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Meat Quality and Carcass Characteristics of Lambs Born to Supplemented Hamari Ewes, Sudan

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ABSTRACT

Background and Objectives: In the Sudanese economy, the livestock sector plays an important role, with sheep producing lamb and mutton mainly for local consumption and exportation. As a result, feed supplementation together with natural grazing could improve production in terms of quality and quantity. Therefore, this study investigated carcass characteristics and meat quality of lambs born to Sudanese desert ewes that were fed with concentrated supplements in the open range. **Materials and Methods:** Ninety ewes were randomly divided into three groups A, B and C (n = 30). Before being introduced to the rams, groups A and B received concentrated supplements for 30 days, while group C (control) did not receive concentrated supplements. Lambs from each group grazed on natural pasture during the day and received a concentrated supplement at mealtime. Weaned lambs born to groups A and B received concentrated supplements ad libitum for 60 days, while lambs born to group C were only allowed to graze on natural pasture. Thereafter all lambs were slaughtered to measure their carcass qualities. **Results:** The slaughter and carcass (hot, cold and half) weights and the empty body weight were heavier ($p<0.05$) in all treatment groups, with no significant differences. All groups had no significant differences in dressing percentage and wholesale cuts. There was an increase ($p<0.001$) in muscle composition percentages in all treatment groups. There was an increase in the protein and fat percentages and a decrease in the moisture in all treatment groups. **Conclusion:** It was concluded that providing concentrated supplements to lambs and ewes improved the lamb's meat quality.

KEYWORDS

Carcass characteristics, hamari ewes, meat quality, concentrated supplements, Sudanese desert ewes

INTRODUCTION

The sheep population in the world amounts to one billion[1] and their production is spread worldwide, because of their ability to adapt to various climates and types of vegetation. The demand for meat is increasing and is expected to reach 37 million tons by 2050 due to the world population increase to

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9.1 billion increasing the demand for food by 60%[2]. Sheep meat is a good source of protein, rich in minerals such as iron and zinc and can contribute to supplying the world's demand for meat[3].

The livestock sector plays a critical role in the Sudan economy and sheep particularly produce lamb and mutton for local consumption and export. Ninety percent of sheep flocks in Sudan are in the hands of traditional producers who depend mainly on natural pastures to raise their animals[4]. The nutritive value of pasture and range land in Sudan is greatly affected by the seasonality of rainfall, therefore grazing alone may not be sufficient to meet the maintenance, production and reproductive requirements of these flocks. Feed supplementation is a strategy to solve this problem[5]. Kordofan states of Sudan are famous for the cultivation of groundnut, millet, sorghum and watermelons that yield large quantities of by-products that can play an important role in animal feeding[6]. Nutrition represents an important factor to improve animal performance and, carcass traits[6,7]. Feed supplementation, particularly concentrates, will improve the quality and quantity of natural grazing, alleviate production losses during the dry season, improve the productivity of sheep and enhance their economic contribution to the national economy.

The present work was conducted to study carcass characteristics and meat chemical composition and quality of lambs born to supplemented and non- supplemented ewes raised on natural pasture grazing and concentrate supplementation.

MATERIALS AND METHODS

This study was conducted at East of Elnuhood Town, Elnuhood Locality, West Kordofan State, Sudan. Elnuhood lies between Latitudes (12-14)° North and Longitudes (27-30)° East, about 800 km West of Khartoum. The climate is warm in wet season and hot dry in summer, with temperature range of 33-46°C as the highest temperature. In the cold season (winter), temperature records in the town range from 11-45°C. The rainy season lasts for four months (July to October), annual average rainfall is between (450-550) mm. The relative humidity is uniformly low ranging between 17-30% in the dry season. The soils nature is mostly stabilized sand dunes and smooth undulating sandy plains (Goz) of low fertility and capable of absorbing all the rain fall water and is consisting of yellowish red sandy loam, dissected by batches of loamy clay soils (Gardood) in the Southern part. The ecological zone in the area is mainly determined by rain fall and subdivisions are mostly depending on soil type and vegetation. The dominant vegetation is a variable mixture of thorny trees, shrubs, herbs and grasses. The *Acacia* trees are dominant in the area[8].

