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Research Article

The effect of substitution of groundnut cake by dried rumen content in ration for lamb fattening in Sudan.

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Abstract

This study was conducted to evaluate substitution of groundnut cake by dried rumen content in growing lamb diets. Graded levels of dried rumen content (0, 10 and 20%) were incorporated in three diets iso-energetic, iso-nitrogenous diet for lambs. Thirty yearling male lambs of Sudan desert sheep ecotype Butana Ashgar with average body weight of 20 kg were used for the feeding trial. Each group was offered one of the experimental diets for a feeding period of 49 days. Dietary treatments did not affect any carcass parameter but it significantly affect($p<0.05$) the proportion of the Breast in the whole sale cuts. Carcass composition parameters did not differ significantly($p>0.05$) among the treatment groups. The slaughter by products showed no significant differences($p>0.05$) among dietary treatments. Chemical composition of meat revealed that the protein content in the muscles of group A was slightly higher than that of the other groups, but group C has the highest fat and lowest moisture content. Meat quality of group C was of superior water-holding capacity and lower cooking losses, and was more tender than that of group A and B. The meat colour of group A and B was darker that of group C. Dietary treatments showed no significant effect ($p>0.05$) among the tested groups for taste panel scores of tenderness, juiciness, flavour, colour and overall acceptability. It is thus concluded that dried rumen content when incorporated in lamb diets up to 20% produced carcasses which were significantly not different($p>0.05$) from that produced by the control diet.

Introduction

Feed constitutes the largest single factor in the costs of production of animal of all kinds. Feeding practices and feeds in use today range from excessively costly to nutritionally inadequate and from highly efficient to wasteful materials. In order to achieve successful feeding program one should be able to provide proper nutrients at the least costs. The cost of feed, as percentage of total production costs, accounts for about 50-60% of nutrient feeding systems and56-80% in an industrial system (Khattak *et al*, 2009). Conventional animal feed in the Sudan include groundnut Cake, groundnuts hulls, and sorghum grain and wheat bran. The relative abundance of these products and by-products offers a unique opportunity of fast improvement of animal production in the country. Unfortunately, there are constraints facing their efficient utilization. These include export of these products, human nutrition, food industries and poultry nutrition. Rumen contents are abundantly available as slaughterhouse by-products and mainly considered as waste materials, creating environmental pollution. With appropriate processing and proper use. Rumen content could provide a valuable source of nutrients when included in diets for various classes of livestock. Previous studies have generally indicated that dry rumen contents contained substantial amount of CP and utilizable energy for nutrients (Reddy and Reddy, 1980; Gosh and Dey, 1993). Previous studies have generally indicated that dry rumen contents contained substantial amounts of crude protein and utilizable energy for ruminants (Messersmith *et al.*, 1974; Prokop etal., 1974; Reddy and Reddy, 1980; El-yassin *et al*., 1991; Gosh and Dey, 1993 and Salinas-chavira *et al*., 2007). In practice, the high moisture of the total

rumen contents as collected at the slaughter house is still regarded as one of the obstacles that require an appropriate solution. Goodrich and Meiske (1969) used a forced air oven to dry rumen contents and found that beside its high economical costs, drying temperature had adversely affected the feeding value of the crude protein component. Sun drying is an excellent approach for tackling this problem (Abdelmawla, 1990 and Khattab *et al*., 1996).

The objective of this study is to:

Evaluate the effect of feeding dried rumen content on carcass characteristics and meat quality.

Materials and Methods

3.1 Study area:

The experiment was conducted at the Animal production department farm, Faculty of Agriculture and Natural Resources, University of Kassala,.

3.2 Rumen content collection and treatment:

Rumen content of cattle were collected immediately after slaughtering in plastic bags from a local slaughter house at New Halfa and transported to Animal Production Department Farm then stored for a night at a low ambient temperature and dried by sun which during drying were turned daily for a week to accelerate complete drying then ground to allows easy mix with other ration ingredients. Representative samples of dried rumen content and experimental rations were taken for chemical analysis according to (AOAC 1975).

