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Effect of Feeding Crushed Roselle Seed (*Hibiscus sabdariffa* L.) (Karkadeh) on Carcass Characteristics of Sudan Desert Sheep

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ABSTRACT
Sudan is a vast country that is well known of its large animal population. Roselle is one of the important oil crops usually grown in Sudan for plant oil manufacturing. This experiment was conducted to investigate and evaluate Roselle seed as a ruminants feed through the effects on carcass characteristics of Sudan desert sheep. Crushed Roselle Seeds (CRS) meal was used at three levels (0, 15 and 25%). Roselle seeds were incorporated in three isocaloric, isonitrogenous diets (A, B and C, respectively). Thirty-six male lambs of Sudan desert sheep, Hamari ecotype, were selected according to their age (4-5 months) and their average body weight (21.8 kg). The lambs were randomly assigned to three treatments (12 animals each), then animals in each treatment were subdivided into three groups each of four animals (replicates) the trial extended for two months. The study showed a significant difference ($p>0.05$) among the treatment groups for slaughter weight (highest 38.17, lowest 37.59), empty body weight (highest 23.90, lowest 22.75), dressing percentage on live body weight (highest 52.70, lowest 49.68), dressing percentage on empty body weight (highest 62.25, lowest 60.51), hot carcass weight (highest 20.66, lowest 18.27), cold carcass weight (highest 20.31, lowest 18.23), carcass wholesale cuts, meat quality attributes, carcass physical composition and carcass chemical composition. On other hand slaughter by-products showed no significant differences ($p<0.05$) among treatment groups except liver, mesenteric fat, rumen (empty), reticulum (empty) which showed significant difference ($p>0.05$) among the treatments groups. Feeding of 25% crushed Roselle seed meal seems to enhance carcass characteristics and gave satisfactory results.

Key words: Carcass characteristics, dressing percentage, lambs, oil seed, quality attributes

INTRODUCTION
With the rise in the standard of living, in Sudan, there is an increasing demand for good quality mutton. Quality requirements vary greatly between countries and even between districts within the same country. Quality characteristics may be quantitative or qualitative. They include dressing percentage, carcass yield of muscle, bone and fat, the distribution of fat, proportion of expensive meat cuts, colour of lean, colour of fat and eating quality of the meat, thus the characteristics which contribute to quality are numerous and there is no single definition for carcass quality (Gumaa, 1980).

Oil seed cakes, grains, agricultural and industrial by-products were use for fattening meat animals to improve meat characteristics. Many studies were done for improving performance and meat characteristics through the use of agricultural by-products (Turki *et al*., 2011; Priolo *et al*., 2002; Mahgoub *et al*., 2007; Abbas and Yagoub, 2008; Yagoub and Abbas, 2009; Beshir *et al*., 2009; Suliman and Babiker, 2007).

Therefore, many investigators suggested that Roselle seeds may be used as an alternative for oil seed cakes as a source of protein in small ruminants and poultry feeds (Salih and Abdel-Wahab, 1990; Mohammed and Idris, 1991; El-Toum, 1992; Bakheit 1993; Beshir, 1996; Beshir and Babiker 2009; Agib, 1999). The objective of this work was to study the effect of feeding different levels of roselle seeds on sheep carcass characteristics and meat quality attributes.

MATERIALS AND METHODS

Experimental animals: Thirty-six male lambs of Sudan desert sheep, Hamari ecotype, were selected according to their age (4-5 months) and average body weight (21.8 kg). The animals were fed with experimental rations which include three treatments with three different levels of Crushed Roselle Seeds (CRS) (0, 15 and 25%) (Table 1), for 60 days (finishing).

Experimental house: The experimental animals were sheltered in semi open house the sides of which were made of corrugated steel, bamboo poles and steel bars of about three meters high and the roof was made of zinc sheet. Each pen was provided with water plastic bucket and feed troughs.

