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Carcass Characteristics and Meat Quality in Four Saudi Camel Breeds

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Abstract: The present study was conducted to investigate the carcass characteristics and meat quality in four Saudi camel breeds. Four young male camel breeds were used (Majaheem, Suffr, Sho'l and Wodoh) 6-9 months old with average weight 133.83±2.83 kg. Animals were group fed of three animals in four replicates for each breed. A balanced energy/protein ration was used to ensure that animals get their nutrient requirements using *ad lib* twice feeding system. When animals slaughtered, carcass characteristics were measured to evaluate meat quality. The results obtained from growth trial indicated that the slaughter weight of animals after 204 days was 292.33±6.65, 278.17±11.36, 284.35±21.89 and 270.35±10.69 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively. At slaughter, the hot carcass weight was 176.38, 164.78, 170.21 and 164.9 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively. Dressing percentage was 59.37, 57.88, 58.76 and 60.00% for Majaheem, Wodoh, Suffr and Sho'l, respectively. There were no any significant differences between breeds in most parts of the carcass muscle area especially color of Longissimus dorsi muscle, shear force and chemical analysis of meat.

Key words: Breeds, camel, Majaheem, Suffr, Sho'l, Wodoh, carcass characteristics, meat quality

INTRODUCTION

Camels reared in Saudi Arabia for the production of milk and meat and also for racing. With the increase in the rapid development witnessed by the kingdom in the field of animal production turned attention to the interest in camels as a national treasure and enjoy camel meat is very popular among Saudi people because it contains a small percentage of fat compared to other types of meat.

As mentioned in the earlier study, Saudi Arabia is the fourth country in the population of camels in the Arab World and also camels classified according to their colors (Basmaeil *et al*., 2012). There is no information about Saudi camel breeds which has ability to produce neither meat nor their growth requirements, although in the earlier study researchers published the effect of breeds on growth and digestibility and researchers found that Majaheem breed had the highest value in average daily gain, feed conversion and digestibility followed by Wodoh, Suffr and Sho'l (Basmaeil *et al*., 2012). Therefore, the objective of this study was conducted to investigate the effect of Saudi camel breeds (Majaheem, Wodoh, Suffr and Sho'l) on carcass characteristics and meat quality.

MATERIALS AND METHODS

Animals and diets: Four young male represent common Saudi camel breeds were used (Majaheem, Suffr, Sho'l and Wodoh) 6-9 months old with average live weight 133.83±2.83 kg. Animals are group fed of three animals in four replicates for each breed. Each breed was 12 animals and the total of all breeds were 48 animals. A balanced energy/protein ration consist of Alfalfa hay and concentrate mixture (Table 1) were used to ensure that animals get their nutrient requirements using *ad lib* twice feeding system.

Feeding trial: A total of 48 young camels were weighed and divided to four groups, each group contained 12 young camel allotted by weight to three animals in four replicates for each breed. The experiment lasted for 204 days (approximately 29 weeks). Feed intake for each group were weekly recorded and calculated daily feed. The animal's weights were recorded every 2 weeks, before morning meal. The daily gain weights and feed conversion ratio were calculated.

Carcass characteristics: At the end of growth trial, selected 6 animals of each breed randomly were

Table 1: The proximate analysis of the alfalfa hay and concentrate mixture

Items	DM	CP	EE	CF	NFE	Ash	NDF	ADF
Alfalfa hay	93.53	16.14	1.57	28.62	44.23	9.45	44.27	35.79
Concentrate mixture	93.54	21.01	2.90	3.47	65.36	7.26	17.70	6.87

DM: Dry Matter; CP: Crude Protein; Ee: Ether extract; CF: Crude Fiber; NFE: Nitrogen Free Extract; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber (Basmaeil *et al*., 2012)

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slaughtered after 12 h fasting. Hot carcass, head, liver, spleen, the weights of the digestive system (heart, lungs, kidney and kidney fat) as well as weights of legs, head, neck and hump for each animal were recorded immediately after dressing. The gastro-intestinal content was weighed and empty body weight was calculated subtracting the weight of digesta from the fasted live weight at slaughter. The right side was ribbed between the 12 and 13th ribs. After ribbing, longissimus dorsi muscle area was measured by direct grid reading. The lean tissue was ground through a 4 mm plate, stored at -20°C and kept for chemical analysis.

Samples from the longissimus dorsi muscle between the 5-8th ribs after 24 h of the slaughter were removed and used to analyze the color with the Minolta Chroma Meter CR-300, the values of pH-meter and shear force value were determined using Warner-Bratzler shear device (Pena *et al*., 2009).