3.3 Experimental animals:

Thirty lambs of Sudanese desert sheep (Al-Butana Ashgar) were purchased from New Halfa livestock market. Animals were selected according to age (6-8 months) and weight which was approximately 26 kg transported to Animal Production Department Farm rested, ear tagged and given an adaptation period for two weeks.

3.4 Adaptation period:

During this period animals were fed groundnut halum and a mixture containing equal percentage of the assigned experimental rations *ad libitum.* The groundnut halum was gradually substituted by rations mixture during the first 7 days. The rations mixture feeding continued till the end of the adaptation period. Spraying with an acaricide solution against ecto parasites with Gematoxcine solution and deworming with Thiabenzole as a drench solution was performed and the Thiabenzole treatment was repeated after 15 days. Animals were also injected by antibiotic (oxy-Tetracyciline 20%) as preventive dose.

3.5 Experimental procedure:

After the adaptation period the animals were individually weighed and then randomly divided into three groups (A, B and C) of similar number and weight. The three groups were separately penned. Each pen was provided with watering and feeding facilities.

3.6 Feeds and feeding:

Three iso-caloric and iso- nitrogenous diets containing graded levels of dried rumen content (A 0%, B 10% and C 20%) were used. The other ingredients were sorghum grain, groundnut cake, wheat bran, groundnut hulls, molasses, salt and calcium carbonate. The chemical analysis, ingredient proportion and chemical analysis of dried rumen content and the experimental diets are given in tables (1) and (2).

During the feeding period, animals were fed daily the assigned diets *ad libitum*. The diets were offered in one meal at 7:00 am.throughout the study period which extended for 49 days. Green fodder (*Medicago sativa* and *Sorghum biocolor (L) Moench*) offered once a week at a rate of one kg/head/week to avoid vitamin A deficiency. Clean water was available throughout the experiment period.

3.7 Data recorded:

3.8 Slaughter procedure and slaughter data:

At the end of the experimental period, five lambs were randomly taken from each group and transported to the department of meat production, Faculty of animal production, University of Khartoum for slaughter. Slaughter weights were taken after an overnight fast except for water. The animals were slaughtered following the Local Muslim Practices i.e. by severing both the jugular veins, carotid arteries and esophagus by a sharp knife without stunning. When complete bleeding was attained, the head was removed at the atlantooccipital joint, the body was practically skinned on its back and the feet were cut at knee and hock joints, the body was then hanged using hooks and skinning was completed. The skin, feet as well as the thoracic and visceral organs were individually weighed.

Table 1. Chemical analysis (%) on DM basis of dried Rumen content

Dry matter (DM)	96.20
Crude protein	14.38
Crude fibre	24.80
Ether extract	4.40
Ash	16.42
NFE1	36.20
ME2 (MJ/kg DM)	8.08

1 NFE: Nitrogen free extract

2ME: Metabolizable Energy was calculated according to the equation:

ME (Mj/kg DM) = 0.012CP + 0.031EE + 0.005CF + 0.014NFE (MAFF, 1975).

Table2. Ingredients proportions and chemical composition of experimental diets.

Item	Treatment group		
	A (0%)	B (10%)	C (20%)
Ingredients (as fed)			
Dried rumen content	0	10	20
Sorghum grain	40	42	45
Wheat bran	9	6	5
Groundnut cake	21	19	16
Groundnut hulls	6	0	0
Molasses	22	21	12
Salt	1	1	1
Lime stone	1	1	1
ME (MJ/kg DM)	10.88	10.89	10.85
Crude Protein (%)	17.06	17.04	17.06
Chemical composition (DM %)			
DM	93.69	93.29	93.96
Crude protein	16.39	15.84	15.29
Crude fibre	18.62	20.75	26.76
Ether extract	3.91	3.79	3.85
Ash	8.57	8.87	12.85

Gut fill was determined as the difference in weight between the full and empty alimentary tract. The kidneys and kidneys knob channel fat were left intact in the carcass. The carcasses were weighed warm and then chilled at 4c° for 24 hours; thereafter the cold carcasses were reweighed. The tail was removed at its based and weighed. The kidneys and kidneys knob channel fat were removed and weighed. The carcass was then split along the vertebral colum into left and right sides, the left side was weighed and broken into whole sale cuts according to M.L.C procedure (1976), these included :

Neck: which was removed by cutting through the junction of sixth and seventh cervical vertebrae at right angle to the axis of the vertebrae?