The study was conducted in the winter season (January-February 2015). Shortly before the breeding period and extended up to the weaning of born lambs. A total of ninety ewes (local Sudanese desert, Hamari subtype) which have similar age and body weight (40-58 kg) were used in this study. During the acclimatization period, animals were fed a concentrate ration for 15 days (Table 1). Albendazole was administrated and Ivomec was injected to eliminate internal and external parasites, respectively. Animals were then randomly divided into three groups A, B and C (n = 30 per group) Ewes concentrate supplement was given at the rate of 0.5 kg/head/day. Group (A) was given the supplement 30 days before and 30 days after the introduction of the ram and 30 days before lambing. Group (B) was given the concentrate supplement for 30 days before the introduction of ram and group (C) was left without supplement as a control. Mature rams were introduced to ewes at the beginning of the mating season (January-March). Born lambs were allowed to suckle their dams until weaning.

Sixteen weaned lambs born, to concentrate supplemented ewes and another equal number of weaned lambs born to ewes left to feed on natural grazing were used for concentrate supplementation. Lambs were eight from group (A) = ewes and eight from group (B). From group (C) ewe's two lamb groups of eight individuals each were taken and designated (C) and (D). Lambs were of equal average weight 25.75 kg and all had milk teeth. Lambs were given the concentrate diet (Table 1) for an adaptation period

Table 1: Ingredient proportions and chemical composition of the concentrate diet

Ingredients (g/kg as fed basis)	Percentgae	Proximate analysis (%) on dry matter basis	Percentage
Groundnut cake	20	Crude protein	18.51
Sorghum grains	15	Ether extract	4.65
Molasses	15	Nitrogen free extract	61.27
Limestone	1	Ash	8.1
Salt	1	Dry matter	95.15
Groundnut hulls	23	Crude fiber	7.27
Wheat bran	25		
Calculated crude protein (CP) (%)	18.47		
Calculated metabolizable energy (ME) (MJ/kg)	10.7		

of fifteen days during which they were ear-tagged and weighed. Following the adaptation period lambs of groups (A and B) and (C) were given the concentrate diet *ad libitum* for 60 days but not group (D) which was the control. All Lambs were allowed to graze on natural pasture during the day. Lamb watering frequency was (2-3) days throughout the experimental period. Health care of lambs was closely observed for any deviation.

Slaughter procedure and data collection: At the end of the fattening period, lambs were individually weighed after an overnight fast except for water. Only twenty lambs, five from each group were randomly selected and weighed, the average mean live weight of each group was 29.81 kg. Slaughter and carcass processing of lambs were conducted in the Laboratory of the Department of Meat Production, Faculty of Animal Production University of Khartoum. Slaughter weights of lambs were taken immediately before slaughter. After complete bleeding, the head was removed and weighed. After skinning all external and internal visceral organs were separated and weighed immediately and then hot carcass weight was recorded. The alimentary tract (rumen and intestine) was weighed full, then emptied and re-weighed and the gut "fill" weight was determined. Carcasses were chilled at 4°C for 24 hrs and cold carcass weights were recorded. Kidneys and kidney knob and channel fat were removed and weighed. The tail was removed and weighed separately. The right and left sides of the carcass were then separated along the vertebral column. In order to produce wholesale cuts, the left carcass side was weighed and processed according to Kempster[9] procedure giving the following cuts: Single short forequarter, leg and chump, loin, best end of neck, breast, neck and tail. Each cut was weighed and expressed as percentage of cold carcass weight. Loin cuts were dissected into, muscle, bone, fat and trim and each tissue weight was recorded. The empty body weight (EBW) was calculated by subtracting the gut fill from the slaughter weight. The dressing percentage of the hot carcass was calculated on slaughter and empty body weight bases. The University of Khartoum Research Committee approved this study.

Chemical analysis and quality attributes of lamb's meat: Meat samples (n = 5) for chemical analysis and quality determination were taken from semi membranous and longissimus dorsi muscles. Each sample was wrapped in a polythene bag and stored in a deep freezer at (-18°C) for a waiting analysis. Semi-membranous muscle samples were used for color and cooking loss determinations while longissimus dorsi muscle samples were used for proximate analysis and water-holding capacity determinations.

Chemical analysis of lamb meat: Meat chemical analysis was performed according to the procedure of Baur and Ensminger[10]. Proximate determination included moisture, protein, fat (ether extract) and ash content.

Meat quality attributes

Water holding capacity: It was determined by Press Method according to Toldrá and Reig[11] on 0.5 g of ground meat from longissimus dorsi muscle.

Cooking loss determination: Frozen meat samples were thawed overnight by refrigeration. Using a water bath and plastic bags, samples were weighed and cooked for 90 min at 90°C and then cooled in a running

tap water for 20 min, dried using absorbent kitchen paper and weighed. The differences in weights of the samples before and after cooking were recorded as the total cooking loss and were expressed as a percentage of weight before cooking.

