COMPARATIVE EVALUATION OF THE INFLUENCE OF SPECIES, AGE AND SEX ON CARCASS CHARACTERISTICS OF CAMELS, CATTLE, SHEEP AND GOATS IN SAHEL ENVIRONMENT

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ABSTRACT

This study, comparative evaluation of sources of supply of edible meat from camel with cattle, sheep and goats in Sahel environment was conducted at Zinder Abattoir in Niger Republic. The factors considered were species, sex and age. Species significantly influenced (p<0.01) the meat evaluation indices with camel being highest in most of the meat indices. Cattle yielded highest head and skin weights. Goat yielded highest dressing percentage. The sheep had no superiority in any index. Sex of the animal had no significant effect (p>0.05) on meat evaluation indices in camel and goats. It significantly affected (p<0.05; 0.01) the indices in cattle and sheep; except for hind quarter weights and edible offals in sheep (p>0.05). Age of the animals significantly (p<0.01) affected the meat evaluation indices in camel, cattle and sheep. It only significantly affected (p<0.05; 0.01) hind quarter weight, legs weight and edible offals in goats. The correlation observed among the meat evaluation indices showed some variable correlated relationship (p<0.05 – 0.01; r = 0.25 – 0.97 and r = 0.29 – 0.93) and (p> 0.05; r = -0.03 – 0.24 and r = 0.00 – 0.20). In conclusion, camel and ruminants meat productive performance can be assessed through their respective meat indices. Camels could serve as good sources of meat supply in the arid environment to supply the needed animal protein to the populace.

Keywords: Camel, Ruminants, Meat evaluation indices, Meat supply, Sahel environment

INTRODUCTION

The role of camel as domestic and food animal has received increased recognition in recent years particularly in the arid and semi-arid regions where cattle, goat and sheep cannot thrive well due to extremely harsh environments (Kadim *et al.*, 2008). This is because camel possesses some characteristics over ruminants such as great tolerance to high temperatures, high solar radiation and water scarcity. It can survive well on sandy terrain with poor vegetation and may chiefly consume feeds unutilized by other domestic species to produce protein at a comparably low cost in the arid zones (Kadim *et al.*, 2008).

Camels are used for production of milk, meat, hides, and for riding, racing, packing and agricultural activities (Albert, 2002; Hamed *et al.,* 2014). The local consumption of camel meat had increased in most countries, especially from young camels due to their nutritional value and health reasons. Camels are known to produce meat with relatively less fat than cattle and sheep and are used to cure diseases such as hyperacidity, hypertension, pneumonia and cardiovascular disease (El-Faer *et al.*, 1991; Dawood and Alkanhal, 1995; Kurtu, 2004; Kadim *et al.*, 2008). Camel meat composition has been compared with meat from other farm animals (beef, lamb, goat and chicken) and found to have more moisture, less fat, less ash, cholesterol and similar protein contents (Elgasim

and Alkanhal, 1992; Dawood and Alkanhal, 1995; Kadim *et al*., 2008; Soltanizadeh *et al*., 2010). Camels are good potential source of meat as they yield reasonably heavy carcasses under inexpensive management systems that are used as sausages, killichi, hamburgers and minced meat. A wide range of carcass characteristic such as live weight, carcass weight, dressing percentage, four quarter weight, hind quarter weight and head weight have been reported for camels, with the variation apparently due to condition, sex, breed and age at slaughter (Herrmann and Fisher, 2004; Kurtu, 2004; Choat *et al*., 2006). This paper is therefore aimed at evaluating the influence of species, age and sex on carcass characteristics of camels, cattle, sheep and goat.

MATERIALS AND METHODS

Data on seventy two animals (72) were used for the experiment, 18 from each species (9 males and 9 females) of camel, cattle, goat and sheep collected at Zinder Abattoir situated at Southern part of Niger Republic. For camel and cattle, animals aging less than 2 years, 2 – 4 years and greater than 4 years were sampled. This gave rise to animals being categorized as young, adult and aged for both males and females. For goats and sheep, and for each sex, animals were categorized into age groups as follows: less than 1 year, 1 – 2 years and more than 2 years. These for both males and females gave rise to young, adult and aged animals, respectively. Dental formulae of the animals and information from the butchers on the animals were used to estimate their ages for the different species. For ruminants and camels, the formula used was (003/4033 and 0033/4033), (113/312 and 1133/3123) for young and adult, respectively.

