was purchased from local market and rumen protected fat was made in the laboratory by double decomposition method. Thirty cull ewes (>6 years old, BW 29.2±0.9 kg) were equally divided into three groups of 10 each. The animals were provided diet containing 0% rumen protected fat (T_1), 2% rumen protected fat (T_2) and 4% rumen protected fat (T_3) for 90 days. They were fed adlib roughage and concentrate in cafeteria system.

Feed was withheld overnight with free access to water before slaughter. The weight of ewes was recorded before slaughter (pre-slaughter weight) and animals were slaughtered in the abattoir by halal method. Immediately after dressing, carcass depth (across the posterior to the scapula-humerus joint), carcass length (measured from the point of the hock to the point of the shoulder, anterior to the scapula-humerus joint) of the carcass hanging with achilles tendon were recorded.

The weight of digestive contents was obtained from difference between full and empty digestive tract. The Empty Live Weight (ELW) was computed as the difference between slaughter weight and weight of digestive content. Loin eye area (cm^2) was recorded on the cut surface of *Longissimus dorsi* muscle at the interface of 12th and 13th rib on both side of the carcass. The carcass was then split along the vertebral column into left and right halves. Left half was cut into leg, loin, rack and neck and shoulder and breast and foreshank as per ISI (1963) specification

pH of the samples was determined by homogenizing 10 g sample with 50 mL distilled water. The pH of the suspension was recorded by dipping combined glass electrode of digital pH meter. The method used by Hornsey (1956) was adopted for measurement of total pigments. Salt Extractable Proteins (SEP) and Water Extractable Proteins (WEP) were estimated as per the method of Kang and Rice (1970). Cook loss was determined by weight loss after cooking of meat for 1 h in water bath maintained at 80°C (Babiker *et al.*, 1990). The shear force value of cooked meat sample was determined by using Warner Bratzler Shear Press apparatus. The Water-Holding Capacity (WHC) was measured by the procedure of Trout (1988).

The data obtained for carcass and meat quality traits were subjected to analysis of variance (Snedecor and Cochran, 1968) using SPSS Base 13. Main effects were considered to be significant at $p<0.05$.The data is presented with mean values and standard errors.

RESULTS

Carcass characteristics: Average pre-slaughter and hot carcass weights of cull ewes for T_1, T_2 and T_3 groups were 32.6, 15.71 kg; 38.33, 18.4 kg and 37.05, 19.4 kg, respectively (Table 1). The carcass length and depth was non-significantly ($p>0.05$) higher in T_3 group. Dressing percentage on pre-slaughter weight was significantly ($p<0.05$) higher in T_3 group indicating the beneficial effect of dietary incorporation of fat. Total edible and inedible offal weights for T_1, T_2 and T_3 groups

Table 1: Carcass characteristics of culled ewes supplemented with different levels of rumen-protected fat