Color measurements: Frozen semi membranous muscles were overnight thawed in refrigerants, freed from external fat and connective tissue and then allowed to oxygenate for 30 min at 4°C before use for color determination by Hunter Laboratory Tri-stimulus colorimeter (Minolta Chroma Meter Measuring Head CR-410 Minolta, Osaka, Japan). Meat color- co-ordinates L (lightness), a (redness) and b (yellowness) were recorded.

Statistical analysis: The data were subjected to analyses of variance applicable to a randomized complete block design[12] using the computer program Statistical Package for the Social Sciences, software package (SPSS version 11.50 2002). Duncan multiple range test was used to detect difference between means[13]. Statistical significance was set at ($p<0.05$).

Ethical consideration: The study was done in accordance with the University of Khartoum's Animal and Ethics committee approval.

RESULTS

Effect of concentrate supplementation of lambs on slaughter weight and carcass characteristics

Carcass yield: Slaughter and carcass weights of fattened and control lambs were presented in Table 2. Slaughter weight was not significantly different among lamb groups that were supplemented with concentrate on concentrates (A, B and C), however, lambs from group (D) that were left on natural grazing had lighter slaughter weights which were significantly ($p<0.05$) lower than those of group (A) and (C). Hot and cold carcass weights as well as empty body weight were not significantly different among lamb groups that were supplemented with concentrate but were significantly ($p<0.05$) heavier than those of lambs left on natural grazing. Half carcass weight was also not significantly different among lamb groups supplemented with concentrates, however, the lamb group left on natural grazing had lighter half carcass weight than those supplemented with concentrates, but the difference was only significant ($p<0.05$) for lambs of group (A).

There were no significant differences in dressing percentage between lamb groups, however lambs of treatment (D) born to ewes left on grazing and allowed to finish on grazing had lighter dressing percentage than that of lambs from the other treatment groups. Lambs of group (A) had heavier or significantly heavier slaughter weight, empty body weight, carcass weight and dressing percentage than those of the other treatment groups.

Non-carcass components: Data of non-carcass components of experimental lambs were given in Table 3. There were no significant differences in most of the non-carcass components of lambs finished on grazing supplemented with concentrates or left to finish on natural grazing except genital organs and fat depots. Genital organs were significantly ($p<0.01$) lighter in lambs finished on natural grazing than those finished on grazing supplemented with concentrates. Omentum fat depot was lower but not significantly different in lambs left to finish on natural grazing than in those supplemented with concentrates.

Kidney fat of lambs finished on grazing only was significantly ($p<0.001$) lower than those of lambs of a group (A) and (C) supplemented with concentrates. Mesenteric fat of lambs left to finish on grazing only was lower than those of lambs supplemented with concentrate, but the difference was only significant ($p<0.001$) between the former lamb's group and those of group (A) and (C).

Table 2: Effects of the concentrate supplementation on slaughter weight and carcass characteristics of Hamari lambs

	Lamb group					
Item	A	B	C	D	SE	p-level
Slaughter weight	30.50[a]	28.60[ab]	29.20[a]	25.90[b]	0.12	*
Hot carcass weight	12.10[a]	11.40[a]	11.55[a]	9.60[b]	0.31	*
Cold carcass weight	11.75[a]	11.10[a]	11.20[a]	9.30[b]	0.32	*
Half carcass weight	5.95[a]	5.45[ab]	5.45[ab]	4.67[b]	0.16	*
Empty body weight	23.06[a]	21.89[a]	22.40[a]	19.28[b]	0.51	*
Dressing percentage						
Hot carcass/slaughter weight	39.79	39.78	39.40	37.32	0.47	NS
Cold carcass/slaughter weight	38.47	38.71	38.11	35.99	0.50	NS
Hot carcass/empty body weight	52.61	51.96	51.58	50.10	0.44	NS
Cold carcass/empty body weight	50.88	50.81	50.00	48.31	0.47	NS

Group (A), (B), (C) lambs finished on grazing supplemented with concentrate, Group (D) lambs finished on natural grazing only. [abc]Denotes significant differences between groups, $p \leq 0.05$, No: No significant differences ($p \geq 0.05$) and SE: Standard error

Table 3: Effect of concentrate supplementation on non-carcass components of Hamari lambs (% empty body weight)