Data collection was carried out in Zinder Abattoir situated at Southern part of Niger Republic. The following characteristics were measured: (i) Live weight – this is the weight of animal when alive. For camel and cattle, barometric, crevats and Indian corps methods were used respectively. For goat and sheep, the live weight was taken by weighing them directly on the weighing scale, (ii) carcass weight – this is the weight of the carcass after removing the skin, gastrointestinal tracts, head and legs. Toledo weighing scale was used to estimate the carcass weight and (iii) carcass yield or dressing percentage was estimated using the formula: D% = carcass weight / live weight x 100.

Other parameters measured were: (i) fore quarter weight – the weight of the frontal half of the animal containing the fore legs, (ii) hind quarter weight – this is weight of the rear half of the animal containing the hind legs, (iii) head weight – this is the weight of the animal's head after the horns had been removed, (iv) skin weight – this is the weight of the fresh skin of the animal and (v) edible offals weight – this is the weight of the animal internal organs comprising of the lungs, heart, stomach, intestine, spleen, kidney and liver.

Statistical Analysis: Data collected were subjected to analysis of variance (ANOVA) of SAS (2002) and the significant treatment means were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1955). Correlation between two variables was estimated using the PROC CORR procedure of the same software. The following model was used for the analyses: $Y_{ijkl} = \mu + S_i + A_j + S_k + e_{ijkl}$, where Y_{ijkl} is the dependent variable, μ = over al mean, S_i = effect of i^{th} species (camel, cattle, goat and sheep), A_j = effect of the j_{th} age of the animal (young, adult, aged), S_k = effect of the k^{th} sex (male, female) and e_{ijkl} = residual error.

RESULTS AND DISCUSSION

The effect of species on meat indices of the sampled animals indicated that species of the animal significantly influenced ($p<0.01$) the meat evaluation indices (Table 1). With regards to species, camel was superior in live weight, carcass weight, fore and hind quarters weights, legs and edible offals. Cattle were superior in head and skin weights, but similar to camel in carcass weight dressing percentage, hind quarter weights and edible offals. Goat was superior in dressing percentage, but ranked the least in other meat evaluation indices.

Table 1: Effect of species on carcass characteristics of camels, cattle, sheep and goats in Sahel environment

Characteristics	Camel (18)	Cattle (18)	Goat (12)	Sheep (12)
Live weight	330.7 ± 29.18^{a}	297.7 ± 25.27^{b}	18.4 ± 0.49^{d}	35.1 ± 2.95^{c}
Carcass weight	139.9 ± 10.30^{a}	131.4 ± 20.37^{a}	11.3 ± 0.34^{b}	18.0 ± 2.15^{b}
Dressing percentage	41.0 ± 0.56^{c}	43.3 ± 3.92^{c}	56.6 ± 1.95^{a}	49.6 ± 2.04^{b}
Fore quarter weight	41.9 ± 2.97^{a}	32.3 ± 4.56^{b}	4.1 ± 0.43^{c}	5.7 ± 0.38^{c}
Hind quarter weight	31.3 ± 2.33^{a}	29.3 ± 4.28^{a}	4.5 ± 0.56^{b}	5.5 ± 0.30^{b}
Head weight	10.2 ± 1.31^{b}	11.7 ± 1.72^{a}	0.8 ± 0.09^{d}	2.1 ± 0.29^{c}
Skin weight	17.4 ± 0.52^{b}	18.20 ± 1.45^{a}	1.4 ± 0.09^{c}	2.3 ± 0.30^{c}
Legs weight	1.10 ± 0.56^{a}	5.8 ± 0.59^{b}	0.6 ± 0.08^{c}	0.9 ± 0.09^{c}
Edible offal	18.4 ± 2.04^{a}	18.4 ± 2.25^{a}	2.2 ± 0.08^{c}	6.0 ± 0.16^{b}

Number in parenthesis = number of animals sampled, means with different letter superscript within the same row are significantly different