Slaughter procedure: At the end of the experimental period, three animals were taken from each treatment according to the average body weight of each treatment for slaughter. Slaughter weight

Table 1: Experimental rations formulation

	Groups (CRS level)		
Item	A (0%)	B (15%)	C (25%)
Ingridients (%)			
Crushed roselle seed	0.00	15.00	25.00
Ground nut cake	25.00	10.00	0.00
Wheat bran	25.00	25.00	25.00
Sorghum gain	30.00	30.00	30.00
Molasses	14.00	11.19	10.65
Bagasse	2.00	4.00	4.00
Urea	0.00	0.81	1.35
Oyster shell	2.00	2.00	2.00
NaCl	2.00	2.00	2.00
Total	100.00	100.00	100.00
Experimental rations chemical composition			
Dry matter (%)	96.20	95.70	96.00
Crude protein (%)	19.00	18.40	18.80
Crude fiber (%)	8.40	9.20	10.00
Ether extract (%)	3.60	4.90	5.20
Ash (%)	10.50	11.90	13.90
Metabolized energy (MJ kg^{-1} DM)	11.60	11.64	11.80

was taken after an overnight fasting. The animals were slaughtered according to Muslims procedure, by severing the jugular veins, carotid arteries, trachea and esophagus using a sharp knife without stunning. After complete bleeding, the head was removed at atlanto-occipital joints. The feet were cut at knees and hock joints, the body was then hanged by hooks and skinning was completed.

Slaughter data: After skinning was completed, the skin, feet, as well as the internal organs, were individually weighed. The alimentary tract was separated into the rumen, the reticulum, the omasum, the abomasum, the small intestine and the large intestine and then weighed (empty). The testicles were separated and weighed.

Carcass data: The carcasses were weighed warm and then chilled at 4°C for about 24 h, thereafter the cold carcasses were reweighed. The kidneys and kidney knob channel fat were removed and weighed. The carcasses were then separated into wholesale cuts according to Smith *et al*. (1989) and individual cut weight was obtained.

Meat dissection: A rib section containing four ribs (9-12) was obtained from each carcass, then weighed and dissected into muscles, bones, connective tissues and fats. The weight of each tissue was determined and recorded. The meat was covered by wet towels and kept on labeled sacks throughout the dissection to prevent loss of weight through water evaporation.

Samples for chemical analysis and quality determination: Samples taken from longissimus dorsi were kept in polythene bags and stored in deep freezer waiting physical and chemical analysis. The frozen tissues was prepared for analysis by grinding in an electric grinder, weighed and left for analysis. Two types of samples were prepared for analysis: Carcass sample: which contains all tissues (muscles, bone and fat). Muscle sample: This contains only muscles.

Carcass quality attributes

Water-holding capacity (WHC): Water holding capacity was calculated according to Alaswad (1984). Three meat samples from each rib sections about 0.3 g were ground and were placed on a humidified filter paper (What man No. 40) of known weight then the samples were pressed between two Plexiglas plates for 10 min at 1 kg load. Each filter paper was reweighed and the difference between the two weights was obtained. The water holding capacity then calculated using the following equation:

$$\text{WHC (\%)} = \text{Actual moisture (\%)} - \text{Free water in sample (\%)}$$

Carcass shrinkage: Carcass shrinkage is an expression that shows the differences between warm and cold carcass weight as a percentage. The carcass shrinkage was calculated using the following equation:

$$\text{Carcass shrinkage (\%)} = \frac{\text{Warm carcass wt.} - \text{Cold carcass wt.}}{\text{Warm carcass wt.}} \times 100$$

Cooking loss determination: Semi-membranous samples were thawed, placed in plastic bags in a water bath at 80°C for 90 min. Samples were then cooled in running water, dried from fluids and reweighed. Cooking loss was calculated as the loss in weight during cooking and it was expressed as a percentage of pre-cooking weight:

$$\text{Weight loss during coking (\%)} = \frac{W_1\text{-}W_2}{W_1} \times 100$$

where, W_1 is weight before cooking and W_2 is weight after cooking.

Panel test and panelists: Meat quality attributes were evaluated by a panel test. The quality parameters evaluated in this study were tenderness juiciness, color and flavor. Twenty questioner cards were distributed to the individuals who were intended to test the experimental animal's meat.

