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NON-CARCASS COMPONENTS IN OMANI CAMELS (*Camelus dromedarius*) RAISED UNDER VARIOUS LEVELS OF FEED INTAKE

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ABSTRACT

The current experiment describes the effects of feeding varying levels of feed intake on non-carcass components on Omani dromedary camels. Twelve Omani male camels (6-8 month old and 203.5± 15.5 kg body weight) were fed a concentrate and Rhodesgrass hay (RGH) diet at a 60:40 then 80:20 concentrate:hay ratio. Camels received a feed intake equivalent to 1.5, 2.0 and 2.5% of body weight for 162 days at the end of which all camels were slaughtered. The slaughter weight of the Omani camels ranged between 228 to 268.5 kg for the low to high intake animals, respectively. The corresponding hot carcass weights were 104.5 and 131.5 kg. The dressing out percentage (DOP) ranged between 45.7 to 48.7%. The skin contributed the highest proportions of the EBW (8.8-9.5%). The proportions of head, feet and neck in the EBW were 3.9-4.16%, 3.9-4.2% and 5.3%, respectively. Generally, the proportions of carcass fat in the camel are higher than the non-carcass due to the significant proportion of the hump (30%). The camel had a low subcutaneous fat cover when the hump is excluded. The total non-carcass fat appears to be lower in camels as compared to other meat animals. The proportion of the kidney plus pelvic fat was the most significant (11.5%) and appears to be similar to other animals. Omental fat was lower as compared to that of other meat animals. A significant fat depot is found on the abdominal floor accounting for 16.8% of total body fat. This is unique to the camel and it may be an adaptation feature possibly to provide insulation when the animal is crouching. It should be noted that the camel carcasses may become extremely fat under intensive management with hump fat extends over the cutis and with the abdominal flap fat, a camel carcass may be classified as over-fat upon carcass grading.

Key words: Camel, carcass, fat depots, Oman

The total population of camels in the world in 2012 was 26,684,669 heads mostly of the one-humped (*Camelus dromedarius*) type, with about 85% in Africa (FAOSTAT, 2013). The rest of 15% were in Asia with Europe and the America having nominal camel population. These numbers would significantly contribute to provision of high quality animal protein in areas with deprived population, and if managed well, camels may produce high quality meat for the supermarket industry similar to that of other livestock such as beef and mutton.

Camels are well equipped with unique anatomical features and physiological abilities that enable them to survive, thrive and produce under the most demanding conditions. They have the ability to withstand dry hot conditions and water shortage for weeks but they can drink this water deficit in few minutes (Wilson, 1998). Yield of camel meat is significant with carcasses yielding large amounts of meat and some parts such as the hump and liver are regarded as a delicacy in some parts of the world (Kadim *et al,* 2008). Camel meat has excellent quality attributes (Kadim *et al,* 2006a,b). It is now recognised to have similar flavour and texture to that of beef, especially if slaughtered at comparable ages, but may have a comparatively higher moisture content and less fat (Kadim *et al,* 2008).

Camel is a more economical meat animal as compared to other livestock. Their ability to thrive on low level feeds and dress well with a higher feed conversion efficiency suggest that they are more economical meat producing animals than other farm animals such as goat, sheep or cattle. However, meat produced from range camels would be of low quality and more difficult to market in supermarket systems prevailing in the country. Traditionally, camels are raised on the scarce resources. This might be the reason that their true performance and potential for producing meat has not been exploited. Improving the environment, health, management and nutrition of the camel under intensive systems would be expected to result in a marked improvement in its performance.

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In many parts of the camel raising countries, non-carcass components such as the head, viscera and even fat are consumed. Skins are used for household items and used well for nomadic populations as well as for modern leather industry.

This study aims to evaluate the effect of nutrition on carcass and non-carcass components in Omani camels raised under stall feeding.

Materials and Methods

Animals and feeds

Twelve 6-8 month old Omani male camels of 203.5± 15.5 kg body weight (BWT) were housed in partially shaded pens equipped with individual concentrate and hay feeders as well as automatic water troughs. They were fed a concentrate and Rhodesgrass hay (RGH) diet. The concentrate feed was a 14% crude protein (CP) pelleted feed manufactured by the National Livestock Development Company, Salalah, Sultanate of Oman as a whole ration for ruminants. The concentrate and Rhodesgrass hay (RGH) contained 92.5 and 91.5 dry matter (DM); 14.4 and 9.4 crude protein; 1.8 and 1.1 ether extract; 12.1 and 9.6 ash; 19.3 and 30.6 crude fiber, 24.1 and 35.8 ADF; 51.3 and 68.3 NDF as per cent in the DM, respectively. Camels were allocated according to BWT into 3 groups of 4 camels each. They received a feed intake equivalent to 1.5, 2.0 and 2.5% of their body weight, respectively with a 60:40 concentrate:RGH ratio for the first 10 weeks followed by an 80:20 concentrate:hay ratio for the rest of the experimental period. The feeding period continued for 162 days at the end of which camels were slaughtered. Mineral blocks were offered.