	Lamb group					
Body components	A	B	C	D	SE	p-level
Liver	1.76	1.89	1.75[a]	1.81	0.04	NS
Spleen	0.27	0.52	0.36	0.31	0.40	NS
Lungs and trachea	2.06	2.00	2.30	2.33	0.06	NS
Heart	0.53	0.55	0.45	0.45	0.20	NS
Genital organs	1.03[a]	1.05[a]	0.89[a]	0.38[b]	0.07	**
Rumen full	29.80	27.35	27.28	30.33	0.90	NS
Rumen empty	3.88	3.83	4.03	3.81	0.07	NS
Intestine full	10.15	10.95	11.10	11.50	0.22	NS
Intestine empty	3.16	3.83	3.75	3.63	0.10	NS
Omentum fat	0.30	0.44	0.45	0.29	0.03	NS
Mesentric fat	0.89[a]	0.62[bc]	0.81[ab]	0.54[c]	0.04	***
Kidneys	0.37	0.40	0.36	0.39	0.00	NS
Kidney fat	0.51[ab]	0.36[c]	0.57[a]	0.38[bc]	0.03	**
Head	8.59	8.49	8.10	8.62	0.11	NS
Four feet	3.28	3.47	3.16	3.42	0.07	NS
Skin	10.08	10.49	9.15	9.89	0.38	NS
Gut fill	7.45	6.71	6.81	6.62	0.19	NS

Group (A), (B), (C) lambs finished on grazing supplemented with concentrate, Group (D) lambs finished on natural grazing only. [abc]Denotes significant differences between groups, **$p \leq 0.01$, ***$p \leq 0.001$, NS: No significant differences ($p \geq 0.05$) and SE: Standard error

Carcass cuts: Carcass cuts of Hamari lambs finished on grazing plus concentrate supplement and the controls left to finish on natural grazing. Only single short forequarter and loin cuts showed significant differences. The former cut was not significantly different in carcasses of lambs of group (A), (B) and (C) which were finished on concentrates as shown in Table 4. These cuts were only significantly ($p<0.05$) lighter in lambs of group (A) and (B) than those of group (D) which were finished on natural grazing. The loin cut was only significantly ($p<0.01$) heavier in lambs of group (C) than in those of group (A) and (B). Leg and chump, breast and tail cuts were lighter in lambs of group (D) than in the other lamb groups. Best end of neck was slightly heavier in lambs of group (D) than in lambs of the other three groups.

Loin cut composition: The effect of concentrate supplementation of grazing on loin cut composition, meat chemical composition and quality attributes. Muscle percentage was higher in loin cut of grazing lambs supplemented with concentrates than in those left to finish on natural grasses. The latter group had significantly ($p<0.05$) lower muscle percentage than that of group (B). There were no significant differences among treatments in bone percentage, but the concentrates supplemented groups had lower bone percentage than the control group. Fat percentage was higher or significantly ($p<0.001$) in lambs

Table 4: Effect of concentrate supplementation on carcass cuts of Hamari lambs (% of cold carcass weight)

	Lamb group					
Cuts	A	B	C	D	SE	p-level
Single short forequarter	29.11^{b}	29.12^{b}	30.57^{ab}	30.89^{a}	0.28	*
Leg and chump	32.27	31.53	33.26	29.75	0.60	NS
Loin	8.83^{b}	8.42^{b}	10.67^{a}	9.8^{ab}	0.29	**
Best end of neck	7.33	7.09	7.64	8.39	0.22	NS
Breast	5.07	5.07	5.37	5.00	0.11	NS
Neck	8.66	7.94	8.99	8.00	0.18	NS
Tail	5.31	5.43	5.66	4.33	0.42	NS

Group (A), (B), (C) lambs finished on grazing supplemented with concentrate, Group (D) lambs finished on natural grazing only. ^{abc}Denotes significant differences between groups, *p≤0.05, **p≤0.01, NS: No significant differences (p≥0.05) and SE: Standard error

Table 5: Effect of concentrate supplemented grazing on loin cut composition, chemical composition and some quality attributes of Hamari lambs (% of cut weight)