The chemical analysis: Samples of meat and of the experimental rations were subjected to proximate analysis according to AOAC (1995) at the Center of Animal Nutrition Research Laboratory, Kuku, Sudan. Traits studied (as percentages) were total moisture, ash, crude protein, crude fibre and fat (ether extract).

The statistical analysis: Data sets were subjected to Minitab Stat V. 13 (randomized complete block designs) according to Steel and Torrie (1980). Duncan multiple range test was used to detect difference between means (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Table 2 shows the results of carcass yield. There were significant differences (p>0.05) among treatments for slaughter weight (38 vs. 37), empty body weight (23 vs. 22), hot carcass weight 20 vs. 18), cold carcass weight 20 vs. 18), dressing percentage (on slaughter weight basis) (52 vs. 49) and dressing-out percentage (on empty body basis) (62 vs. 60). Group B and C had highest values of carcass characteristics compared to group A. Values of these traits increased as the CRS level increased in the formulated ration, this is in accordance to Beshir (1996).

Table 2: Carcass data and carcass composition values of experimental lambs fed with CRS

	Groups (CRS level)		
Item	A (0%)	B (15%)	C (25%)
Slaughter weight (kg)	37.59±0.06[b]	38.48±0.11[a]	38.17±0.34[a]
Empty body weight (kg)	22.75±0.03[c]	23.46±0.02[b]	23.90±0.02[a]
Hot carcass weight (kg)	18.27±0.02[c]	20.15±0.02[b]	20.66±0.03[a]
Cold carcass weight (kg)	18.23±0.02[c]	19.60±0.05[b]	20.31±0.01[a]
Dressing in live weight (%)	49.68±0.01[b]	52.23±1.00[a]	52.70±0.35[a]
Dressing in empty weight (%)	60.51±0.01[c]	61.16±0.03[b]	62.25±0.02[a]
Total muscles (%)	53.10±0.05[a]	52.76±0.12[b]	53.06±0.03[a]
Total bone (%)	22.76±0.02[a]	20.20±0.05[c]	20.80±0.01[b]
Total fat (%)	24.10±0.03[c]	25.60±0.05[b]	26.53±0.08[a]
Total connective tissues (%)	11.54±0.79[a]	8.86±0.20[b]	9.87±0.47[ab]

Values (Mean±SE) with different letters are significantly different at p≥0.05

Table 2 showed that there were significant differences ($p>0.05$) among the treatment groups for total muscles (53 vs. 52%), total bone (22 vs. 20%), total fat (26 vs. 20%) and total connective tissues percentage. Treatment A and C appeared to have high values of total muscles and bone percentage while treatment B and C recorded highest values of total fat percentage. The fat percentage increased with increase level of Roselle seed, this may be attributed to high oil content of Roselle seed meal that provides more energy for fat deposition.

Table 3 showed the results of wholesale cuts for the experimental Sudanese lambs as percentage of carcass weight. There were significant differences ($p>0.05$) among the treatment groups (legs 30.71 vs. 30.35, shoulder 16.95 vs. 16.29, loin 12.44 vs. 12.13, rack 14.65 vs. 13.55, breast (6.56 vs. 6.30, neck 6.97 vs. 6.59 and tail 5.53 vs. 4.28). Values of shoulder, legs, loin and rack cuts were high in treatments B and C. Tail weight showed significant difference ($p>0.05$) among the treatments. Lambs fed rations containing Roselle seeds meal tended to have heavier tail weight compared with those fed no Roselle seeds meal (treatment A), This result agreed with Beshir (1996).

Table 4 showed values of non-carcass traits, some of which showed significant differences ($p<0.05$) among treatments (Liver 3.34 vs. 2.73, mesenteric fat 4.31 vs. 2.86, testicles 2.37 vs. 1.54, rumen 3.49 vs. 2.61 and the reticulum 1.15 vs. 0.57). Treatments (A), the control group, have the highest testicular weight compared to group B and group C. Testicular weight was adversely proportioned to the level Roselle seed meal. This may be attributed to the suggested estrogenic effect of Roselle seed meal. Treatment C tended to have high values for mesenteric fat and liver weight which attributed to fat content and estrogenic effect of Roselle seed meal. Obtained results disagreed with Beshir (1996).