Sheep had no superiority in any of the meat evaluation indices. It ranked similar to goat in carcass weight, fore and hind quarters weights and legs weight. The superiority of camel over other species in the characteristics measured agreed with the reports of Al-Ani (2004), Saparov and Annageldiyev (2005) and Kadim *et al.* (2008). All authors reported that camels are good potential sources of meat as they yield reasonably heavy carcasses under inexpensive management system that could be used to meet the growing needs for meat in developing countries especially for low income population groups. It is also not surprising that the camel yielded the highest live weight. This is because the size of an animal positively influences the live and carcass weights of an animal (Hammond, 1983) and that camel can thrive well in arid and semi-arid environments than cattle, sheep and goat. The highest yield of cattle in head and skin weight concord with the reports of Herrmann and Fisher (2004) and Kadim *et al.* (2008) that the camel head and skin weight is proportionately lower than that of cattle. This could be attributed to the fact that camels lack horns. The similarity in value of edible offal recorded for camel and cattle in this study agreed with Al-Ani (2004) that reported that camels and cattle had proportionately heavier kidney and lighter digestive tracts and head than sheep and goats. Also the results of this study on the superiority of camel and cattle in carcass weight, hind quarter weight and edible offal over sheep and goat agreed with the previous reports of Camfield *et al.* (1999) and Short *et al.* (1999) that the larger frame-sized animals attain heavier final weights and have heavier carcasses than the smaller frame-sized animals. The high dressing percentage of goat over camel, cattle and sheep confirmed the study of Eusminger (1977) who reported high dressing percentage of goat over sheep, cattle and camel. This could be attributed to the lesser bones in goat than the other species.

The influence of sex and age of the animals on meat evaluation indices across the studied animals, indicated that the sex of the animal had no significant effect ($p>0.05$) on meat evaluation indices in camel and goats (Table 2). Sex of the animal significantly affected ($p<0.05$; 0.01) meat evaluation the indices in cattle and sheep; except for hind quarter weights and edible offals in sheep ($p>0.05$). Generally, males were superior in the performance of the meat evaluation indices compared to females.

The effect of sex on carcass parameters on cattle and sheep in this study agreed with Choat *et al*. (2006), Guillemin *et al*. (2009) and Panjono-Kang *et al*. (2009) that sex is one of the ante-mortem factors contributing to variation in beef muscle and carcass characteristics in cattle because it affects fat depositions in the muscle of the cattle. The result of this study is at variance with the earlier report by Peña *et al.* (2007) who reported no significance of sex on carcass traits in Florida suckling lamb. Furthermore, Falagan (1992), Vergara *et al*. (1999), Santos *et al.* (2000) and Pérez *et al*. (2000; 2002) reported carcass yield to be better in females as opposed to the better performance in males observed in this study.

Table 2: Effect of age and sex on meat evaluation indices of camel, cattle, goat and sheep in Sahel environment