Chemical analysis: Feed and ground lean tissues were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and ash according to AOAC (2004). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) in feed were determined according to Van Soest *et al.* (1991).

Statistical analysis: The data were analyzed according to SAS (2004). Duncan (1955)'s tests were used to compare the treatment means.

RESULTS AND DISCUSSION

The effect of Saudi breeds camel on growth and digestibility (Basmaeil *et al*., 2012) and the current study, researchers examined the effect of same breeds of camel on carcass characteristics and meat quality. Therefore, the proximate analysis of the alfalfa hay and concentrate mixture which fed to experimental animals in the both studies is shown in Table 1.

Feeding trial: The initial weight of animals was 135.25±2.53, 135.77±1.92, 134.65±1.88 and 129.63±1.93 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively (Table 2). The final weight of animals after 204 days was 291.78±2.53, 278.17±5.68, 283.56±10.95 and 269.61±5.35 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively (Table 2). The average daily gain was 0.767, 0.698, 0.730 and 0.686 kg for Majaheem, Wodoh, Suffr and Sho'l respectively. Feed intake was 4.73±0.05, 4.68±0.05 and 5.24±0.42 and 4.53±0.13 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively (Table 2).

Wilson (1984) reported that the camel only needs small amounts of food to cover their requirements and also it can compensate for the loss quickly when feeding back to the normal level. The part of the results of Basmaeil *et al.* (2012) presented in this study (Table 2) is in agreement with the results of Basmaeil (1989) and Farid *et al.* (1990). El-Amin (1979) stated that there are many factors influence animals growth including breed, nutrition, sex and health and growth in body weight is the basis of meat production in animals. Average Daily Gain (ADG) for camels also vary widely between regions, breeds and within the same breed. The present results are in agreement with the results of Bissa (1996) who reported that the average body weights of 39, 119 and 171 kg at birth, 90 and 180 days, respectively for Indian camels indicating ADG of 733 g day^{-1} between birth and 180 days. These growth rate values are lower than those commonly reported for cattle but it should be noted that camels are normally raised under extensive systems depending mainly on rangeland grazing rather than on feedlots. The limited research carried out on improving camel nutrition demonstrated significant relationships between ADG and feed intake of concentrates for camels. Camels fed a diet with high dietary protein and energy gained more body weight than non-supplemented camels fed only on mangroves (Kamoun, 1995). Although, the present study formulated a balanced energy/protein ration used to ensure that animals get their nutrient requirements using *ad lib* twice feeding system but there is disagreement between the part of this study which presented in the earlier study of Basmaeil *et al.* (2012) (686-767 g day^{-1}) and the study of Kamoun (1995) (550 g day^{-1}) in ADG. In general, the growth curve for Saudi camels follows a pattern more or less similar to that of other farm animal species. There is sex affected ADG with the results of Kurtu (2004) and Wilson (1978), they found that mature male camels were heavier than females

Table 2: Effect of camel breeds on growth, feed intake and Average Daily Gain (ADG) (Mean±SE)

	Breed			
Items	Majaheem	Wodoh	Suffr	Sho'l
Period (day)	204	204	204	204
Initial weight (kg)	135.25±2.53^{a}	135.77±1.92^{a}	134.65±1.88^{a}	129.63±1.93^{a}
Final weight (kg)	291.78±3.32^{a}	278.17±5.68^{ac}	283.56±10.95^{bc}	269.61±5.35^{ac}
ADG (kg)	0.767±0.016^{a}	0.698±0.021^{a}	0.730±0.054^{a}	0.686±0.024^{a}
Feed intake (kg)	4.73±0.05^{ab}	4.68±0.05^{ab}	5.24±0.42^{a}	4.53±0.13^{b}

$^{a-c}$Means in the same row with different letters in their superscripts differ ($p<0.05$) (Basmaeil *et al.*, 2012)

by 38 and 8%, respectively. In Australia, Wilson (1984) found mature camels weights ranged from 514-645 kg for males and 470-510 kg for females.

Carcass trials: At the end of the feeding period, 6 animals of each breed were slaughtered after 12 h fasting. Hot carcass weight to the superiority Majaheem breed at the level of 5% compared to the other three breeds and the results are 176.38, 164.78, 170.21 and 164.9 kg for each of the Majaheem, Wodoh, Suffr and Sho'l, respectively. The dressing percentage of in the four breeds was 59.37, 57.88, 58.76 and 60.00% for each of Majaheem, Wodoh, Suffr and Sho'l, respectively. The decrease in carcass weight and dressing percentage of Wodoh breed to decrease the weight of the hump of that breed (Table 3). Abdel-Rahman found that the average carcass weight of about 400 kg by age, sex and type and level of nutrition, characterized by the meat of camels that dressing percentage ranging from 52-77% as the results of this study indicate that the dressing percentage ranging from 57.88-60.00% this is in agreement with the results of Abdel-Rahman.