After experimental feeding for 162 days, the animals were taken to the Baushar Central Abattoir and kept overnight to rest. They were then slaughtered and processed the following morning according to the routine Halal procedure. The carcass was immediately weighed and split into right and left halves. The head, skin, neck, feet and internal organs were weighed immediately to the nearest gram.

Statistical analyses

Data were subjected to analysis of variance using the General Linear Models procedure of SAS (1991) for effects of level of feed intake, using the diet as a class in the GLM statement in a completely randomised experimental design. Significant treatment means were assessed using LsMEANS command on the SAS (1991). Significant differences were accepted if $P < 0.05$.

Results and Discussion

Slaughter and carcass weight

Performance of Omani camels in the current experiment had been described previously (Mahgoub *et al,* 2014). Briefly, the camel's initial weight averaged 203.5 kg and their mean slaughter body weight was 256.6 ± 32.3 kg (range 218-322 kg). The camels on the 2.5% BWT intake gained more weight (64.5 kg) over the study period followed by those on the medium intake (56.3 kg). The camels on the low feed intake (1.5% BWT) grew at the slowest rate but did not loose weight gaining 11.5 kg over the experimental period (Mahgoub *et al,* 2014). The average daily gain was 71, 347 and 400 g/d for the animals given low, medium and high intake.

The slaughter weight of the Omani camels ranged between 228 to 268.5 kg for the low to high intake animals, respectively. This is within the range reported for camels of light conformation such as the Sudanese camels (Kadim *et al,* 2008). The corresponding hot carcass weights were 104.5 and 131.5 kg (Table 1). These carcass weights are comparable to those reported for Sudanese camels by Wilson (1978); Saudi Najdi males (Abouheif *et al,* 1999); but lower than those reported for Somali camels (Herrman and Fischer, 2004). The latter breed has a larger conformation compared to the Omani light camel.

Gastrointestinal tract fill

Although, camels on the high feed intake consumed more concentrate feeds than the other 2 groups (Mahgoub *et al,* 2014), there was a trend of animals on low and medium feeds having higher values for gut fill but the difference was not significant (Table 1) due to high variability of data. Animals on the highest feed intake (2.5%BWT) had higher (more than double) concentrate feed that consumed by camels on the low intake (Mahgoub *et al,* 2014). The high gut fill in the low and medium intake groups indicate a slower ingesta flow from the rumen most probably was because of the high fibre content in the diet. However, dromedaries are reported to digest cell wall carbohydrates better than small ruminants (Gihad *et al,* 1989).

Dressing out percentage (DOP)

The DOP in the current study ranged between 45.7 to 48.7% computed on 12-h fasted body weight. This was lower compared to published reports on the dromedary. Extremely high DOP was reported for the Najdi camels (61.5%) by Abouheif *et al* (1990)

Table 1. Slaughter and carcass weight and dressing out percentage of Omani camels maintained on 3 levels of feed intake.

Parameter	Treatment groups						Treatment Effect
	Low		Medium		High		
	Mean	SE	Mean	SE	Mean	SE	
Slaughter weight (kg)	228.000	22.660	259.110	15.981	268.500	15.981	NS
Gut fill (kg)	35.721	4.351	36.865	3.076	26.520	3.076	NS
Empty body weight (kg)	192279	1.674	222135	1.184	241980	1.184	NS
Half carcass wt. (kg)	52.250	7.392	59.375	5.227	65.750	5.227	NS
Hot carcass wt. (kg)	104.500	14.783	118.750	10.454	131.500	10.454	NS
Dressing %	45.74	1.674	45.82	1.835	48.65	1.835	NS

Table 2. Proportions of non-carcass components in empty body weights of Omani camels maintained on 3 levels of feed intake.