Leg and chump: was removed by cutting between both sixth and seventh lumbar vertebrae.

Single short forequarter: this joint was removed by cutting along the posterior edge of the sixth rib, sawing through the sternum and vertebral bodies.

The loin: was separated from the best end of neck joint by cutting along the posterior edge of the 13^{th} rib.

Best end of neck and Breast : were removed by cutting and sawing along a straight line from apoint on the posterior surface of 13^{th} rib (2.5 inch from the ventral tip of the eye muscle) to apoint on the posterior surface of the 7^{th} rib(3 inch from the ventral tip of the eye muscle). The dorsal cut comprised the best end of neck and the ventral one was the breast.

Each cut was weighed and dissected in to muscle, bone, fat and trim. The weight of each tissue was determined and recorded. The meat was covered by wet towels throughout the dissection to prevent loss of weight by evaporation.

3.9 Samples for chemical analysis and quality determination

Longissumus dorsi muscle samples were taken from loin joint. Samples were kept in polythenebags and frozen stored awaiting chemical analysis. *Semi membranous* muscle was also removed from both sides of the carcass. Each muscle was freed from external visible fat and connective tissues and utilized for meat colour determination. Chemical analysis of protein, fat, ash and moisture was done according to (AOAC 1975).

3.9.1 Moisture content determination:

Determination of moisture content was based on weight loss from a definite quantity of 5gm sample from *longissumus dorsi* muscle, dried overnight in drying oven at 100-105 c^o for 18 hours. The dried sample was cooled in desiccators for half hours and weighed. The moisture content was calculated as a percentage of fresh sample weight as follows:

$$\text{Moisture \%} = \frac{(\text{weight of fresh sample} - \text{weight of dried sample})}{\text{Weight of fresh sample}} \times 100$$

3.9.2 Protein content determination:

Crude protein content was determined by using kjeldahl method and calculated by multiplying the amount of nitrogen by 6.25. One gram of dried sample was weighed in kjeldahl flasks. Two tablets of catalyst mixture (10 parts K_2So_4 to 1 part of $CuSo_4$) and 10 ml of concentrated H_2So_4 were added. The content of the flask was digested under boiling at maximum heat for 3 hours, and then the flask was cooled and transferred to distillation unit. The sample was distilled by using NaoH solution. The content was titrated against Hcl acid 0.1N and crude protein percentage calculated as follows:

$$N = TX \frac{0.1 \times 0.014 \times 20 \times 100}{\text{Weight of sample}}$$

T = pepate reading

$$C.P = N \times 6.25$$

3.9.3 Ether extracts Determination:

Fat content was determined by ether extract method. Three grams of dried samples was placed in soxhellet tubes. The samples were subjected to continuous extraction with 150-200 ml petroleum ether for 5-6 hours. The flasks were then removed from the extractor and all owed to dry for 2 hours in a drying oven until no traces of ether remained. The flasks were weighed after cooling in desiccators. The difference between the flasks containing the fat and weight of the empty flasks was the fat weight in the samples. The calculation was performed using the formula:

$$\text{Fat \% of sample} = \frac{\text{fat weight}}{\text{Weight of sample}} \times 100$$

3.9.4 Ash content determination:

Ash content was determined by weighing 5grams of dried fat free sample in to dried crucibles of known weight. The crucibles were placed inside amuffle furnace at 550 – 600c^o for 18 hours, cooled in desiccators and weighed to determine the ash percentage as follows:

$$\text{Ash \%} = \frac{\text{weight of Ash}}{\text{Weight of sample}} \times 100$$

3.10 Quality attributes:

3.10.1 Objective evaluation:

3.10.1.1 Water -holding capacity (W.H.C)

Samples weighing about 0.5gm from the minced *L.dorsi* muscles were used. Each sample was placed on a humidified filter paper (whatman No.1) kept in adesictor over saturated Kcl solution and pressed between two plexiglass plates for 3 minutes at 25 kg load. The meat film area was traced with a ball ben and the filter paper was allowed to dry. Meat and moisture areas were measured with a compensating planometer.