The breed and nutrition is a determinant of growth and its lead to increase the production of meat so the effect of breed on some of the weights of the components of carcasses breeds of Majaheem, Wodoh, Suffr and Sho'l, respectively.

Table 3 shows the average weight of the animal head was 8.21, 7.73, 7.78 and 7.76 kg for each of the Majaheem, Wodoh, Suffr and Sho'l, respectively. There were no significant differences in the weight of the head among the breeds and when calculating the average percentage of weight the head of the carcass weight observed 4.65, 4.69, 4.57 and 4.71% for Majaheem, Wodoh, Suffr and Sho'l, respectively. The weight of the hump showed the low Wodoh breed markedly ($p<0.05$) when compared to the hump weights of the other three breeds and the values were 12.38, 8.78, 12.01 and 12.13 kg for each of the Majaheem, Wodoh, Suffr and Sho'l, respectively (Table 3) and when calculated as a percentage for the carcass weight is also noted that the decline in the ratio for other the three breeds and the values are 7.12, 5.33, 7.59 and 7.36% for Majaheem, Wodoh, Suffr and Sho'l, respectively and it is may be due to low ranking weight Wodoh hump in the breed to failure by a large deposition of fat in the hump compared to the other three breeds under this study and the weight of the living body.

There were no differences significant among all breeds in the weights of the liver, heart and kidney (Table 3). It is clear that the breed does not have effect on some carcass weights and the values for liver weight were 5.53, 5.17, 5.45 and 5.04 kg ($p>0.05$) and there were significant differences ($p<0.05$) between Suffr and both the Wodoh and Sho'l in the weight of the heart but no significant differences ($p>0.05$) between Suffr and Majaheem and the values were 1.33, 1.25, 1.50 and 1.23 kg. The kidney weights were 1.31, 1.06, 1.25 and 1.15 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively and there were no significant differences among all breeds.

It was also noted that there were no significant differences in spleen weights among the four breeds and the values were 0.29, 0.35, 0.30 and 0.29 kg. There were significant differences in the neck weights between the Majaheem and Sho'l and Suffr and the values were 14.93 0.13, 86, 14.38 and 12.78 kg for Majaheem, Wodoh, Suffr and Sho'l, respectively (Table 3). Camels are a good

Table 3: Effect of camel breeds on carcass characteristics (Mean±SE)

	Breed			
Items	Majaheem	Wodoh	Suffr	Sho'l
Slaughter weight (kg)	291.78±3.320^{a}	278.17±5.6800^{ac}	283.56±10.95^{bc}	269.61±5.350^{ac}
Hot carcass weight (kg)	176.38±4.410^{a}	164.78±3.5800^{b}	170.21±3.110^{ab}	164.90±2.240^{b}
Dressing percentage (%)	59.37±0.530^{a}	0.92±57.880^{a}	0.84±58.76^{a}	0.59±60.00^{a}
Liver weight (kg)	5.53±0.190^{a}	5.17±0.0800^{a}	5.45±0.410^{a}	5.04±0.120^{a}
Heart (kg)	1.33±0.050^{ab}	1.25±0.0.06^{b}	1.49±0.100^{a}	1.23±0.060^{ab}
Kidney weight (kg)	0.15±1.310^{a}	0.02±1.0600^{a}	1.25±0.060^{a}	0.10±1.150^{a}
Kidney fat weight (kg)	0.92±0.230^{a}	0.08±0.7700^{a}	0.84±0.090^{a}	0.57±0.090^{a}
Spleen weight (kg)	0.29±0.040^{a}	0.35±0.0400^{a}	0.30±0.030^{a}	0.29±0.020^{a}
Lungs weight (kg)	2.50±0.090^{a}	2.38±0.0900^{ab}	2.46±0.110^{a}	2.09±0.100^{b}
Neck weight (kg)	0.34±14.93^{a}	13.86±0.5600^{ab}	0.34±14.38^{a}	0.45±12.78^{b}
The digestive system before cleaning weight (kg)	1.71±37.18^{a}	0.68±33.930^{a}	37.97±2.020^{a}	34.37±1.530^{a}
Legs weight (kg)	17.01±0.890^{a}	13.97±0.3600^{b}	14.25±0.570^{ab}	13.38±0.650^{bd}
Hump weight (kg)	3.98±0.110^{a}	3.55±0.1100^{a}	3.97±0.450^{a}	3.71±0.260^{a}
Rumen contents weight (kg)	16.19±1.640^{a}	16.42±0.6600^{a}	19.75±1.970^{a}	17.28±1.120^{a}
The digestive system with empty rumen weight (kg)	20.98±0.950^{a}	17.52±0.3300^{b}	18.22±0.350^{ab}	17.08±0.680^{bd}
Legs weight (kg)	11.54±0.170^{a}	10.98±0.1100^{ac}	11.08±0.340^{ac}	10.53±0.200^{bc}
Head weight (kg)	8.21±0.090^{a}	7.73±0.1300^{a}	7.78±0.270^{a}	7.76±0.270^{a}
Skin weight (kg)	28.85±1.240^{a}	29.48±1.7100^{a}	28.73±1.720^{a}	30.12±0.210^{a}
Hump weight (kg)	12.38±1.240^{a}	8.78±0.8500^{a}	12.01±1.070^{a}	12.13±0.460