Characteristics	Sex		Age		
	Male	Female	Young	Adult	Aged
			Camel		
Live weight	338.8 ± 11.69	322.8 ± 11.64	224.7 ± 53.4^{b}	388.9 ± 29.10^{a}	378.4 ± 23.85^{a}
Carcass weight	135.1 ± 5.27	132.5 ± 5.92	96.3 ± 1.00^{b}	154.1 ± 7.10^{a}	151.0 ± 5.55^{a}
Dressing percentage	40.7 ± 0.77	41.2 ± 0.75	43.0 ± 21.80	40.1 ± 0.45	39.8 ± 0.60
Fore quarter weight	42.3 ± 1.22	41.1 ± 1.27	31.0 ± 5.45^{b}	46.1 ± 2.1^{a}	48.2 ± 3.15^{a}
Hind quarter weight	31.2 ± 0.97	31.4 ± 0.97	22.8 ± 4.25 ^{b}	36.2 ± 2.45^{a}	34.8 ± 1.75^{a}
Head weight	10.3 ± 0.45	10.0 ± 0.48	10.0 ± 0.10^{b}	14.4 ± 2.10^{a}	6.1 ± 2.05^{c}
Skin weight	17.2 ± 0.24	17.6 ± 0.24	15.5 ± 0.95^{b}	18.3 ± 0.45^{a}	18.4 ± 0.50^{a}
Legs weight	11.0 ± 0.21	11.0 ± 0.21	9.2 ± 0.90^{c}	11.2 ± 0.10^{b}	12.7 ± 0.85^{a}
Edible offal	18.2 ± 0.73	18.9 ± 0.81	13.2 ± 2.60^{c}	16.8 ± 0.80^{b}	25.7 ± 3.65^{a}
			Cattle		
Live weight	351.8 ± 27.05^{a}	243.7 ± 27.00^{b}	203.3 ± 47.2^{c}	298.0 ± 0.15^{b}	391.8 ± 47.05^{a}
Carcass weight	173.0 ± 20.80^{a}	89.8 ± 20.80^{b}	75.3 ± 28.05^{b}	167.3 ± 17.95^{a}	151.5 ± 10.05^{a}
Dressing percentage	50.2 ± 3.45^{a}	36.8 ± 3.25^{b}	36.5 ± 3.40^{b}	55.5 ± 6.10^{a}	38.5 ± 2.40^{b}
Fore quarter weight	41.9 ± 4.80^{a}	22.6 ± 4.85^{b}	20.1 ± 6.10^{b}	40.2 ± 3.95^{a}	36.5 ± 2.10^{a}
Hind quarter weight	38.4 ± 4.55^{a}	20.1 ± 4.60^{b}	19.0 ± 5.15^{c}	37.9 ± 4.30^{a}	30.8 ± 0.75^{b}
Head weight	14.3 ± 1.30^{a}	9.1 ± 1.30 ^{b}	6.4 ± 2.65^{c}	13.0 ± 0.65^{b}	15.7 ± 2.00^{a}
Skin weight	21.6 ± 1.70^{a}	18.5 ± 0.15^{b}	20.3 ± 1.05^{b}	15.6 ± 1.30^{c}	24.2 ± 3.00^{a}
Legs weight	6.1 ± 0.15^{a}	5.5 ± 0.15^{b}	3.7 ± 1.05^{c}	7.1 ± 0.65^{a}	6.6 ± 0.40^{b}
Edible offal	22.2 ± 1.90^{a}	14.6 ± 1.90^{b}	24.4 ± 3.00^{a}	12.4 ± 3.00^{c}	18.4 ± 0.00^{b}
			Goat		
Live weight	19.1 ± 0.35	17.8 ± 0.30	17.5 ± 0.45	19.3 ± 0.45	
Carcass weight	9.8 ± 0.750	10.7 ± 0.30	10.9 ± 0.20	9.5 ± 0.90	
Dressing percentage	51.8 ± 2.40	56.4 ± 0.10	58.3 ± 0.85	49.8 ± 3.40	
Fore quarter weight	3.2 ± 0.45^{b}	5.0 ± 0.45^{a}	4.7 ± 0.30	3.6 ± 0.25	
Hind quarter weight	3.8 ± 0.35	5.2 ± 0.35	5.7 ± 0.60^{a}	3.3 ± 0.60^{b}	
Head weight	1.0 ± 0.10	0.7 ± 0.05	1.0 ± 0.10	0.7 ± 0.05	
Skin weight	1.4 ± 0.00	1.5 ± 0.05	1.6 ± 0.10	1.2 ± 0.10	
Legs weight	0.6 ± 0.00	0.6 ± 0.00	0.8 ± 0.10^{a}	0.4 ± 0.10^{b}	
Edible offal	2.2 ± 0.00	2.2 ± 0.00	2.0 ± 0.10^{b}	2.4 ± 0.10^{a}	
			Sheep		
Live weight	37.8 ± 1.35^{a}	32.6 ± 1.25^{b}	28.4 ± 3.35^{b}	41.9 ± 3.40^{a}	
Carcass weight	20.3 ± 1.15^{a}	15.5 ± 1.25^{b}	13.2 ± 2.40^{b}	22.6 ± 2.30^{a}	
Dressing percentage	52.5 ± 1.45^{a}	46.9 ± 1.35^{b}	45.6 ± 2.00^{b}	53.9 ± 2.15^{a}	
Fore quarter weight	6.5 ± 0.40^{a}	5.0 ± 0.35^{b}	6.3 ± 0.30^{a}	5.2 ± 0.25^{b}	
Hind quarter weight	5.7 ± 0.10	5.2 ± 0.15	6.2 ± 0.35^{a}	4.8 ± 0.35^{b}	
Head weight	2.9 ± 0.40^{a}	2.0 ± 0.05^{b}	1.9 ± 0.10^{b}	3.0 ± 0.45^{a}	
Skin weight	2.5 ± 0.10^{a}	2.1 ± 0.10^{b}	1.6 ± 0.35^{b}	3.0 ± 0.35^{a}	
Legs weight	1.0 ± 0.05^{a}	0.7 ± 0.10^{b}	0.7 ± 0.10^{b}	1.0 ± 0.05^{a}	
Edible offal	3.5 ± 1.25	3.2 ± 1.40	3.0 ± 1.50^{b}	3.7 ± 1.15^{a}	

