

Effect of sex on the characteristics and composition of carcass of Desert goat kids

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Received: 13/ 1/ 2026

Accepted: 30/ 6/ 2026

Abstract

This experiment was conducted at the Faculty of Animal Production - Elkhawie, West Kordufan University, Sudan in March 2023. This work was aimed to study the effect of sex on carcass characteristics and composition of Desert goat kids raised under grazing natural range-land. Eighteen kids (9 males and 9 females) of about 8 months of age (based on the investigation of the milk teeth) with an average body weight of (17.83) kg for males and (18.50) kg for females were randomly selected from Elkhawie livestock market. The purchased kids were slaughtered after an overnight fast except for water. The results found that empty body weight was higher in female kids but not significant. The carcass data revealed that warm dressing out percentage on slaughter weight was higher for male than female kids, while on empty body weight dressing out percentage was higher in female kids (52.32 versus 51.31) % but the difference was not significant. The data also indicated that female kids had higher total edible portion compared to male kids but the difference was not significant. Wholesale cuts were not significantly affected by sex, yet male kids had higher neck and leg proportions while the best end of neck, loin, breast and single short forequarter cuts were higher in female kids. Non carcass components proportions were not affected by kid sex except for head percentage, which was significantly higher ($P<0.05$) in male kids. The kid sex did not significantly affect the carcass composition although total carcass fat proportion (12.05 versus 8.56) % and muscle to bone ratio were higher in female kids. On the other hand, total carcass muscle and bone portions were higher in males compared to females. It could be concluded that, Desert goat kids of both sexes slaughtered directly from pasture could be an alternative source of meat for local consumption while lamb and mutton produced for export.

Keywords: Carcass characteristics, edible meat, kids.

Introduction:

Sudan has a large goat population estimated as 32.42 million (AOAD, 2022) which are classified into four major types including the Desert goats. Moreover, more than 70% of Sudan goats are produced under extensive production systems. Desert goats are one of the most predominant goats in Western Sudan and are calcified as meat producing goats. In Sudan, approximately 99% of goat meat produced is consumed locally without undergoing finish. Thus, there is a considerable requirement for developing goat production not only for domestic meat consumption but also for export.

Goats are multipurpose animals producing meat, milk, skin and hairs (French, 1970). However, in Sudan out of these products, meat is the major form in which goats are consumed. Goats contribute to the meat supply mainly in less developed countries, where most of the marketed meat goats are butchered and sold at local markets, with little attention being paid to the quality (Gall, 1982).

The perceptions about goat meat are changing due to the health benefits of consumption of lean meat with reduced fat and cholesterol content (Webb, 2014). Furthermore, Ivanovic *et al.* (2016) indicated that goat meat has a smaller amount of cholesterol and saturated fatty acids which were considered good for health compared to other types of red meat. The consumption of goat meat is currently increasing worldwide and the quality of meat and its health benefits are decisive parameters, as they determine the interest and acceptability of the product (Mazhangara *et al.*, 2019).

The demand for goat meat is high in Western Sudan and goat meat has the same market prices as mutton and highly valued than beef especially during the dry season (Elbukhary *et al.*, 2019). Moreover, male and female goats have become equally potential candidates for selling or slaughter in rural animal markets and the consumer does not distinguish between sexes in price but sometimes culled females 1.5 – 2 years old (jazaria) have higher price than males (Elbukhary *et al.*, 2019).

Carcass characteristics and composition are of great importance in meat production and highly affect it is commercial quality due to their economic implications. Goat meat is known for high muscle and bone percentages and low-fat content, especially subcutaneous fat (Guerrero *et al.*, 2018). In Elkhawie goats are reared under traditional management system and slaughtered for consumption directly from the range without fattening. The aim of this study was to compare slaughter characteristics and carcass composition of male and female Desert goat kids raised under traditional livestock production system based on natural range-land grazing in Western Sudan.