	Lamb group					
Tissue	A	B	C	D	SE	p-level
Muscle	56.00^{ab}	59.62^{a}	55.96^{ab}	51.10^{b}	1.11	*
Bone	23.41	20.12	22.42	27.33	1.12	NS
Fat	4. 87^{ab}	5.04^{ab}	5.58^{a}	1.48^{b}	0.66	*
Trim	13.47^{a}	11.94^{a}	12.60^{a}	4.17^{b}	1.11	***
Meat chemical composition and some quality attributes						
Moisture	76.11^{c}	76.99^{b}	77.46^{b}	78.62^{a}	0.25	***
Protein	18.97^{a}	18.11^{b}	17.67^{b}	16.85^{c}	0.21	***
Fat	1.5^{a}	1.26^{b}	1.09^{b}	0.77^{c}	0.07	***
Ash	1.05	1.02	1.01	1.13	0.02	N S
WHC	1.24^{c}	1.49^{c}	2.28^{b}	2.84^{a}	0.16	***
Cooking loss (%)	40.42^{c}	41.60^{b}	43.36^{a}	44.17^{a}	0.38	***
Color-coordinate						
Lightness	33.96	34.48	34.40	34.65	0.17	NS
Redness	14.15	13.42	13.16	13.05	0.22	NS
Yellowness	6.98	7.13	7.00	6.83	0.06	NS

Group (A), (B), (C) lambs finished on grazing supplemented with concentrate, Group (D) lambs finished on natural grazing only. ^{abc}Denotes significant differences between groups, *p≤0.05, ***p≤ 0.001, NS: No significant differences (p≥0.05) and SE: Standard error

finished on concentrates than those left on natural grazing. Trim percentage was significantly (p<0.001) lower in lambs of group (D) than in lambs of group (A), (B) and (C) which were supplemented with concentrate moisture percentage was significantly (p<0.001) higher in the meat of lambs of group (D) which were finished on natural grazing than in that of lambs supplemented with concentrates as shown in Table 5. Protein percentage was significantly (p<0.001) higher in the meat of group (A) than in that of the latter three groups. Lambs of group (A) had the highest (p<0.001) meat protein percentage. Fat percentage was significantly (p<0.001) higher in meat of lambs of group (A) than that of the other lamb groups. Fat percentage of group (C) was significantly (p<0.001) lower than that of the other lamb groups. Ash percentage was not significantly different in the meat of all treatment groups.

Meat quality attributes as cooking loss, water holding capacity and color of Hamari lambs finished on concentrates or left to finish on natural grazing were also shown in Table 5. Cooking was significantly (p<0.001) higher and water holding capacity was significantly (p<0.001) inferior in the meat of lambs finished on natural grazing than those left to finish on natural grazing plus concentrate supplements.

Meat color co-ordinate was not significantly different between lamb groups. However high co-ordinate (L) was higher and redness (a) and yellow (b) co-ordinate were lower in the meat of lambs left on grazing than those supplemented with concentrates.

DISCUSSION

In the current study, there were significant differences ($p<0.05$) were found between treatment groups for empty body weight, warm carcass weight and cold carcass weight. Significant different ($p<0.05$) were found between treatment groups for empty body weight, warm carcass weight and cold carcass weight. Concentrate supplementation of grazing lambs born to concentrate supplemented ewes or those born to non- concentrate supplemented ones on carcass yield resulted in significantly heavier slaughter weight, carcass weight and empty body weight than in lambs that were left to finish on grazing only. Concentrate supplementation of natural pasture grazing is expected to increase the nutrition level which will improve growth rate and carcass characteristic[14] found that lambs born to flushed desert ewes and raised on concentrate supplemented grazing had increased live weight gain as the duration of supplanted increased. Boughalmi and Araba[5], have also found that empty body weight increased in grazing lambs with increase of the concentrate supplement level and that hot carcass weight was significantly lower in zero concentrate supplemented group (control)[15] attributed the performance, carcass characteristics and meat quality to ewes raised under range conditions with or without concentrate supplementation.

Dressing percentages of hot and cold carcasses expressed in terms of slaughter weight or empty body weight were not significantly ($p<0.05$) different between treatments group. However, lambs of treatment (D) born to ewes left on grazing and were left to finish on grazing had lighter dressing percentage than lambs born to concentrate supplemented ewes and finished on concentrate supplemented. Concentrate feeding is known to increase carcass fatness and dressing percentage[5] found that dressing percentage increased with concentrate supplementation compared to those of non- supplemented grazing lambs[16]. Studied the effect of two different roughage to concentrate rations on carcass traits of Sudan desert sheep and reported that lambs fed high concentrated diets dressed higher than those fed diets of low concentrate level. Increasing concentrate to roughage ratio was found to increase lambs dressing percentage[17].