$^{a-d}$Means in the same row with different letters in their superscripts differ ($p<0.05$). Carcass weight = Front and rear quarters + neck + hump

Table 4: Effect of camel breeds on pH, longissimus dorsi area, shear force and color profile (Mean±SE)

	Breed			
Properties	Majaheem	Wodoh	Suffr	Sho'l
pH	6.07[a]	6.07[a]	6.01[a]	5.99[a]
Longissimus dorsi area (cm^2)	76.26[a]	75.03[a]	76.62[a]	76.42[a]
Shear force (kg cm^{-2})	4.20[a]	4.25[a]	4.36[a]	4.29[a]
Color profile				
L*	35.15[a]	35.45[a]	36.10[a]	35.80[a]
a*	16.02[b]	17.58[a]	14.83[b]	15.88[b]
b*	7.86[a]	7.99[a]	6.96[a]	7.91[a]

[a, b]Means in the same row with different letters in their superscripts differ ($p<0.05$). L* = Lightness; a* = Redness; b* = Yellowness

Table 5: Chemical analysis of longissimus dorsi muscle of camel breeds (Mean±SE)

	Breed			
Components (%)	Majaheem	Wodoh	Suffr	Sho'l
Moisture	73.01[a]	72.87[a]	73.35[a]	72.99[a]
Crude protein	20.97[a]	21.59[a]	21.31[a]	21.63[a]
Ether extract	4.14[b]	4.82[a]	3.76[b]	3.52[b]
Ash	1.32[a]	1.42[a]	1.45[a]	1.40[a]

[a, b]Means in the same row with different letters in their superscripts differ ($p<0.05$)

source of meat. There are wide differences in carcass weight between breeds and some of them due to the state, sex, age and weight at slaughter of animals. Carcass weight usually ranges between 125 and 400 kg and increases with the increase in body weight as expected. The average carcass weight of 168 kg in the study of Abouheif *et al.* (1986) but it was higher in Iranian camels and the values were 300-400 kg (Khatami, 1970). Table 3 also shows that there were no significant differences in weight among the breeds in the digestive system and rumen empty weight as well as in the skin.

Table 4 shows that there were no significant differences among all breeds in properties of meat by measuring both pH and longissimus dorsi muscle area, shear force and the color of the meat with the exception of a* (degree of redness) in the Wodoh breed which gave the highest value compared to other breeds (17.58). The red color in Wodoh breed may be due to genetic factors because all breeds were fed on same diet so the feeding has no effect on the quality of meat. The pH of the meat of measurements important to determine the degree of meat quality and it validity and low values of pH in meat increases the amount of liquid separated from frozen meat or when cooking or processing, causing some economic losses. Trout (1988) stated that the rate of loss during cooking muscle depends on the degree of pH so the pH was measured and there was no significant difference among the four breeds which the breed has no effect on the pH of the meat.

Table 5 shows the chemical analysis of the components of the longissimus dorsi muscle and there were no significant differences among breeds in moisture, protein, ash and these results were confirmed with the results of shear force, pH and color but there is an increase in the proportion of fat in Wodoh breed compared to other breeds. This result suggested the possibility that Wodoh breed has the ability to deposition fat between muscles of meat although their meat has a dark red as shown in Table 4.

CONCLUSION

It is noted that the results of the meat quality under this study, the meat of camels close to meat of sheep and goats in terms of protein but it has a decrease in fat content. Hence, it is clear that the breed has no effect on some measurement of parts of the carcass or meat quality but according to the results obtained through the experimental of growth and slaughter that Majaheem breed is one of the breed of camels, specialized in the production of meat because it gave the highest growth rate as well as the highest weight of the carcass.

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