Materials and Methods

1. Study area:

This study was carried out at the Farm of the Faculty of Animal Production, West Kordufan University, Elkhawie, Sudan. Elkhawie is located between latitudes 11° 47' to 11° 39' N and longitudes 28° 40' to 28 ° 49' E . The area is characterized by a tropical climate with an average monthly temperature of 34.6°C. The coldest months are December with an average temperature of 14.1°C and January with a temperature of 13.5°C, whereas the hottest months are April, May and June with an average temperature exceeding 30°C. The area has a mean annual precipitation of 347.8 mm (Elfaig, 1996). Local pasture is dominated by; major Grass species which include; Aborakhus (*Andropogon gayanus*), Bano (*Eragrostis tremula*), Difra (*Echinocloa colonum*), Huskneet (*Cenchrus biflorus*) and Shuleny (*Zornia glochidiata*). However; the dominant trees include Arad (*Acacia etbaica*) Higlig (*Balanites*), Humied (*Sclerocarya birrea*) and Sider (*Zizuphus spina*). Kursan (*Boscia senegalensis*), Mereikh (*Polygala eriotera*) and Usher (*Calotropis*) were the most common leguminous shrub species (MARF, 2009). The area is known for its large livestock population especially sheep and goats.

2. Experimental animals:

Eighteen Desert goat kids (9 males and 9 females) of about 8 months of age with an average body weight of 17.83kg for males and 18.50kg for females were bought from Elkhawie livestock market. In Elkhawie goats are raised under traditional extensive management system, in which they are

allowed to graze and browse on naturally available pasture around the villages during the day (Free grazing system), without any supplements (Elhag *et al.*, 2013).

3. Slaughtering procedure:

Kids were fasted overnight except for water before slaughtered. Live weight prior to slaughter and the slaughter weight were then recorded. The kids were slaughtered according to Muslim (Halal) method as described by (Kadim *et al.*, 2004). After complete bleeding, the slaughtered kids were skinned and eviscerated according to commercial procedures. Carcass and non-carcass components were weighted immediately after skinning and eviscerating using a spiral balance.

4. Slaughter data:

The carcass comprised the body after removing non carcass components (blood, skin, head, four feet, digestive tract, liver, heart, lungs, spleen and pancreas in addition to omental and mesenteric fat).

Since no refrigerators are available, dressed carcasses were weighed within 1 hr to obtain hot carcass weights (HCW) and the weights of non-carcass components using a spiral balance. Empty body weight (EBW) was obtained by excluding the gastro-intestinal tract contents from slaughter weight.

Dressing percentage (DP) was calculated on the basis of hot carcass weight. Dressing percentage on live weight was calculated as follows: $DP = (\text{Hot carcass weight} / \text{Live weight}) \times 100$. While dressing percentage on empty body weight was calculated as follows: $DP = (\text{Hot carcass weight} / \text{Empty body weight}) \times 100$.

5. Edible meat and saleable body components:

Edible proportion of live weight was obtained as slaughter weight minus skin, blood and gut fill as described by (Elbukhary *et al.*, 2019). On the other hand total saleable part percent was estimated as the sum of the weights of commercially valuable parts, which is the slaughter weight less the weight of the blood and gut contents (Jibir *et al.*, 2012). Edible and saleable body components were expressed as a percentage of the slaughter weight of the animal.

6. Carcass characteristics and composition:

After removing the tail, the hot carcass was split along the dorsal mid-line using a hand meat saw. The left half of the carcass was weighed and then jointed into wholesale cuts, i.e; Leg and chump, loin, Single short forequarter, neck, breast and Best end of neck according to (MLC, 1976). The weight of each cut was recorded and expressed as percent of half carcass weight. Each cut was dissected and the different tissues were separated in terms of lean (muscle), bone and fat and weighed to estimate the total carcass composition as percentage of the half carcass weight. Muscle to bone ratio was obtained by dividing total carcass muscle weight by total carcass bone weight and compute it as a ratio.

7. Statistical analysis:

Data were analyzed using t-test for independent samples for mean comparisons, to evaluate the effect of sex on all independent measured parameters with the application of SPSS statistics software version 20 (Landau and Everitt, 2014).