abc: Means with different superscript within the same row are significantly different

The general superiority of males over females could be attributed to more fat deposition, especially at the renal region of the female animals and possibly due to the physiology of the male, which includes an advanced growth rate and consequently, a greater elongation of bones (Wylie *et al.*, 1997).

Age of the animal significantly affected ($p<0.01$) the meat evaluation indices in camel, cattle and sheep.

Age of the animals only significantly affected ($p<0.05$; 0.01) hind quarter weight, legs weight and edible offals in goats. In this study, very old small ruminants were not processed for meat supply. In camel and cattle, the adults and aged were superior to the young source in performance of meat evaluation indices. However, in the goats, a better source of supply of hind quarter weight and legs weight was from young goats compared to the adult goats, while the adults were a better source for edible

offals. In the sheep, the young animals were better source of supply of fore and hind quarters while adult animals were better in supplying live weight, carcass weight, dressing percentage, head weight, skin weight, legs weight and edible offals.

Age effect on carcass quality as observed in this study for camel, cattle and sheep agreed with earlier reports of Hammond (1983), Abouheif *et al*. (1990), Kadim *et al.* (2008) and Hamed *et al*. (2014) who reported that age is among the factors that affect carcass characteristics in animals. The significant effect of age on goat's edible offals, hind quarter and legs weights observed in this study concord with the earlier reports (Marichal *et al.* 2003; Peña *et al.* 2007; Mayi *et al.,* 2010; Kaić *et al*., 2012) that indicated an increase in these characteristics of goats with increasing slaughter age but contradicted the findings of Bonvillani *et al.* (2010) and Assan (2012) who reported that the contribution of visceral organs and fat depots as the percentages of empty body weight did not change with slaughter weight in Criollo Cordobés kids goat and Matebele goat respectively. The significant effect observed in this study could be attributed to the fact that fat deposition is more in older animals than in younger ones**.**

The general superiority of the adult and aged animals over the young ones concord with the reports of Koknaroglu *et al*. (2005) in cattle and Gaili *et al.* (1972) in goats indicating increased fat with increasing age and that the goats were at their peak of growth and development. The better source of fore and hind quarters in sheep could be as result of the fact that the young animals brought for slaughter were at their rapid growth rate and the superiority of adult sheep in supplying live weight, carcass weight, dressing percentage, head weight, skin weight, legs weight and edible offals could be as a result of an increased carcass characteristics with increased age.