Parameters	T_1 (n = 5)	T_2 (n = 8)	T_3 (n = 8)
Carcass measurements and dressing yield			
Length (cm)	68.60±0.75	70.75±2.43	73.13±1.75
Depth (cm)	76.20±3.35	77.75±2.38	78.38±1.71
Pre slaughter wt (kg)	32.60±3.52	38.33±2.53	37.05±2.09
Empty live wt (kg)	28.12±3.04	32.61±2.21	32.64±1.67
Hot carcass wt (kg)	15.71±2.33	18.40±1.35	19.40±1.15
Dressing % PSW	47.66±2.02^b	47.91±0.96^b	52.45±1.55^a
Dressing % ELW	55.16±2.04	56.28±0.75	59.37±1.61
Forequarter wt (kg)	6.36±1.71	8.02±1.27	9.28±0.45
Hind quarter wt (kg)	5.44±1.52	7.18±1.15	8.19±0.45
Loin eye area (cm^2)	11.94±1.48^b	15.56±1.11^a	15.72±0.92^a
Inedible offal weight (kg)			
Blood	1.60±0.11	1.70±0.09	1.75±0.09
Head	1.92±0.15	1.93±0.10	1.85±0.09
Fore canon	0.40±0.03	0.40±0.03	0.38±0.03
Hind canon	0.30±0.04	0.32±0.02	0.29±0.03
Skin	2.82±0.35	2.99±0.21	2.83±0.25
Gall bladder	0.02±0.00	0.02±0.00	0.02±0.00
Uterus	0.12±0.05	0.14±0.02	0.09±0.02
Lung along with trachea + diaphragm	0.77±0.08	0.78±0.07	0.77±0.04
Total inedible offal	7.95±0.66	8.27±0.48	7.97±0.50
Edible offal weight (kg)			
Spleen	0.11±0.02	0.10±0.01	0.10±0.01
Pancreas	0.05±0.01	0.06±0.01	0.05±0.01
Caul fat	0.90±0.24^b	1.46±0.14^a	1.68±0.14^a
Kidney fat	0.52±0.14^b	1.03±0.15^a	1.08±0.05^a
Kidney	0.09±0.01	0.10±0.00	0.08±0.01
Heart	0.11±0.01	0.14±0.01	0.14±0.01
Liver	0.54±0.05	0.56±0.05	0.60±0.05
Total edible offal	2.37±0.43^b	3.52±0.30^a	3.87±0.23^a

Means bearing different superscripts between columns differ significantly ($p<0.05$)

were 2.37 and 7.95 kg; 3.52 and 8.27 kg; 3.87 and 7.97 kg respectively and edible offal was significantly ($p<0.05$) higher in T_3 than T_2 and T_1 groups while inedible offal was higher in T_2 than T_3 and T_1 groups. The muscular development as indicated by loin eye area for T_2 and T_3 was 11.94, 15.56 and 15.72 cm^{-2} and it was significantly ($p<0.05$) higher in T_2 and T_3 than T_1. The depot (non-carcass) fat distribution in both control and treated groups are presented in Table 1 and 2. Kidney and caul fat deposition was significantly ($p<0.05$) higher in treated group (T_2 and T_3).

The primal cut yields and lean fat ratio of lambs are presented in Table 3. The difference for wholesale cuts as a percentage of chilled half carcass tended to be small and mostly non-significant. Total fat content (subcutaneous and inter-muscular fats) of ewes for T_1, T_2 and T_3 was 13.62, 21.55 and 17.92% and it was significantly ($p<0.05$) higher in T_2 than T_1 and T_3 groups (Table 2).

Lean, fat and bone contents in individual cuts are presented in Table 3. Irrespective of treatments, leg contained maximum lean and loin contained maximum fat. In leg, lean content was more ($p>0.05$) in T_2 and T_3 as compared to T_1. Fat content showed the reverse trend, it was lower in T_3 than T_1. In rack cuts, lean content was higher ($p<0.05$) in T_3 while subcutaneous fat was significantly ($p<0.05$) higher in T_2. Bone content was significantly ($p<0.05$) higher in T_1, which may be due to proportionate decrease in lean and to some extent fat yield.

Table 2: Primal cut yield (% of half carcass) of culled ewes supplemented with different levels of rumen-protected fat

Parameters	T_1 (n = 5)	T_2 (n = 8)	T_3 (n = 8)
Carcass composition (%)			
Leg	29.98±1.18	29.55±0.71	30.07±0.32
Loin	13.87±0.88	15.80±0.47	14.47±0.43
Rack	15.15±0.52	14.11±0.55	14.29±0.27
Neck and shoulder	23.42±0.59	22.93±0.94	23.77±0.20
Breast and shank	17.58±1.02	17.62±0.48	17.40±0.47
Total separable (%)			
Lean	57.45±2.53	52.11±2.59	58.01±2.45
Subcutaneous fat (A)	6.18±0.40^{a}	10.71±0.94^{a}	9.38±1.12^{ab}
Inter muscular fat (B)	7.44±0.84	10.83±1.22	8.54±1.29
Total fat (A+B)	13.62±1.25^{b}	21.55±1.95^{a}	17.92±2.35^{ab}
Dissected bone	26.41±2.70^{a}	23.21±1.40^{ab}	19.91±0.88^{b}
KOH bone	17.46±2.13^{a}	13.52±0.94^{b}	11.99±0.81^{b}