Results and Discussion

1. Carcass Characteristics of Desert Goat Kids:

Slaughter weight, empty body weight (EBW), hot carcass weight (HCW) and dressing percentages of male and female Desert goat kids are presented in table (1). There were no significant differences

in slaughter weight and empty body weight between male and female kids. Consequently, no significant differences in hot dressing percentage son slaughter or empty body weight bases between male and female kids were observed table (1). Dressing percentage based on slaughter weight was slightly higher in males than females, while on empty body weight dressing percentage was higher in females but the differences between sexes were not significant. These results are in agreement with that of Santos *et al.* (2008) who found that the sex of the animal did not affect carcass measurements of goat kids.

The present dressing percentages for Desert goat kids on slaughter weight bases are within the range of 40.45 - 47.35% reported for different Sudanese goat breeds (Babiker *et al.*, 1985; Elbukhary and Babiker, 2008; Mudawi, *et al.*, 2012; Tameem Eldar *et al.*, 2012; Elbukhary *et al.*, 2019). These dressing out percentages generally compared well with values reported for various goat breeds worldwide (Devendra and Owen, 1983; Kadim *et al.*, 2004) and Mehjabin *et al.* (2016) for Black Bengal goats, while they were slightly lower than the values of 47.15% and 51.79% for intact male of Small East African goats from traditional production system in Tanzania reported by Shija *et al.* (2013) and values of 50 – 51 % reported by Ukanwoko and Onuoha (2011) for West Africa Dwarf goats fed oil palm leaf meal in the humid tropics. Furthermore, it was higher than 40.9% versus 41% reported by Simela *et al.* (2011) for male and female kids respectively of South African indigenous goat. Moreover, it was also higher than the values of 36.30% and 35.74% for females and males respectively reported by (Rodriguez *et al.*, 2014) in Puerto Rico for goats of different origins raised under grazing conditions without supplementation. These findings agreed with Azeem *et al.* (2023) who indicated that sex did not significantly affect killing out percentages of Local Goats in Pakistan, although male kids have slightly higher killing out percentage. Similarly these findings agreed with Mehjabin *et al.* (2016) who stated that the dressing percentage of Black Bengal goat did not differ significantly among the different sex groups of goat but the highest dressing percentage was observed in castrated males followed by does and the least in bucks.

This finding is attributed to the fact that under tropical conditions, potential effects of the animal's sex on carcass characteristics at the same stage of maturity are not expressed because of the low level of management (Santos *et al.*, 2008).

Table (1): Carcass characteristics of Desert goat kids

No	Treatment	Male (mean±Se)	Female (mean±Se)	Significant level
1.	Slaughter body weight (kg)	17.83±8.33	18.50±10.00	N.S
2.	Empty body weight (kg)	14.87±10.20	14.98±3.35	N.S
3.	Hot carcass weight (kg)	7.600±3.05	7.83±2.19	N.S
4.	DP (SBW basis) %	42.64 ±0.45	42.17 ±2.10	N.S
5.	DP (EBW basis) %	51.31 ±1.39	52.32±1.66	N.S

Se = Standard error of the treatment means

N.S = Not significantly different

DP = Dressing out percentage

SBW = Slaughter body weight

EBW = Empty body weight

2. Non-carcass components of Desert goat kids:

Proportions of non-carcass components of Desert goat kids on slaughter weight base are presented in table (2). Male kids had significantly $p < 0.05$ higher percentages of head and not significantly higher percentages of skin, four feet, empty rumen, heart, lungs and trachea and reproductive organs than females on the other hand Intestine empty, liver, kidneys, kidney fat, mesenteric and omentum fat, pelvic fat and digesta were heavier in female than male kids.

The values of non-carass components in this study are comparable to those reported for Sudanese goats (Elbukhary and Babiker, 2008; Mudawi *et al.*, 2012) for Tagger goat. Moreover, the same observation was also reported by Elbukhary *et al.* (2019) for Misseriya goat kids in West Kordufan State. The total non-carass components in this study were higher in female than male kids. These results disagreed with Azeem *et al.* (2023) who observed that the offal values were higher in male and lower in female kids of Local Goats in Pakistan.