Table 5 and 6 showed results of carcass and muscles chemical composition. There are significant differences ($p>0.05$) among the treatments for moisture, crude protein, ether extract and ash. Lambs that received Roselle seed in their rations had the highest value of moisture, ether extract and ash for both carcass and muscles chemical composition. While lambs fed rations containing no Roselle seed meal had the highest value of crude protein. This is in accordance to Beshir (1996). This maybe due to high protein, fat and minerals content of ration A attributed to groundnut cake incorporated in this ration. This is in agreement to Al-Wandawi *et al*. (1984) and El-Adawy and Khalil (1994).

Table 7 depicts results of meat quality attributes. Carcass shrinkage values, showed no significant difference ($p<0.05$) among different treatments. However treatment C had the highest values, while treatment A had the lowest Beshir (1996) reported high values for this trait (5.14, 4.90 and 3.71) with no significant difference ($p<0.05$) among treatments.

Table 3: Average values of wholesale cuts out of carcass weight of experimental lambs fed with CRS

	Treatment groups (CRS level)		
Item (%)	A (0%)	B (15%)	C (25%)
Legs	30.35 ± 0.03^{b}	30.59 ± 0.05^{a}	30.71 ± 0.02^{a}
Shoulder	16.29 ± 0.01^{c}	16.70 ± 0.05^{b}	16.95 ± 0.03^{a}
Loin	12.13 ± 0.02^{c}	12.44 ± 0.02^{a}	12.26 ± 0.03^{b}
Breast	6.56 ± 0.03^{a}	6.37 ± 0.06^{b}	6.30 ± 0.01^{b}
Rack	13.55 ± 0.03^{b}	14.65 ± 0.02^{a}	14.63 ± 0.02^{a}
Neck	6.97 ± 0.01^{a}	6.59 ± 0.02^{b}	6.62 ± 0.01^{b}
Tail	4.28 ± 0.01^{a}	5.22 ± 0.01^{b}	5.53 ± 0.02^{c}

Values (Means±SE) with different letters are significantly different at $p\geq0.05$

Table 4: Non-carcass components values as percentage of empty body weight of experimental lambs fed with CRS meal

	Treatment groups (CRS level)		
Item (%)	A (0%)	B (15%)	C (25%)
Skin	13.90±0.31	13.32±0.43	12.95±0.52
Head	12.39±0.16	10.55±0.16	9.89±0.15
Feet	4.30±0.04	4.06±0.01	4.25±0.01
Heart	0.94±0.01	0.92±0.12	0.74±0.12
Lungs and trachea	2.34±0.01	2.21±0.13	2.31±0.13
Liver	2.73±0.01^{ab}	3.34±0.01^{a}	2.97±0.01^{b}
Spleen	0.48±0.00	0.61±0.00	0.70±0.00
Pancreas	0.22±0.00	0.21±0.00	0.32±0.00
Mesenteric fat	2.86±0.01^{ab}	3.53±0.16^{a}	4.31±0.16^{b}
Rumen (empty)	2.61±0.01 ^{ab}	3.49±0.16 ^{a}	3.27±0.01^{b}
Reticulum (empty)	0.62±0.05^{b}	0.57±0.00^{ab}	1.15±0.01^{a}
Small intestine (empty)	3.44±0.11	3.80±0.00	3.34±0.05
Large intestine (empty)	3.74±0.14	3.23±0.21	3.23±0.01
Abomasum	0.97±0.00	0.68±0.00	1.39±0.00
Omasum	0.63±0.02	0.63±0.02	0.66±0.00
Testicles	2.37±0.00^{a}	1.71±0.01^{b}	1.54±0.02^{ab}

Values (Means±SE) with different letters are significantly different at p≥0.05

Table 5: Carcass chemical composition

	Treatment groups (CRS level)		
Item (%)	A (0%)	B (15%)	C (25%)
Moisture	50.75±0.02^{b}	52.62±0.05^{a}	51.60±0.00^{ab}
Crude protein	20.95±0.03^{b}	20.72±0.01^{b}	20.30±0.01^{c}
Ether extract	22.96±0.03^{c}	23.99±0.01^{b}	26.22±0.01^{a}
Ash	4.05±0.01^{c}	4.85±0.02^{b}	5.40±0.03^{a}