The resulting area covered by the moisture was divided by the meat film area to give a ratio expressed as water holding capacity of meat. A larger ratio indicates an increase in the watery condition of the muscle or a decrease in water holding capacity (Babiker and lawrie, 1983).

$$\text{W.H.C} = \text{Loose} \frac{\text{water area} - \text{meat film area}}{\text{Meat film area}}$$

3.10.1.2 Colour determination:

Colour was determined on the semi-membranous muscles. Each muscle was allowed to oxygenate for half an hour at 4^{o}C before colour determination.

Hunter colour components L (lightness). a (redness) and b (yellowness) were recorded using Hunter lab Tristismulus colour meter ($D_{25.2}$). Subsequently these samples were frozen for cooking loss.

3.10.1.3 Cooking loss determination:

Semi-membranous samples were thawed at 4ºC for 24 hours, placed in plastic bags in a water bath at 80cº for 90 minutes. Muscle samples were then cooled in running water, dried from fluids and reweighed. Cooking loss was determined as loss in weight during cooking and expressed as percent of pre-cooking weight.

$$\text{Cooking loss} = \frac{W1 - W2}{W_1} \times 100$$

Where:

W_1 = weight before cooking

W_2 = weight after cooking

3.10.2 Subjective Evaluation:

3.10.2.1 Taste panel:

Sensory panel sessions were conducted to compare some selected sensory properties of the five treatments. The frozen meat samples (*L.dorsi* muscle) from each treatment were thawed for 24 hours in a refrigerator (4ºC). The samples were then cut into equal pieces and wrapped individually in aluminum foil and roasted in an oven at 180ºC for 60 minutes. The cooked samples were then cut into pieces and served warm.

Fifteen samples from the five treatments were evaluated at each session by semi trained panelists (stone, *et al.*, 1974 and Cross, *et al*., 1978). Panelists were instructed to record their responses for each attribute (tenderness, juiciness, flavour, colour and overall acceptability) according to especial scale (Appendix 2).

3.11 Statistical analysis:

Data collected were subjected to analysis of variance (Steel and Torrie, 1990) of complete Randomized Design model while significant treatment means were separated by Duncan (Duncan, 1955) multiple range test.

Results

2 Carcass yield and characteristics:

The data of carcass yield and characteristics of experimental lambs are shown in Table 4. No significant differences($p>0.05$) among the treatment groups were observed for slaughter weight, hot carcass weight, cold carcass weight, empty body weight, half carcass weight, dressing-out percentage (on slaughter weight or empty body bases) and chiller shrinkage.

Table 4 .slaughter weight and carcass characteristics.

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Slaughter weight (kg)	36.60	37.40	36.38	N.S	0.62
Empty body weight (kg)	32.19	33.37	32.79	N.S	0.56
Gut fill (as % of slaughter weight)	12.05	10.77	9.85	N.S	0.44
Hot carcass weight (kg)	18.80	19.30	19.06	N.S	0.34
Cold carcass weight (kg)	18.30	18.85	18.38	N.S	0.37
Half carcass weight (kg)	8.75	9.10	8.88	N.S	0.19
Hot dressing (%) live body wt.base	51.31	51.62	52.09	N.S	0.30
Empty body wt. base	58.94	57.87	57.82	N.S	0.39
Cold dressing (%) live body wt.base	49.87	50.42	50.31	N.S	0.40
Empty body wt. base	56.69	56.51	55.84	N.S	0.42
Chiller shrinkage (%)	1.81	1.49	1.78	N.S	0.19
Total muscle (as % of cold side wt.)	56.67	56.02	56.27	N.S	0.59
Total bone (as % of cold side wt.)	19.82	20.92	19.39	N.S	0.76
Total fat (as % of cold side wt.)	16.09	19.73	21.21	N.S	1.07
Total trim (as % of cold side wt.)	6.59	6.95	5.47	N.S	0.58

Gut fill percentage was not significantly different($p>0.05$) among the treatment groups. Maximum gut fill (12.05%) was found in group A and minimum gut fill (9.85%) was found in group C.