Parameter	Treatment groups						Treatment Effect
	Low		Medium		High		
	Mean	SE	Mean	SE	Mean	SE	
Head	3.90	0.318	4.16	0.225	3.88	0.225	NS
Neck	5.39	0.641	5.24	0.453	5.27	0.453	NS
Skin	8.84	0.690	9.57	0.488	9.50	0.488	NS
Omental fat	0.08	0.027	0.12	0.019	0.14	0.019	NS
Lungs & trachea	1.23	0.268	1.38	0.190	1.45	0.190	NS
Diaphragm	0.57	0.060	0.56	0.142	0.52	0.142	NS
Heart	0.51	0.048	0.50	0.034	0.83	0.034	NS
Kidneys	0.38	0.025	0.43	0.017	0.41	0.017	NS
Liver	1.40	0.100	1.70	0.100	1.80	0.100	NS
Four feet	3.98	0.254	4.16	0.180	3.89	0.180	NS
Hump	0.900	0.314	1.43	0.221	1.56	0.221	NS
Genitals	0.16	0.055	0.29	0.045	0.23	0.039	NS

and Asian camels (62.1%) by Herrmann (2004). Lower DOP comparable to that obtained in the current study, was reported for Somali camels (47.5) by Herrman and Fischer (2004). Intermediate figures were reported for Ethiopian males (50.7%) by Kurtu (2004) and Najdi (48.7%) by Al-Owaimer (2000). Extremely high values (60.3-71.4%) were reported by Kamoun (1995) and attributed to difference in age (8-26 month). The wide variation in DOP in camels is mainly attributed to variation in gut fill as some of the animals are fasted before slaughter and others are not. For instance Yousif and Babiker (1989) reported a DOP of 51.1-67.2% calculated on basis of full and empty body weight. Similar effects of method of calculation was reported by Mohamed (2007). Differences in DOP were attributed to variation in breed, age and body weight with heavier animals having higher DOP. Issa Ethiopian camels had an average carcass weight of 233.4 kg and dressing percentage of 52.7 % with males DOP ranging between 40 and 66.5% (Abebe *et al* 2002). These authors reported a positive correlation between live weight and carcass weight and dressing percentage. Eltahir *et al* (2011) reported a DOP of 52.7-65.4% depending on the method of calculation (hot carcass or cold carcass over body weight or EBW).

Non-carcass organs

Proportions of non-carcass components in Omani camels are presented in Table 2. The skin contributed the highest proportions of the EBW (8.8-9.5%). The hide was the heaviest component of the camel body (Yousif and Babiker, 1989). Lower proportions (7.2%) were reported by Herrman and Fischer (2004). Wilson (1978) reported a higher value (10.2%). Although, the hide is not edible, it is an important by-product of the camel as it is commonly used by nomadic tribes for making house hold items as well as being used in leather industry. The proportions of the head in the EBW of the camel is lower than in cattle, possibly because of lack of horns in the camel (Kadim *et al,* 2008). The head and feet proportions in the Omani camel contributed 3.9-4.16% and 3.9-4.2%, respectively. The proportions of the these in the Somali camels were 2.4 and 3.4%

(Herrman and Fischer, 2004). Wilson (1978) reported 3.6 and 4.3% of EBW for the head and feet. Eltahir *et al* (2011) reported proportions of non-carcass organs in the Sudanese camel similar to the current study. These included 3.8% for the head; 7.6% for the hide; 3.8% for the feet; 0.63% for the kidney; 2.0% for the liver; 0.45% for the heart and 1.7% for lungs and trachea. The neck was separated immediately after slaughter and therefore, was not added to the carcass. It contributed about 5.3% of the EBW in Omani camels.

The kidney's proportions in the EBW of Omani camel ranged between 0.35 to 0.43%. Al-Ani (2004) reported that the kidneys represents a high proportion in camel body compared to other farm animals. Mahgoub *et al* (1995a) reported a proportion of 0.26% in body weight in Omani Dhofari cattle.

The proportions of edible non-carcass components are high in the camel (Kadim *et al,* 2008). This makes it a very important protein source in arid areas. For instance Eltahir *et al* (2011) reported a value of about 35% of total non-carcass components including about 20% internal components. The camel body contained an average of approximately 4.2% offals (liver, heart and lungs) (Kadim *et al,* 2008). Similarly, proportions of these organs in the EBW in the current study were 3.14-4.08%.

Table 3 describes the relationship between body components and body weight. There was a strong relationship between all body components and body weight as reflected in the high correlation coefficient (R2). For instance these equations indicates that camels with heavier body weights would have heavier carcasses with larger humps. These equations may be used for prediction of proportions of carcass and non-carcass components in the dromedary.

Fat Partitioning in the Camel Carcass

Table 4 describes fat partitioning in the camel body in the current study, as well as providing a comparison with other farm animals. Generally, the proportions of carcass fat in the camel are much higher than the non-carcass mainly due to the large proportion of fat in the hump (30%). Camels are reported to have less fat in their carcasses compared to other livestock (Kadim *et al,* 2008). But this is more likely to be when the hump is excluded. In the current study, the camel had a low subcutaneous fat cover when the hump is excluded. This is an important adaptation feature where less subcutaneous fat reduces insulation and consequently enhance heat exchange with the atmosphere. This is essential for camel's adaptation to hot climates. Yet it should be noted that the size of the hump in the dromedary changes with the change in body condition as a result of changes in feed supply according to season and grazing range conditions. Therefore, there is wide variability in hump size in camels in the literature. For instance, Kadim *et al* (2008) indicated that the hump may contribute up to 9% of the total carcass weight. Abebe *et al* (2002) reported a proportion of 2% in live weight of Ethiopian range camels. Variability in the hump size would have a serious implication on marketing camel meat especially, if a standard method of carcass cutting is adopted in for camels. The camel hump would fall in the loin and rack (rib) cuts. The way hump fat is removed (prior or after cutting) would influence the cut tissue compositions and customer's impression on the camel meat.