Table (2): Proportions of non-carass components of Desert goats (on slaughter weight base)

No	Treatment	Male (mean±Se)	Female (mean±Se)	Significant level
1.	blood%	4.09 ± 0.32	4.16 ± 0.36	N.S
2.	Head%	7.10*± 0.04	6.69±0.17	P<0.05
3.	Skin%	7.10 ± 0.04	6.78 ± 0.23	N.S
4.	Four feet%	3.73±0.10	3.00±0.29	N.S
5.	Rumen full%	15.82±1.29	15.78±2.55	N.S
6.	Rumen empty%	3.18±0.18	2.94±0.4	N.S
7.	Intestine full%	8.42±0.20	8.81±0.70	N.S
8.	Intestine empty%	3.92±0.52	4.55±0.42	N.S
9.	Heart%	0.74±0.15	0.72±0.08	N.S
10.	Liver%	1.67±0.10	1.79±0.18	N.S
11.	Spleen%	0.31±0.08	0.31±0.02	N.S
12.	Kidney%	0.34±0.03	0.38±0.08	N.S
13.	kidney fat%	0.43±0.23	0.81±0.17	N.S
14.	Mesenteric and omentum fat%	1.11±0.12	2.58±0.44	N.S
15.	lung & trachea%	1.21±0.03	1.17±0.03	N.S
16.	Reproductive organs	0.89±0.10	0.57±0.11	N.S
17.	pelvic fat%	0.36±0.12	0.59±0.05	N.S
18.	Digesta %	16.80±1.81	18.73±2.69	N.S

S.e = Standard error of the treatment means

N.S = Not significantly different

*= significantly different at 0.05

3. Edible meat (edible non carcass components plus carcass) of Desert goat kids:

In Sudan and some countries where goat meat is eaten, many non-carass components and the carcass are also consumed. These commonly include the liver, kidneys, heart, tongue, brain, cheek, intestines, rumen, lungs, spleen, visceral fat, and even feet. In this work the percentage of the total edible meat (non-carass components plus the carcass) was 67.64% and 68.26% for male and female Desert goat kids respectively table (3). Female kids had higher edible meat percentage compared to males but the difference was not significant. Similar results were obtained by Elbukhary *et al.* (2019) who found in Misseriya goat kids females had higher edible meat percentage compared to males but did not differ significantly. On the other hand, the edible meat percentages found in the present study were slightly lower than (72%) for the desert goats (Gaili, 1976), 72.59% reported by Jibir *et al.* (2012) and those reported by Owen and Norman (1977) as 70% and 74% for indigenous Malawi goats and Boer goats respectively. The obtained edible meat percentages in this study were much higher than the values ranged from 60.9 to 63.8% of slaughter weight for Ethiopian male goat breeds (Ameha *et al.*, 2007) and the values of 45.99% versus 53.79% reported for does and males of Zimbabwe indigenous goats (Assan, 2013). The latter stated that the edible proportion of live weight was obtained as all body components minus skin, lungs, heart, head, feet and gut fill. Moreover Awan *et al.* (2015) stated that edible offals included heart, liver, tongue, kidney, tails, tripe (stomach), spleen, Chitterlings, sweet breads (pancreatic) gland (thymus), intestine, rinds, lips, fats, testicles, trimmings, blood and certain bones.

The total edible non carcass components in this work was 25.51% which is comparable to the total edible offal content of 21.23 – 22.86% (Alemu *et al.*, 2020) and a value of 26.8 – 30.3% for

Abergelle Goats in Tigray, Ethiopia (Redae *et al.*, 2020), although total edible offal component (TEOC) in their study was computed as the sum of tongue, liver, kidneys, empty gut, visceral fat (kidney fat and omental fat), and tail.

These variations in the percentages of edible meat could possibly be due to gut content, the type of non – carcass components consumed and feeding custom of the society in the different countries.