No significant differences ($p>0.05$) among treatment groups were observed for carcass muscle, bone and fat percentages (Table 4). However, lambs fed ration A tended to have a greater value of carcass muscle (56.65%) while those fed ration B have the lowest value (56.02%). Lambs fed ration C were intermediate (56.27%). On the other hand, lambs fed ration B tended to have a higher value of carcass bone percentage than those fed rations A and C. Lambs fed ration C appeared to have amore developed carcass fat than those fed rations B and A.

4.3 Non-carcass components:

Non-carcass components expressed as percentage of empty body weight are represented in Table 5. No significant difference($p>0.05$) among the treatment groups was observed for head, skin, four feet, heart , lung and trachea, intestine (empty), stomach (empty and full), liver, spleen, kidney, kidneys knob and channel fat, reproductive organs, omental fat and mesenteric fat, but these values tended to be slightly higher in group A than the other groups.

Average intestine weight (full) was significantly different ($P < 0.05$) among the treatment groups. Group A (5.87%), followed by group C (5.42%) and group B which had the least intestine weight (full) (5.24%).

Table 5 .Non carcass components (as percentage of empty body weight) .

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Head	5.23	5.13	5.16	N.S	0.05
Skin	5.96	6.04	6.03	N.S	0.08
Four feet	3.39	3.30	3.21	N.S	0.04
Heart	1.58	1.56	1.67	N.S	0.03
Lung and trachea	3.03	2.98	2.93	N.S	0.04
Intestine (Full)	5.87^{a}	5.24^{b}	5.42^{ab}	*	0.11
Intestine (empty)	4.08	3.84	3.83	N.S	0.09
Rumen (Full)	6.77	6.61	6.16	N.S	0.15
Rumen (empty)	3.62	3.48	3.51	N.S	0.06
Liver	3.01	2.80	3.01	N.S	0.05
Spleen	1.62	1.64	1.82	N.S	0.06
Kidneys	1.51	1.49	1.51	N.S	0.01
Kidney knob and channel fat	2.54	2.58	2.60	N.S	0.06
Reproductive organs	2.41	2.11	2.43	N.S	0.09
Omentum fat	2.73	2.89	2.78	N.S	0.11
Mesenteric fat	2.46	2.35	2.33	N.S	0.05

4.4 Whole sale cuts yield:

The whole sale cuts of the experimental lambs from cold carcass (left side) are shown in Table 6. The proportion of the various whole sale cuts obtained from the carcass sides of the experimental lambs as leg and chump, single short fore quarter, loin, best end of neck and neck were not significantly different($p>0.05$) among the treatment groups. However, a significant differences among the treatment groups was observed for breast ($P < 0.05$) . The tail and loin weights though not significantly different among the treatment groups, but their values were slightly heavier for group C than for the other groups.

4.5 Joint composition:

Joint composition of the experimental lambs expressed as percentage of joint weight are presented in Table 7. No significant differences($p>0.05$) among the treatment groups were observed for all joint composition.

4.6 Meat chemical composition:

Meat chemical composition data of the experimental lambs are shown in Table 8. There were significant differences($p<0.05$) among treatment groups in percentages of protein. Group C had the highest muscle fat and lowest moisture percentage than the other groups. No significant differences among the treatment groups were observed for moisture, fat and ash percentage.

4.7 Meat quality attributes:

Data of meat quality attribute of the experimental lambs are also shown in Table 8.

4.7.1 Meat colour:

No significant differences($p>0.05$) among the treatment groups were observed for Hunter lightness (L), redness (a) and yellowness (b). Group C had the highest values for lightness and redness and lowest values for yellowness, while group A had the highest values for yellowness.