The correlated relationships among the meat evaluation indices according to animal species indicated that the edible offal was positively correlated with live weight in all the species studied ($p<0.01$, $r = 0.62 – 0.90$) (Table 3). The edible offal was negatively correlated with skin weight in camel ($p<0.01$, $r = -0.65$), dressing percentage and legs weight in cattle ($p<0.05$, $r = -0.28$ to -0.43), and dressing percentage, fore quarter weight, hind quarter weight and leg weight in goats, while having a positive relationship with carcass weight, dressing percentage, head weight, skin weight and leg weight in sheep. There were some species differences in the relationship of edible offals with other meat evaluation indices. Leg weight had positive correlations with meat evaluation indices across species ($p<0.05 – 0.01$, $r = 0.25 – 0.97$) except in the sheep where it was negatively correlated with hind quarters ($p<0.05$, $r = -0.42$). Skin weight was positively correlated with live weight, carcass weight, fore quarter weight and hind quarter weight in camel ($p<0.01$, $r = 0.79$-0.89), live weight and hind quarter weight in cattle ($p<0.05$, $r = 0.37 – 0.51$), carcass weight, dressing percentage, fore quarter and hind quarter weight in goat ($p<0.05 – 0.01$, $r = 0.30 – 0.66$), and live weight, carcass weight, dressing percentage and hind quarters in sheep ($p<0.01$, $r = 0.81 – 0.97$). It was negatively correlated with fore quarter and hind quarter weights in sheep ($p<0.05$, $r = -0.32$ to -0.45). Head weight had no significant ($p>0.05$) relationships with live weight, carcass weight, dressing percentage, fore and hind quarters weight in camel ($r = 0.01, -0.19$). They were positively correlated with it in cattle ($p<0.05 – 0.01$, $r = 0.29 – 0.93$). In the goat, it was negatively correlated with dressing percentage and fore quarter weight ($p<0.05$, $r= -0.30$ to -0.44), and hind quarter weight in the sheep ($p<0.05$, $r = -0.28$). The fore and hind quarters positively correlated among themselves and with live weight, carcass weight and dressing percentage in camel and cattle ($p<0.01$, $r = 0.60 – 0.99$). However, they were negatively correlated with live weight, carcass weight and dressing percentage in sheep ($p<0.05$, $r = -0.33$ to -0.40). Carcass weight and live weight were positively and significantly correlated across species ($p<0.01$, $r = 0.75 – 0.95$) except in goats where there was no significant relationship ($p>0.05$).

Table 3: Effect of species on the correlated relationship among the meat evaluation indices of camel, cattle, goat and sheep in Sahel environment

Variables	LW	CW	%D	FQW	HQW	HW	SW	LW	EO
					Camel				
LW	0.00	0.77**	- 0.37*	0.81**	0.75**	0.08	0.79**	0.70**	0.62**
CW		0.00	0.29*	0.97**	0.99**	0.16	0.89**	0.97**	0.65**
%D			0.00	0.19	0.31	0.15	0.07	0.20	-0.03
F QW				0.00	0.97**	0.01	0.89**	0.94**	0.75**
HQW					0.00	0.19	0.88**	0.86**	0.61**
HW						0.00	0.07	-0.24	-0.65**
SW							0.00	0.84**	0.70**
LW								0.00	0.88**
EO									0.00
					Cattle				
LW	0.00	0.75**	0.15	0.72**	0.60**	0.93**	0.37*	0.72**	0.07
CW		0.00	0.76**	0.98**	0.96**	0.81**	0.12	0.78**	-0.15
%D			0.00	0.76**	0.85**	0.29*	-0.24	0.48*	-0.28*
FQW				0.00	0.97**	0.80**	0.17	0.74**	-0.15
HQW					0.00	0.68**	0.03	0.70**	-0.12
HW						0.00	0.51*	0.77**	-0.19
SW							0.00	-0.07	-0.08
LW								0.00	-0.43*
EO									0.00
					Goat				
LW	0.00	0.07	-0.36*	-0.16	-0.14	0.12	0.18	-0.14	0.70**
CW		0.00	0.78**	0.78**	0.81**	-0.15	0.66**	0.52*	-0.12
%D			0.00	0.79**	0.81**	-0.30*	0.33*	0.36*	-0.52*
F QW				0.00	0.88**	-0.44*	0.30*	0.34*	-0.27*
HQW					0.00	-0.14	0.57*	0.68**	-0.37*
HW						0.00	0.21	0.25*	-0.13
SW							0.00	0.82**	0.03
LW								0.00	-0.33*
EO									0.00
					Sheep				
LW	0.00	0.95**	0.60**	-0.11	-0.40*	0.94**	0.93**	0.84**	0.90**
CW		0.00	0.83**	-0.11	-0.33*	0.93**	0.97**	0.76**	0.90**
%D			0.00	-0.13	-0.35*	0.71**	0.81**	0.43*	0.62**
F QW				0.00	0.60**	0.10	-0.32*	0.00	-0.10
HQW					0.00	-0.28*	-0.45*	-0.42*	-0.10
HW						0.00	0.85**	0.86**	0.82**
SW							0.00	0.73**	0.88**
LW								0.00	0.60**
EO									0.00