Table (3): Edible Meat and Saleable body components of Desert Goat Kids on Slaughter Weight Base

No	Treatment	Male (mean±Se)	Female (mean±Se)	Significant level
1.	Hot carcass%	42.64 ±0.45	42.17 ±2.10	N.S
2.	TENCC%	25.00±1.09	26.09±0.84	N.S
3.	Total Edible Meat%	67.64±0.34	68.26±1.65	N.S
4.	TSBC%	74.75±1.37	75.04±1.49	N.S

TENCC =Total edible non carcass components, TSBC =Total saleable body components

S.e = Standard error of the treatment means

N.S = Not significantly different

4. Saleable body components of Desert goat kids:

The saleable body components of Desert goat are given in table (3), which includes: (carcass, head, skin, four feet, empty rumen, empty intestine, heart, liver, spleen, kidneys, kidneys fat, Mesenteric and omentum fat, lung and trachea, Reproductive organs and pelvic fat). Total saleable part percent in this work was estimated as percentage of slaughter weight and it was higher in female than male kids 75.05% versus 74.75% but the difference was not significant. These values were lower than those given by Redae *et al.* (2020) for Abergelle Goats in Tigray, Ethiopia (90.8% – 95.7 94.3%). This was due to the fact that blood and gut fill is included as usable parts in their study while in our study blood and gut fill were excluded.

5. Wholesale cuts of Desert goat kids:

Table (4) gives yield of wholesale cuts from Desert goat kids. The effect of kid sex was not significant on the proportions of wholesale cuts. The leg and chump 33.75% for males versus 31.96% for females and it was higher in male kids. These values were closer to the values obtained by Elbukhary and babiker (2008) and Mudawi *et al.* (2012) for Tagger goat kids and those of Misseriya goat kids reported by Elbukhary *et al.* (2019). Single short forequarter was 28.07% versus 28.09% and it was higher in female than male kids. The percentages of single short forequarter, best end of neck, loin and breast were higher in females than males. On the other hand, male kids had higher leg and chump, and neck compared with females. Similar results were noted by Alkass *et al.* (2014); Elbukhary and Babiker (2008); Mudawi *et al.* (2012); and Elbukhary *et al.* (2019).

Table (4): Wholesale cuts of Desert goat kids

No	Treatment	Male (mean±Se)	Female (mean±Se)	Significant level
1.	leg and chump %	33.75±0.24	31.96 ±1.09	N.S
2.	single short forequarter %	28.07± 0.44	28.09±0.38	N.S
3.	best end of neck %	9.18±0.17	10.03±0.99	N.S
4.	Loin%	11.82±0.36	12.81±1.45	N.S
5.	Breast %	7.41±0.57	7.64±0.59	N.S
6.	Neck %	9.74±1.23	8.05±0.65	N.S

S.e = Standard error of the treatment means

N.S = Not significantly different

In the the present study wholesale cuts were not affected by kid sex, which is agreed with Alexandre *et al.* (2009) and Dosky *et al.* (2009) who noticed no significant differences in commercial cuts due to sex in different breeds of goat kids raised intensively or extensively. Moreover, it is similar to

that of Azeem *et al.* (2023) who indicated that sex had no significant effect on retail cuts percentages of Local Goats in Pakistan.

6. Carcass Composition of Desert goat kids:

In the present study, muscle, fat, bone percentages and muscle: bone ratio and muscle: fat ratios are given in (Table 5). The results indicated that Carcass Composition parameters were not significantly affected by kid sex although male kid carcasses had higher muscle and bone content, while females had higher fat content. There is a great variation in carcass composition between goat breeds; muscle 69 - 50%, bone 34 –11.8% (high rate in young animals), and a percentage of fat between 23.7 and 5% Sanudo *et al.* (2012).

These results were comparable to the findings of Lawrence and Fowler (2012) who reported that entire males had greater carcass muscles and bones than females while the later have greater carcass fat and it is similar to the results obtained by Dai *et al.* (2022). Moreover, it has been reported by Devendra and Burns (1983) and ElMoula, *et al.* (1999) that male goat kid carcasses had less fat and more bone than females. Similarly, El Khidir, *et al.* (1998) and Mudalal *et al.* (2014) obtained the same results with Desert goats. Generally, the carcass composition of desert goat kids in these results appeared to be broadly comparable to other Sudanese goats including Tagger goat kids Elbukhary and Babiker (2008) and Mudawi *et al.* (2012) and Misseriya goat kids Elbukhary *et al.* (2019). These results agreed with the statement that carcasses from intact males had higher contents of muscle and lower contents of fat than carcasses from females Colomer Rocher *et al.* (1992). This might be attributed to the fact that at similar age, female goats tend to have a higher fat content than male goats (Sebsibe, 2011).