Table 6 .Yield of whole sale cuts (as percentage of cold side weight)

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Leg and chump	32.98	32.08	32.71	N.S	0.24
Single short fore quarter	29.61	30.21	29.68	N.S	0.45
Loin	9.73	10.44	10.82	N.S	0.24
Breast	6.10[b]	6.86[a]	6.82[a]	*	0.14
Best end of neck	6.79	7.51	7.05	N.S	0.22
Neck	8.61	8.49	8.38	N.S	0.21
Tail	5.91	6.34	7.14	N.S	0.51

Table 7. Joint composition (as percentage of joint weight).

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Leg and chump :					
Muscle	63.20	60.99	62.22	N.S	0.47
Bone	18.89	18.10	17.55	N.S	0.50
Fat	13.18	15.48	16.47	N.S	0.68
Trim	4.12	3.61	3.41	N.S	0.27
Single short fore quarter :					
Muscle	59.65	57.04	58.14	N.S	0.56
Bone	22.78	22.67	21.75	N.S	0.62
Fat	12.15	15.11	14.06	N.S	0.69
Trim	5.08	4.87	5.07	N.S	0.29
Loin :					
Muscle	53.89	57.53	57.60	N.S	2.09
Bone	13.34	10.72	13.16	N.S	0.71
Fat	15.44	20.49	15.84	N.S	1.21
Trim	8.81	8.40	10.34	N.S	0.38
Breast :					
Muscle	59.06	54.23	54.32	N.S	1.07
Bone	20.12	18.56	18.48	N.S	0.40
Fat	13.65	18.21	16.12	N.S	1.17
Trim	7.91	9.45	9.35	N.S	1.10
Best end of neck :					
Muscle	57.42	53.57	52.22	N.S	1.33
Bone	23.06	23.04	24.76	N.S	1.02
Fat	13.20	15.08	16.59	N.S	1.09
Trim	8.33	6.79	5.02	N.S	1.00
Neck :					
Muscle	58.69	55.89	58.48	N.S	1.10
Bone	19.94	20.01	17.44	N.S	0.93
Fat	9.33	10.70	13.21	N.S	0.98
Trim	10.35	9.99	8.80	N.S	0.85
Tail :					
Muscle	12.24	12.02	11.26	N.S	0.97
Bone	18.10	14.43	14.26	N.S	1.45
Fat	66.56	74.03	70.04	N.S	2.17

Table 8. Meat chemical composition and quality attribute (as percentage of fresh meat weight)

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Moisture %	75.39	74.60	74.28	N.S	0.40
protein %	22.39[a]	20.72[b]	20.99[b]	**	0.20
Fat %	1.90	1.58	2.07	N.S	0.14
Ash %	0.90	0.94	0.86	N.S	0.08
Lightness(L)	28.14	27.58	29.16	N.S	0.33
Redness (a)	7.80	7.30	8.12	N.S	0.27
Yellowness (b)	3.90	3.80	3.52	N.S	0.24
Water holing capacity (ratio)	1.57	1.66	1.53	N.S	0.09
Cooking loss (%)	36.91	37.72	36.52	N.S	0.57

4.7.2 Water- holding capacity:

Water-holding capacity values of muscle studied were not significantly different($p>0.05$) among the treatment groups. Group C showed superior WHC values than the other groups table (8).

4.7.3 Cooking loss:

Although cooking loss values were not significantly different($p>0.05$) among treatment groups, meat from group B had higher cooking loss while meat from group C had the least cooking loss.

4.8 Subjective evaluation of meat quality:

Subjective evaluation of meat quality is presented in Table 9. There were no significant differences($p>0.05$) among the treatment groups for all evaluated eating quality attributes. Colour scores were higher for group B, followed by group C, but group A had received lower colour scores. Flavour scores were higher in group C then for the other groups. Higher scores for tenderness were given for lambs in group B. Juiciness scores were highest in group C and least in group B. Generally meat from group C tended to have the highest scores for flavour, juiciness and overall acceptability while group A tended to have the least scores for colour, flavour and overall acceptability.