The total non-carcass fat appears to be lower in camels as compared to other meat animals (Table 4). The proportion of the kidney plus pelvic fat was the most significant (11.5%) and similar to that in other animals. Similarly, reports indicated that Sudanese camel's bodies contained higher values of kidney fat compared to that in mesenteric and omental (Eltahir *et al,* 2011) with animals depositing more fat when supplemented with a molasses-based diet. These authors reported values of 1.24, 0.56 and 0.14% of empty body weight for kidney, mesenteric and omental fat, respectively. Omental fat was lower compared to that of other meat animals.

One interesting characteristic of the camel fat partitioning is the significant fat depot found on the abdominal floor. A thick sheet of fat is covering the

Table 3. Prediction equations between body weight (independent variable) and non-carcass components (dependent variables) in Omani camels raised under stall feeding.

Body component	Equation	R^2
Carcass	y = 0.0007x2 - 0.0764x + 31.258	0.9538
Empty gut	y = -0.0002x2 + 0.132x - 10.448	0.6146
Head	y = 4E-05x2 + 0.0125x + 3.0387	0.6535
Neck	y = -0.0002x2 + 0.1665x - 16.937	0.5188
Skin	y = -0.0008x2 + 0.5789x - 71.564	0.8662
Lungs & trachea	y = -0.0003x2 + 0.1781x - 23.285	0.5003
Diaphragm	y = 1E-05x2 - 0.0005x + 0.5636	0.6301
Heart	y = -1E-05x2 + 0.0099x - 0.6494	0.5227
Kidneys	y = -3E-05x2 + 0.02x - 2.3398	0.8615
Liver	y = -0.0003x2 + 0.1667x - 20.983	0.7651
Four feet	y = -0.0005x2 + 0.3137x - 36.598	0.9296
Hump	y = -0.0002x2 + 0.1227x - 16.862	0.6816

Table 4. Distribution of fat in the carcass of camel, cattle, sheep and goats (% in total body fat).

Fat depot	Camel[1]		Cattle[2]		Sheep[3]		Goats[4]	
	Mean	SD	Mean	SD	Mean	SE	Mean	SE
Kidney + pelvic	11.45	1.927	12.97	0.88	10.33	0.35	11.51	0.37
Omental	3.97	1.783	13.72	0.74	13.87	0.38	15..39	0.40
Channel	4.93	3.646	1.28	0.16	1.04	0.07	1.25	0.07
Abdominal wall	16.77	3.411	NA		NA		NA	
Total non-carcass	37.12	7.685	43.13	1.25	39.49	0.61	45.59	0.64
Hump	30.34	7.234	NA		NA		NA	
Subcutaneous	10.92	3.477	18.08	1.07	31.81	0.62	25.14	0.65
Intermuscular	21.62	4.629	34.87	1.06	28.69	0.55	29.27	0.58
Total carcass fat	62.88	7.685	53.69	1.25	60.51	0.61	54.41	0.64

[1]Current study; [2]Mahgoub *et al,* (1995b); [3,4]Mahgoub and Lodge (1998)

abdominal muscles (Rectus abdominis, Transverse abdominis) and it extends backward to meet with the kidney fat. It accounted for 16.8% of total body fat. This appears to be unique to the camel and it may be an adaptation feature. This fat depot at the floor of the abdomen would be close to the ground when the camel crouches in its normal way of sitting. This fat layer would provide a good insulation against the heat radiated from the hot sand in the desert. It should be noted that the camel carcasses may become extremely fat under intensive management with hump fat extends over the cutis and with the abdominal flap fat, a camel carcass may be classified as over-fat upon carcass grading.

Effect of level of feed intake

Although, there were no significant effect of level of feeding on the carcass and non-carcass components of Omani camels, there was a constant trend of increasing carcass weights and non-carcass weights with increasing levels of feed intake. Lack of significance may have been probably due to the small difference in feed intake (1.5, 2.0 and 2.5% of body weight) as well as, the large variability in the data.

The current study indicated that dromedary camels may be raised under stall systems on a feed intake of 2.5%. They produce significant volume of non-carcass components which are commonly used in arid and semi-arid regions of the world as a source of protein.

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