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THE EFFECTS OF FEEDING HIGHER FIBER FEED ON MEAT QUALITY CHARACTERISTICS OF *M. LONGISSIMUS DORSI*

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Introduction

In the Sultanate of Oman, the protein and energy requirements of growing livestock are obtained mainly from soybean and maize, the major ingredients in concentrate feeds. These ingredients are imported at high cost. The country does not produce enough animal feed due to an acute shortage in fresh water and limited utilization of arable land. However, there are some readily available livestock feeds in the natural range grazing and browsing land as well as agricultural by-products, especially those from date palms and prosopis pods (Prosopis juliflora). The byproducts offer a cheap potential animal feed resource in Oman, which if effectively utilized could improve the supply of animal feeds and increase profit for local farmers.

Meat quality has recently become an important aspect in the marketing of meat products in Oman. Therefore, it is time to produce high quality meat. This is also applicable for the whole Gulf region due to similarity in breeds and environmental conditions and consumer's habits. An efficient marketing system for the Omani meat industry needs more information on meat quality in relation to consumers.

Objectives

This study aimed to investigate the effects of replacing commercial concentrate with a concentrate made mainly from native feed resources and a roughage made from palm frond silage on meat quality characteristics of *longissimus dorsi* (LD) muscle of Omani sheep.

Methodology

Thirty-two, 6 month old Omani male sheep were used in a feeding trial for 120 days. Animals were randomly divided into four groups of eight animals each and allocated randomly to one of four experimental diets groups. Animals for the first group were fed ad libitum chopped Rhodes grass hay plus 400 g of the commercial concentrate. Animals of the second group were fed ad libitum palm frond silage plus 400 g of the commercial concentrate. Animals of the third group received 400 g of the local by-products concentrate plus ad libitum chopped Rhodes grass hay. Animal of the fourth group received 400 g of the local by products concentrate plus ad libitum palm frond silage.

The by-product concentrate was made from 25% ground date fronds, 25% wheat bran, 20% ground prosopis pods, 15% barley and 12% dried sardines plus vitamin and mineral additives. The palm date frond silage was prepared by shredding palm fronds to approximately 1-2 cm size. A 3% urea solution was prepared by dissolving commercial fertilizer grade urea in tap water in a large sprayer's tank. Shredded palm fronds was weighed, loaded in a Reel Augie mixer, sprayed with urea solution using a sprayer and mixed thoroughly. The fronds-urea mix was then transferred into a 600-gallon plastic tank and manually pressed as hard as possible to reduce air. The tank was tightly sealed to avoid air entrance to the silage to allow anaerobic processing of fronds and urea mixture. The silage was kept in the tank for 4 weeks at the end of which it was emptied and spread for drying before feeding to animals.

Feed (Rhodes grass hay, palm frond silage, by-product and commercial concentrates) were analysed for dry matter (DM) by drying in an oven at 60^0C until no decrease in weight occurred, and for organic matter (OM) and ash by ashing at 450^0C for 12 h in a muffle furnace. Triplicate samples of approximately 2 g each were freeze-dried for 4 days for ether extracted (EE) by petroleum ether in a Soxhlet apparatus. Nitrogen was determined by Kjeldahl method according to the procedures of AOAC (1990). Acid detergent fiber (ADF), cell wall constituents neutral detergent fiber (NDF) were determined by the methods of Van Soest et al. (1991). Gross energy (GE) was measured using a calorimeter bomb. Analysis for all items was done in duplicates and expressed on dry matter basis.

The animals were slaughtered at the Municipality slaughterhouse in Muscat (Sultanate of Oman) according to routine slaughterhouse methods. The carcasses were kept at 1-3^0C for 24 h and then longissimus dorsi from the lumbar (loin) region was removed from the left side of the carcasses and frozen at -20^0C until processing. Meat quality-related measurements included ultimate pH, WB-shear force, sarcomere length; expressed juice and color (CIE L*, a*, b*) were determined. The ultimate pH was assessed in homogenates at 20-22^oC (using a Ultra Turrax T25 homogenizer) of duplicate 1.5-2 g of muscle tissue in 10 ml of neutralized 5-mM sodium iodoacetate and the pH of the slurry measured using a Metrohm pH meter (Model No. 744) with a glass electrode. Chilled muscle samples (13 mmx13 mm cross section) for assessment of shear force by a digital Dillon Warner-Bratzler (WB) shear device after prepared from muscle samples cooked in a water bath at 70^oC for 90 min (Purchas, 1990). Sarcomere length was determined by laser diffraction according to procedure Cross, et al. (1980/1981). Expressed juice was assessed by a filter paper method, as the total wetted area less the meat area (cm^2) relatively to the weight of the sample (g). Approximately 60 min after exposing the fresh surface, CIE *L**, *a**, *b** light reflectance coordinates of the muscle surface were measured at room temperature (25 ± 2^oC) using Minolta Chroma Meter CR-300 (Minolta Co., Ltd., Japan), with a colour measuring area 1.1 cm diameter. It was calibrated using a Minolta calibration plate (*L** =97.59, *a** =-5.00, *b** =+6.76). The *L** value relates to Lightness; the *a** value to Red-Green hue where a positive value relates to the red intensity; and the *b** value to the Yellow-Blue where a positive value relates to yellow. The average of two measurements from each sample was recorded as the colour coordinate value of the sample.

Data were analyses using the GLM procedure within SAS (SAS, 1993), with the model containing items for the four treatments.