As seen in (Table 5) muscle: bone ratio was higher in female kids due to lower bone content and muscle: fat ratio was lower in female kids due to high fat content. Muscle + fat: bone ratio was also greater in female kids due to the high fat in female carcasses but the differences were not significant. These results agreed with Alkass *et al.* (2014) who stated that the percentage of bone and lean: bone ratio in Iraq goat kids was not significantly different between sexes.

Table (5): Carcass Composition of Desert goat kids as % of the left Carcass Halves

No	Treatment	Male (mean±Se)	Female (mean±Se)	Significant level
1.	Muscle%	61.86±1.74	60.10±2.48	N.S
2.	Bone%	28.80±1.60	27.39±1.18	N.S
3.	Fat%	8.56±0.87	12.05±1.43	N.S
4.	Muscle: bone	2.17±0.17	2.21±0.19	N.S
5.	Muscle: fat	7.43±1.02	5.18±0.84	N.S
6.	Muscle + Fat: Bone	2.46±0.17	2.65±0.16	N.S

Se = Standard error of the treatment means

N.S = Not significantly different

Conclusion and Recommendations

The results of this study underscore the meat productivity of Desert goat kids slaughtered directly from traditional production system. It could be concluded that, Desert goat kids of both sexes could be a sustainable source and an alternative red meat option for local consumption while lamb and mutton will be produced for export.

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أثر الجنس على صفات وتركيب ذبائح جديان الماعز الصحراوي

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تاريخ الاستلام: 2026 / 1 / 13 تاريخ القبول: 2026 / 6 / 30

الملخص

اجريت هذه الدراسة في كلية الانتاج الحيواني - جامعة غرب كردفان بمحلية الخوي - ولاية غرب كردفان - السودان في مارس 2023 لدراسة أثر الجنس على صفات وتركيب ذبائح الماعز الصحراوي. تم شراء عدد ثمانية عشرة رأس من جديان الماعز الصحراوي من سوق المواشي بمدينة الخوي (تسعة ذكور وتسعة إناث) بمتوسط وزن 17.83 و18.50 كيلوجرام للذكور والإناث على التوالي وبمتوسط عمر 8 أشهر وقدر العمر عن طريق فحص القواطع اللبنية. تم ذبح جميع الجديان لدراسة صفات وتركيب الذبائح. بين التحليل الإحصائي تفوق الإناث نسبيا في متوسط وزن الجسم الفارغ 14.98 مقابل 14.87 كيلوجرام للإناث والذكور على التوالي إلا أن الفروقات غير معنوية. كما أوضح التحليل الإحصائي أن نسبة التصافي على أساس الوزن الحي ووزن الجسم الفارغ لم تتأثر معنويا بجنس الجدي بالرغم من تفوق الإناث على الذكور في نسبة التصافي على وزن الجسم الفارغ (52.32 مقابل 51.31) % . ووضحت النتائج أن الإناث تفوقت قليلا على الذكور في الجزء الصالح للأكل من ذبيحة الحيوان. وعند مقارنة تركيب الذبائح نجد أنها لم تختلف معنويا بين الذكور والإناث في نسبة العضلات والعظام والدهن بالرغم من تفوق الإناث في نسبة الدهن (12.05 مقابل 8.56) % . توصي هذه الدراسة بأن لحوم الماعز المغذاة على المراعي الطبيعية بغض النظر عن جنسها يمكن أن تكون كمصدر إضافي للحوم الحمراء للاستهلاك المحلي خاصة في المدن الريفية ويكون انتاج الاغنام والحملان للصادر.

الكلمات المفتاحية: لحم الماعز، تركيب الذبيحة، الماعز الصحراوي.