Key: *** = correlation is significant at 0.01 level, * = correlation is significant at 0.05 level, LW= live weight, CW= carcass weight, D% = Dressing percentage, FQW= Fore quarter weight, HQW= Hind quarter weight, HW = Head weight, SW = Skin weight, LW = Legs weight, EO = Edible offal*

Correlation between carcass characteristics had earlier been reported by Abouheif *et al*. (1986; 1990) and Kadim *et al*. (2008) in camels. The positive correlation between edible ofalls with live weight in all species concord with the earlier reports (Marichal *et al.* 2003, Peña *et al.* 2007; Mayi *et al.,* 2010; Kaić *et al*., 2012) who reported that increase in live weight resulted in increase in edible offal of goats. The negative correlation observed between edible offal and dressing percentage, fore quarter weight, hind quarter weight and leg weight in goat could be as a result of the earlier established fact that most of the fat is deposited in the visceral rather than in carcass deposits and once the visceral is removed, the dressing percentage dropped (Kirton, 1988).

Table 4: Pooled correlated relationship among the meat evaluation indices of camel, cattle, goat and sheep in Sahel environment

Variables	LW	CW	%D	F QW	HQW	HW	SW	LW	EO
LW	0.00	0.93**	-0.41*	0.94**	0.90**	0.87**	0.85**	0.88**	0.72**
CW		0.00	-0.14	0.97**	0.99**	0.87**	0.78**	0.84**	0.64**
D%			0.00	-0.20	-0.11	-0.22	-0.45*	-0.35*	-0.48*
F QW				0.00	0.98**	0.81**	0.78**	0.92**	0.66**
HQW					0.00	0.83**	0.76**	0.84**	0.64**
HW						0.00	0.83**	0.68**	0.48*
SW							0.00	0.70**	0.64**
LW								0.00	0.64**
EO									0.00

Key: *** = correlation is significant at 0.01 level, * = correlation is significant at 0.05 level, LW= live weight, CW= carcass weight, D% = Dressing percentage, FQW= Fore quarter weight, HQW= Hind quarter weight, HW = Head weight, SW = Skin weight, LW = Legs weight, EO = Edible offal*

It therefore means that increase in live weight in any of the species will automatically result to an increase in edible offal. Also the negative correlation between edible offals with dressing percentage in cattle and goat suggest that high amount of edible offal in these animals reduces dressing percentage.

The positive correlation of head weight with live weight, carcass weight, dressing percentage, fore and hind quarter weight in cattle might be as a result of long horns the cattle had which may add to the weight of the animal. Generally, the positive correlation between indices in this study suggests that an increase correlated indices would result to an increase in the other indices for any of these traits that are positively correlated would have a considerable positive impact on others. Negatively correlated indices suggest that an increase in some indices may result to a better or lesser yield of the other depending on the indices with which they negatively correlated with.

The pooled correlated relationships among the meat evaluation indices of the studied animal species showed that the dressing percentage was negatively and significantly correlated with other indices ($p< 0.05$, $r = -0.35$ to -0.48) but not significant with carcass weight, fore quarter weight, hind quarter weight and head weight ($p>0.05$, $r = -0.11$ to -0.22) (Table 4). The implication was that high yields of the meat indices in these species would result in low dressing.

The correlated relationships among live weight, carcass weight, fore quarter weight, hind quarter weight, head weight, skin weight, leg weight and edible offal were positive and highly significant ($p<0.01$, $r = 0.64 – 0.99$); thus indicating that they positively complement each other in meat yield. This is in agreement with the earlier reports of Russel *et al*. (1969) who reported similar values of relationships in meat samples. Also, Kadim *et al.* (2008) and Salehi *et al*. (2013) had reported a positive correlation between live weight and carcass weight and some carcass characteristics.

Conclusion: The result in this study showed that camel and ruminants meat productive performance can be accessed through their respective meat indices. Though sex could not be distinguished in camel and goat meat indices, preference could still be given to males in exploiting animals with good slaughter potentials especially for cattle and sheep as well as adult stage for all the species. Above all, camels could serve as good sources of meat supply in the arid environment to supply the needed animal protein to the populace.

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