Non-carcass components of Hamari lambs revealed no significant differences between lambs supplemented with concentrate or left to natural grazing, except genital organs, mesenteric and kidney fat which were significantly heavier in lambs supplemented with concentrates. Concentrate feeding is known to increase propionic acid production and consequently body fatness. Genital organs weight increase in concentrate supplemented lambs coincided with body weight increase. Boughalmi and Araba[5] reported that there were no significant differences in percentage of body components of lambs that received concentrate or left on natural grazing. Ali *et al.*[18] also reported that there were no significant differences in non-carcass components except lung and trachea, testicles, mesenteric fat and skin of desert lambs of Hamari type given concentrate supplementation or left on natural grazing. Carcass cuts of lambs supplemented with concentrates and the control left on natural grazing revealed no significant differences between treatments in leg and chump, breast, best end of neck, neck and tail cuts, but leg and chump, breast and tail cuts were relatively heavier in lambs supplemented with concentrate than in those left on natural grazing. Single short forequarter and loin cuts were significantly lighter in lambs that were supplemented with concentrates than lambs left on natural grazing only.

These findings could be explained by the effect of nutrition level on growth rate and development of the various body parts and tissues. The finding that the tail cut was lighter in lambs left on grazing only could be explained by the fact that the tail is a fat depot and that concentrate supplementation favored fat deposition compared to non-supplemented lambs.

Data related to the effect of concentrate feeding on meat composition indicated that bone percentage was similar for the different treatment groups, but muscle, fat and trim percentages were heavier in lambs supplemented with concentrate than those left to finish on natural grasses.

The bone is an early maturing tissue and is little affected by nutrition, while muscle and fat tissues are affected by the level of feeding and tend to develop with the increase of feeding level[19]. This finding was similar to Ali *et al*.[18] who found that pen-fed lambs had higher ($p<0.01$) percentages of fat and muscle in their carcasses and a decreased percentage of bone than lambs kept on natural grazing (control).

The chemical composition of Hamari lamb meat was presented in Table 5 which revealed that meat chemical composition was significantly affected by concentrate feeding and that moisture percentage was significantly ($p<0.05$) higher and fat percentage was significantly ($p<0.05$) lower in the meat of lambs of group (D) which were finished on natural grazing than in that of the three lamb groups which were supplemented with concentrate. These findings coincided with high meat fat of concentrate supplemented lambs[20].

The effect of concentrate supplementation of lambs born to concentrate supplemented ewes on meat quality attributes shown in Table 5, indicated that cooking loss increased, while water holding capacity deteriorated significantly ($p<0.001$) in meat of lambs finished on natural grazing than those given concentrate supplementation. Concentrate feeding is known to increase carcass fatness which will improve meat water holding capacity and reduce cooking less[21]. No significant ($p<0.05$) differences in meat color were found among the treatment groups, but redness color co-coordinate was higher in the meat of lamb of group (A), then decrease gradually in lamb of group (B), (C) and (D) respectively, possibly due to the residual effect of concentrate feeding of their dams.

Color results were also similar to Purslow *et al*.[22] who studied the effect of diet protein source (groundnut, sesame, cotton and sunflower seeds cakes) in lamb fattening and found that there were no significant differences in color co-ordinates in the meat of animals fed the different diets. The current study revealed that water holding capacity was inferior and cooking loss increased in lambs finished on natural grazing than those supplemented with concentrate. This was in line with Mengistu *et al*.[23] and Bushara *et al*.[24] who found an improvement in water holding capacity and a decrease in cooking loss in the meat of Hamari lambs supplemented with concentrate and not in those left on natural grazing.

CONCLUSION

It based on the results of this study, adopting concentrate supplement for ewes and lambs reared in range conditions improved carcass characteristics and meat quality. In addition, feedlot of grazing lambs with concentrate supplementation had better effect on growth performance of lambs and produce heavier carcass weights and enhance muscle compositions and meat quality of the lamb's meat. This study recommended that concentrate supplementation should be undertaken for ewes during breeding season and late pregnancy stage and for weaned lambs to improve their carcass characteristics and to enhance meat quality. Moreover, the range improvement programs are needed to reduce animal's movement searching for forage, as well as water points which reflect positively in productive performance of Hamari sheep.

SIGNIFICANCE STATEMENT

The objective of this study was to investigate the carcass characteristics and meat quality of lambs born to Sudanese desert ewes that were fed with concentrated supplements in the open range. The results of the present study demonstrated that feedlot of grazing lambs with concentrate supplementation improved the growth performance of lambs, increased carcass weights and enhanced muscles and meat quality of the lamb's meat. Thus, its recommended to use concentrate supplements for lambs raised in range conditions.

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