Table 9 .Subjective evaluation of meat quality

Item	Treatment groups				
	A (0%)	B (10%)	C (20%)	L.S	S.E
Colour	3.78	3.88	3.84	N.S	0.07
Flavour	2.72	2.94	3.02	N.S	0.07
Tenderness	3.26	3.34	3.24	N.S	0.06
Juiciness	2.84	2.76	2.98	N.S	0.13
Overall acceptability	3.28	3.34	3.42	N.S	0.06

Discussion

3 Carcass weight and dressing percentage:

There were no significant differences ($p>0.05$)among the treatment groups observed for slaughter weight and carcass weight (cold or warm). Also no significant differences among treatment groups were found for dressing percentage either on empty weight or live weight basis.

The values for the dressing percentage agreed with that reported by Beshir (1996), Abouhief (1999) and Mohammed (2005).El-Karium and Owen (1987) reported a respective dressing percentages of 45.06 and 43.35 for Sudan desert sheep ecotype (Watish and Shugor) which were lower than the values reported in this study. Here, sheep ecotype differences and ration composition might be responsible.

5.4 Gut fill:

The gut fill percentage in this study was 12.05%, 10.77% and 9.85% for group A, B and C respectively. Group C however gut fill percentage could be due to increased digestibility of the diet offered which contained higher proportion of fermented dietary material. This result agreed with the findings reported by Mansour *et al*. (1988), El- khidir *et al*., (1989), Babiker and Mohammed (1990) and EL-Hassan (1994).

El-khidir *et al*. (1989) reported gut fill of Sudan desert sheep in the range of 20.8 to 24.9, also Beshir (1996) reported gut fill of 14.54, 13.14 and 13.00 for Sudan desert sheep. These variations in gut fill could be due to type of feed, ration chemical and Physical composition, age, species and pre-slaughter conditions of the animals.

5.5 Carcass shrinkage:

No significant differences($p>0.05$) were observed among the three dietary treatments in carcass shrinkage. Carcass shrinkage or moisture loss is the proportion of the carcass moisture lost by evaporation during the cold storage period. Generally, carcasses with good subcutaneous fat cover suffer less loss. In addition, refrigeration conditions and duration affect this parameter. The carcass shrinkage values in the present study were lower than that obtained by Beshir (1996) and Beshir (2002). These differences might possibly by due the duration, temperature and humidity of refrigeration used as well as amount of carcass fat.

5.6 Non-Carcass components:

Non- carcass components were not significantly different($p>0.05$) among the treatment groups except for intestine (full) which showed significant difference among treatments . These findings agreed with the findings reported by Beshir (1996) and Beshir (2002). Omental and mesenteric fat depots were greater in group A and B than group C.

5.7 Yield of whole- sale carcass cuts:

The major whole -sale cuts as leg and chump, single short fore quarter, loin, best end of neck, breast, neck and tail were expressed as percentage of cold carcass weight. The cut weights with the exception of breast were not significantly different among the treatment groups. The whole - sale cuts values reported by Beshir (1996) and Beshir (2002) for Sudan desert lambs were in line with the values reported in this study.

5.8 Carcass composition:

In this study the carcass muscle percentage was 56.67, 56.02 and 56.27 for group A, Band C respectively. Although group A had more percentage carcass muscle, the total carcass muscle was not significantly different among the treatment groups. This result was in agreement with the result reported by Beshir (1996) of Sudan desert sheep.

Fat percentage in this study was 16.09, 19.73 and 21.21 for group A, B and C respectively, and was not significantly different($p>0.05$) among the treatment groups, but groups Band C which were fed dried rumen content, had the highest total fat percentage than the control. These results were higher than that reported by Beshir (2002), but lower than that reported by Beshir (1996).

Bone percentage recorded here was 19.82, 20.92 and 19.39 for group A, B and C respectively, which had no significant effect($p>0.05$) among the treatment groups. Group B recorded the highest total carcass bone percentage, while groups C recorded the least value. Total bone percentage reported in this study was greater than that reported by Beshir (1996) and Beshir (2002). This variation in bone percentages might be due to differences in diets and age which affected carcass composition.