Values (Means±SE) with different letters are significantly different at p≥0.05

Table 6: Muscles chemical composition

	Treatment groups (CRS level)		
Item (%)	A (0%)	B (15%)	C (25%)
Moisture	94.20±0.28^{b}	95.70±0.14^{a}	96.00±0.06^{a}
Crude protein	23.59±0.23^{a}	22.65±0.02^{b}	20.80±0.02^{c}
Ether extract	7.83±0.02^{c}	10.83±0.02^{b}	11.20±0.01^{a}
Ash	1.01±0.01^{c}	1.50±0.03^{b}	1.90±0.05^{a}

Values (Means±SE) with different letters are significantly different at p≥0.05

There were high significant differences (p>0.01) among the treatments for water holding capacity (WHC). Treatment C had the highest values of WHC. This might be due to high fat content of the carcass as indicated by Lawrie (1979). On the other hand Beshir (1996) reported WHC of 1.80, 1.96 and 1.66 which showed no significant difference (p<0.05) among the different treatments.

Table 7 present results of cocking losses. Although there were no significant differences (p<0.05) among the different treatments for cooking losses, treatment B had the highest values, while

Table 7: Meat quality attributes

	Treatment groups (CRS level)		
Item	A (0%)	B (15%)	C (25%)
Carcass shrinkage (%)	2.02±0.01	2.04±0.02	2.00±0.01
Water holding capacity (%)	34.41±0.04[c]	35.13±0.31[b]	36.75±0.03[a]
Cooking loss (%)	7.83±0.02[b]	10.83±0.02[a]	11.20±0.01[c]
Extremely tender	8.33±2.96[b]	11.00±0.58[a]	11.00±0.08[b]
Very tender	7.67±0.07	7.33±0.03	8.00±0.08
Moderately tender	1.67±0.02	1.67±0.03	4.00±0.01
Extremely juicy	6.33±0.02	9.00±0.01	7.33±0.03
Very juicy	8.33±0.03	8.67±0.02	7.67±0.08
Moderately juicy	5.33±0.08[a]	4.33±0.03[b]	5.00±0.08[a]
Extremely flavor	7.33±1.67	10.67±1.33	6.33±2.60
Very intense color	8.00±0.02	7.00±0.01	8.00±0.03
Moderately intense color	4.67±0.01	4.33±0.02	5.67±0.02
Extremely desirable color	7.33±0.01[b]	9.33±0.03[a]	5.33±0.01[b]

Values (Mean±SE) with different letters are significantly different at $p \geq 0.05$

treatment C had the lowest values. These differences in cooking losses could be attributed to differences in water holding capacity and fat content. Obtained result is in accordance to Beshir (1996).

The age, sex, degree and system of fattening and type of nutrition affect the tenderness, juiciness, colour, flavor and marbling. The above-mentioned parameters showed different levels of significance among the different treatments. Although, carcass of both group B and C had the best value of above characteristics, the results showed no significant difference ($p>0.05$) among the different treatments for tenderness, juicy and flavor while, carcass from treatment A considered to have the lowest degree of tenderness, juiciness, colour, flavour and marbling. These may be due to high fat content of meat produced from carcass C. On other hand treatment B and C score high values of meat characteristics (extremely tender, extremely juicy, extremely flavor and extremely desirable), that is attributed to the effect of estrogenic factors of Roselle seed meal. Results of this study agree with Beshir (1996) who studied the effect of feeding different levels of Roselle seed on meat characteristics of Sudan desert lambs and reported no significant difference ($p>0.05$) among the different treatments for tenderness, juiciness, colour, flavour and marbling. That is may be due to the high content of phytoestrogenic factors of Roselle seed that, deposition fat, improves growing and improves meat quality.

CONCLUSION

The use of Roselle seed meal for sheep fattening showed positive effects on meat quality as the highest levels of Crushed Roselle seed meal resulted in high carcass quality attributes. Thus, Roselle seed meal may gain grounds in the future as a supplement for sheep fattening.

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