Results & Discussion

All experimental animals including those fed the palm by-products did not signs of ill health throughout the trial. As g%DM, the by-product and commercial concentrates contained 17 and 19% CP; 24 and 6% ADF; 38 and 18% NDF; 12 and 7% ash; and 18 kj/g gross energy, respectively. The date palm silage and Rhodes grass contained 3 and 7% CP; 58 and 45% ADF; 69 and 76% NDF; 12 and 8% ash; and 21 kj/g gross energy, respectively. The chemical composition of the two concentrates and two roughages used are presented in Table 1.On dry matter basis, the local by-products concentrates and commercial concentrates contained 17 and 19% CP; 24 and 6% ADF; 38 and 18% NDF; 12 and 7% ash; and 18 and 18 KJ/g gross energy, respectively. The date frond silage and Rhodes grass contained 3 and 7% CP; 58 and 45% ADF; 69 and 76% NDF; 12 and 8% ash; and 21 and 21 KJ/g gross energy, respectively. These diets are cheap and readily available and can be used for feeding sheep.

The main factor determining the quality of meat is its pH, which is related to biochemical processes during the transformation of muscle to meat. Therefore, changes in the pH during the post-mortem period influence the meat quality characteristics. Higher ultimate pH produces dark meat color, reduces storage life and can lead to tougher meat (Chrystall & Daley, 1996). A low plane of feeding can result in chronic nutritional stress, characterized by low reserves of muscle glycogen and increased final pH values in the meat (Bray, et al., 1989). Meat ultimate pH values in the present study were not significantly ($P>0.05$) different between the four diet groups ranging between 5.77 to 5.9 (Table 2), and they were within the range for sheep reported by Carson, et al. (2001). However, They were higher than those reported by Devine, et al.(1993) and Lanza, et al. (2003) for ultimate pH values. The ultimate pH value depends on glycogen levels as slaughter. Therefore lack of differences in ultimate pH values between the four diet groups indicate that there was no effect of the diet, on the muscle glycogen content at slaughter.

Lightness (L*), redness (a*) and yellowness (b*) values of LD muscle were comparable among the four groups (Table 2). Meat color differences can occur due to a direct effect of the diet on the chemical state of the myoglobin on the surface of the meat (Purchas, 1989). Meat color is related to other factors such as ultimate pH, structure and physical state of muscle proteins carcass fatness, age, carcass weight and proportion of intramuscular fat (Carson et al., 2001; Priolo, et al., 2001). All these parameters that were similar in the present study across the four diet groups may have collectively contributed towards producing similarity in meat color. The color of the LD muscle in the present study was lower than that reported by Devine, et al. (1993); Lanza, et al. (2003) and Carson et al.(2001) for sheep, which may be due to differences in ultimate pH. Values of ultimate pH above the isoleectric point of proteins of 5.5 result in an open structured muscle and a greater diffusing of light between the myofibrils of the muscle, which make the cut face of the meat darker (Seideman and Crouse, 1986). The lower L* values of the meat samples from the present study is in line with the expected changes in lightness vales as given by Seideman and Crouse, 1986). Moreover, increased pigmentation in meat may be due to a higher iron content in diets rich in forages and concentrates or may be also due to age differences The low L* and high a* values could be related to higher haem pigment which has been noted to increase with age (Devol et al., 1985).

Water holding capacity is the ability of meat to retain its constituent water when an extraneous force or treatment is applied to it. This property affects the retention of vitamins, minerals and salts, as well as the volume of water retained. Muscles that lose water easily are drier and lose more weight during refrigeration, storage and marketing. Water holding capacity measured as expressed juice was similar between the four diet groups Sarcomere length was not affected by the experimental diets. Tenderness variation arises mainly through changes to the myofibrillar protein structure of muscle in the period between animal slaughter and meat consumption. Warner-Bratzler shear force was similar between the four diet groups and it was below 6 kg cm^{-2}, which accounted for acceptable tender samples (Devine, et al., 1993). Similarly, Carson et al. (2001) and Lanza, et al. (2001) studied feed efficiency of different rations on meat quality of sheep and concluded that sarcomere length or WB-shear force values were not affected. Overall, the values for sarcomere length and for WB-shear force values were higher than those reported by Carson et a. (2001) for British sheep breeds.

Conclusions

This study indicated that replacing the commercial concentrate and Rhodes grass hay with a more fibrous feed made from local by-products did not produce significant effects on meat quality characteristics.

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Table 1. Chemical composition of the feeds used in the study (g/100g DM).

Chemical component	Rhodes grass	Date Palm frond silage	Commercial concentrate	By-product concentrate
Crude protein	7	3	19	17
ADF	45	58	6	24
NDF	69	76	18	38
Ash	8	12	7	12
Energy (kg/g)	20.96	19.23	18.32	17.91

Table 2. Effects of date palm frond and prosopis pods on meat quality characteristics of *longissimus dorsi* muscle in Omani sheep.

	Diet				SEM	p-value
	A	B	C	D		
Ultimate pH	5.77	5.83	5.86	5.90	0.081	NS
WB-shear force	4.46	4.85	4.46	4.95	0.509	NS
Sarcomere length	2.08	2.08	2.00	2.02	0.066	NS
Expressed juice	28.83	30.24	29.12	29.05	0.986	NS
Color *L**	33.73	33.30	35.03	33.79	0.672	NS
Color *b**	11.04	11.10	11.53	11.24	0.425	NS
Color *a**	23.69	24.22	24.43	23.01	0.486	NS