Means bearing different superscripts between columns differ significantly ($p<0.05$)

Table 3: Lean, fat, bone (% of individual cuts) content and meat quality of culled ewes supplemented with different levels of rumen-protected fat

Parameters	Trait (%)	T_1 (n = 5)	T_2 (n = 8)	T_3 (n = 8)
Leg	Lean	63.49±2.22	63.26±3.01	65.02±2.66
	Subcutaneous fat	4.84±0.81	8.64±2.30	7.14±0.61
	Inter muscular fat	3.90±0.93	6.47±0.76	5.81±0.75
	Bone	25.62±3.32	20.75±0.81	20.18±1.35
	KOH bone	14.30±1.38	13.35±0.68	11.91±0.80
Loin	Lean	62.43±4.41	48.63±7.17	54.48±5.28
	Subcutaneous fat	8.23±1.33	12.60±1.44	15.53±3.20
	Inter muscular fat	10.43±2.15	19.03±5.50	14.14±3.26
	Bone	16.42±2.73	15.85±2.67	12.66±0.81
	KOH bone	21.77±11.31^{a}	7.10±1.27^{b}	6.92±0.84^{b}
Rack	Lean	51.38±0.62^{ab}	44.12±1.82^{b}	56.32±3.21^{a}
	Subcutaneous fat	5.45±0.98^{b}	14.01±2.30^{a}	9.28±1.20^{ab}
	Inter muscular fat	9.93±1.48	10.30±2.48	7.77±1.98
	Bone	29.07±2.43	26.89±3.47	21.65±1.17
	KOH bone	16.99±1.67	16.18±2.31	13.77±1.21
Neck and shoulder	Lean	55.55±5.07	55.75±2.63	61.00±1.85
	Subcutaneous fat	4.96±1.30	7.03±1.26	5.90±1.06
	Inter muscular fat	6.20±1.31^{ab}	8.71±0.75^{a}	5.54±0.69^{b}
	Bone	31.03±3.56^{a}	24.68±1.47^{b}	22.03±0.84^{b}
	KOH bone	19.18±1.25^{a}	14.98±0.76^{b}	13.85±0.80^{b}
Breast and shank	Lean	54.41±3.18	48.80±2.16	53.22±3.39
	Subcutaneous fat	7.42±0.52	11.27±1.28	9.07±1.99
	Inter muscular fat	6.74±1.15	9.65±1.32	9.41±1.50
	Bone	29.89±2.45^{a}	27.88±1.48^{a}	23.05±0.78^{b}
	KOH bone	15.05±1.65	16.00±0.96	13.52±1.19
Meat quality	pH_{24}	5.61±0.17	5.29±0.05	5.50±0.11
	Water extractable proteins	4.48±0.60	5.03±0.42	5.80±0.49
	Salt extractable proteins	12.08±0.53	12.28±0.66	12.00±0.70
	Total pigment (ppm)	182.51±8.8^{b}	188.57±5.3^{b}	225.80±17.3^{a}

Means bearing different superscripts between columns differ significantly ($p<0.05$)