5.9 Joint composition:

Joint composition expressed as percentage of joint weight is shown in table (7). No significant differences($p>0.05$) among the treatment groups were observed for leg and chump, single short for quarter, loin, best end of neck, breast, neck and tail muscle, fat and bone. Generally group A in most joints tended to have greater muscle and lesser fat than the other groups. On the other hand fat in all joints was greater in group B and C. The increased muscle in group A might be due to its carcass weight. These finding were in line with that reported by Beshir (1996) for sheep fed graded levels of Karkadeh seeds and Beshir (2002) for sheep fed graded levels of Water Melon seed cake.

5.10 Meat chemical composition:

5.10.1 Protein:

Meat protein percentage in this study was significantly different($p<0.05$) among the treatment groups. Group A recorded the highest protein, while group B recorded the least protein percentage. The values for meat protein percentage in this study was lower than that reported by Beshir (2002) who found (22.75, 22.75, 22.75, 22.75, and 22.58) for lambs fed graded levels of Water Melon seed cake.

5.10.2 Fat:

Fat percentage in this study was not significantly different($p>0.05$) among the treatment groups. Group C recorded the highest fat percent and group A recorded the lowest fat percentage. The values for fat percentage in this study were lower than that reported by Beshir (1996) and Beshir (2002).

5.10.3 Moisture:

Moisture percentage was not significantly different($p>0.05$) among the treatment groups. Group C had the lowest moisture percentage which coincided with its highest fat percentage.

The values for moisture percentage reported in the present study were in close line with the results reported by Beshir (1996) and Beshir (2002).

5.10.4 Ash:

Ash percentage was not significantly different($p>0.05$) among the treatment groups. Group C had the lowest values for ash percentage which coincided with its highest fat percentages. These findings agreed with that reported by Beshir (1996), but in contrast with that reported by Beshir (2002).

5.11 Meat quality attributes:
5.11.1 Water- holding capacity:

The superior water- holding capacity found in the meat from group C could be explained by the high carcass fat of this treatment. Increased water-holding capacity is found to associate with increased fatness (Lawrie, 1979).

5.11.2 Cooking loss:

Lower cooking loss was found in meat from group C, while highest cooking losses were found in group B. These differences in cooking loss could be attributed to differences in water-holing capacity already mentioned. The values of cooking loss in this study were highest than that reported by Beshir (2002).

5.11.3 Meat colour:

Hunter colour components indicated that group A and B were darker in colour than group C. This finding accorded with myoglobin concentration in meat which decreases as the percentage of intramuscular fat increases (Janicki *et al*., 1963).

5.12 Subjective evaluation of meat quality:

The results of all the tasted attributes i.e. colour, flavour, tenderness, juiciness and overall acceptability were not significantly different($p>0.05$) among the treatment groups. On the other hand, all attributes tended to have higher scores in group C. This might be associated with increased fatness in this group over the others.

Conclusion

Dietary dried rumen content levels has no significant effect ($P> 0.05$) on carcass characteristics, wholesale cuts yield(except Breast)and non-carcass components other than intestine full.

Dietary dried rumen content had no significant ($P>0.05$) effect on carcass composition parameters. Muscle percentage was slightly higher in the control group (0% dried rumen content), fat percentage was higher in group C (20% dried rumen content), but bone percentage was higher in group B (10% dried rumen content).

The slaughter by-products showed no significant differences among dietary treatments. Only depot fats as kidney knob and channel fat and omentum fat showed anon-significant increase with the increase of dried rumen content.

Chemical composition of meat revealed that dietary treatment had significant (($P< 0.05$) effect on protein, but not on fat or moisture percentages.

Water-holding capacity of meat was superior in group C a finding which coincided with its lower cooking losses.

Taste panel scores of tenderness, juiciness, flavour, colour and overall acceptability showed no significant difference among treatment groups, but group C recorded the highest scores for the previous parameters.

Based on the results of the study reported here, the following conclusions can be drawn.

- The protein and energy values of dried rumen content are high enough to allow its inclusion in diets as protein and energy sources for ruminants.
- Dried rumen content up to a level of 20% in lamb diets increased but not significantly carcass and meat fat and improved make quality outhauls
- Dried rumen content had no deleterious effect on ruminant livability.

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