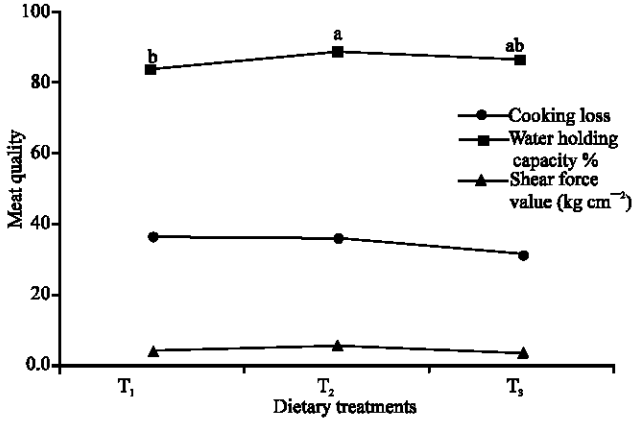

Fig. 1: Cook loss; water holding capacity % and shear force value of mutton from culled ewes fed varying levels of rumen-protected fat (a) T_1: control, T_2: 2% rumen protected fat, T_3: 4% rumen protected fat. Values bearing different superscripts differ ($p<0.05$)

Meat quality: The physico-chemical characteristics of meat are responsible for its quality and acceptability. In the present study, pH_{24} of meat was comparable in all the groups and ranged from 5.29 to 5.61 (Table 3). Mean pH_{24} values obtained from all groups were lower than 5.8 and within the acceptable range. Water extractable proteins were non-significantly ($p>0.05$) higher in treated group (T_2 and T_3) while salt extractable proteins were almost similar in the all the group. Total pigment content was significantly ($p<0.05$) higher in T_3 group.

Cook loss was higher ($p>0.05$) in control compared to treated groups (Fig. 1). Water holding capacity was significantly ($p<0.05$) higher in treated group. There was no significant difference ($p>0.05$) in shear force value of meat from control and treated ewes. In the present study, shear force value of meat samples varied from 3.63 to 5.03 in control and treated groups (Fig. 1).

DISCUSSION

Carcass characteristics: In present study incorporation of rumen-protected fat in the diet of ewes caused non-significant ($p>0.05$) increase in pre-slaughter weight and hot carcass weight. Results are in concurrence with Fernandez *et al.* (2004) who found no significant differences ($p>0.05$) in live-weight gain between the two groups of goats fed with rumen-protected supplements of fish oil. In present study there was slight reduction in pre-slaughter weight in T_3 group however hot carcass weights were higher compared to T_2. This is due to difference in weight of inedible offal (Fore canon and hind canon), total fat content of the carcass and skin weight which were higher in T_2 group. However, Dutta *et al.* (2008) reported that there was no significant improvement in dressing yields of lambs supplemented with graded level of palm oil. Carcass characteristics were not affected by adding increasing coconut oil in the concentrate mixtures of lambs (Bhatt *et al.*, 2011).

Earlier researchers have reported similar results that fat supplementation in the diets of fattening lamb increased carcass fatness (Santos-Silva *et al.*, 2004). It indicates that ewes in tropics deposits more fat in the viscera rather than in the subcutaneous region to facilitate thermolysis by cutaneous evaporative cooling which is a major route of body heat dissipation in sheep of warm climate. Earlier studies also indicated that inclusion of fat supplements results in greater subcutaneous fat thickness and deposition of more kidney and pelvic fats (Lough *et al.*, 1993;

Awawdeh *et al.*, 2009). The inclusion of lipid supplement in the diet of ruminants normally increases both cholesterol and triacylglycerol (Cant *et al.*, 1993).

Meat quality: The ultimate muscle pH observed was also similar between treatments and muscle types, ranging only between 5.56 and 5.85 in lambs fed with different levels of protected linseed oil (Kitessa *et al.*, 2009). Similarly the pH value in the present study was slightly lower than those reported by earlier worker (Banerjee *et al.*, 2009). Meat with lower Water Holding Capacity (WHC) loses more water resulting in higher cook loss (Vergara *et al.*, 1999). Generally, Warner Bratzler shear values that exceed 5.5 kg is considered as objectionably tough both by a trained sensory panel and consumers (Shackelford *et al.*, 1991).

CONCLUSION

The results suggested that dietary incorporation of rumen protected fat increased pre-slaughter weights carcass and edible offal yield but did not improve the meat quality in cull ewes. Moreover, supplementation of rumen-protected fat exaggerated the deposition of caul and kidney fat, which is not a desirable trait for quality meat.

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