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CARCASS TRAITS AND MEAT QUALITY OF ONE-HUMPED CAMELS FED DIFFERENT HALOPHYTIC FORAGES: 2-PHYSICAL, CHEMICAL, AND SENSORY CHARACTERISTICS OF CAMEL MEAT.

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ABSTRACT

Samples of *Longissimus dorsi* and *Biceps femoris* muscles were collected from twelve male one-humped camels carcasses aging 10–12 months having average body weight 250 ± 3.27 kg. They were fed *Acacia saligna* (AS) and/or *Atriplex nummularia* (AN) as roughage component. Ground date stones and olive cakes were added as concentrate to the formula of traditional concentrate mixture at the rate of 20 and 10%, respectively. Camels were divided into four equal groups (3 each). The first group (control) was fed traditional concentrate mixture (TCM) and berseem hay. The second group was fed untraditional concentrate mixture (UCM) and AS. The third group was fed UCM and AN. The fourth group was fed UCM, AS and AN. The influence of feeding camels on halophytic plants on the physical, chemical and palatability traits of camel meat was investigated.

Results indicated that significant differences ($P < 0.01$) for the aroma, flavor, tenderness and juiciness were observed among feeding groups. The BH and AN groups had higher score in meat acceptability than those from the other groups. Results indicated significant differences ($P < 0.01$) in physical properties (cooking loss%, shear force, WHC and plasticity) and pH due to type of feeding. The range of cooking loss was 40.80 - 42.96% for the experimental groups. The means of water holding capacity (WHC) were 10.59, 8.37, 10.89 and 9.58 cm^2 for BH, AS, AN and AS-AN groups, respectively. The pH value of camel meat ranged from 5.55 to 5.81. The BH and AN groups had higher values in shear force (9.23 and 9.00 respectively) than those from the AS, AN groups (8.87 and 870, respectively). Both type of muscle and feeding affected the chemical composition of fresh camel meat.

The *Biceps femores* (BF) muscle contained higher moisture (74.17%) than *Longsimus dorsi* (LD) muscle (69.16%), which could be attributed to high fat content in LD. Meat of camels fed AN had the lowest moisture content in both muscles than the other experimental groups. The overall means of protein were 21.45 and 20.64 % for LD and BF muscles, respectively. The LD muscle had higher percentage of fat (8.31%) than the BF muscle (4.32%). Meat of camels fed AN had higher fat content in both muscles (9.86. and 5.23 % for LD and BF, respectively) than the other groups. The mean ash of LD and BF muscles were 1.06 and 1.07%. Irrespective of type of muscle, the averages ash of camel meat of BH, AS, AN, AS-AN groups were 1.08, 1.06, 1.11 and 1.01%, respectively. On the basis of these overall data, camel meat appears to be similar in chemical composition to other red meats.

According to the present results, the untraditional concentrate mixture (UCM) and edible parts of the halophytic plants in feeding growing camels can be successfully used in feeding growing camels for a period of eight months with no adverse effects on their sensory, physical and chemical characteristics of camel meat.

Keywords: One-humped camel, meat, physical, chemical and sensory properties, halophytic plants.

INTRODUCTION

The dromedary one-hump camel can survive, reproduce and produce meat under harsh environmental conditions that may not suit any other domestic animals. They are an important source of meat in arid and semi-arid areas. (Knoess, 1977 and Yousif and Babiker, 1989). However, their potential as a meat producer has received little attention. Shalash (1979) reported that camel meat varies in amount, composition and quality with age, sex and feeding. El-Gasim *et al* (1987) showed that camel carcass characteristics are comparable to other red meat animal species. Generally, the meat of young camels (below 3 years) is similar in taste and texture to beef (Khatami, 1970 and Knoess, 1977). Nutritive value of the meat depends on its chemical composition, which is greatly influenced by body weight at slaughter, age, sex, carcass weight and degree of fattiness and type of cut (Shalash, 1988).

Halophytic plants used as animal feed have good potentials as feed resources (El-Shaer, 1995 and El-Shaer and Ismail, 2002). Feeding halophytes is a feasible solution to minimize the problem of feed shortage in Egyptian arid and semi-arid regions, where desert represents 96% of the total area. *Atriplex nummularia* is an important saltbush, with a great biomass yield, high crude protein, low crude fiber and high resistant to salinity (El-Hyatemy *et al.*, 1987; Le Houerou, 1992). *Acacia saligna* is an ever-green legume shrub that extensively grows in arid and semi-arid zones. It contains high crude protein, high fiber content and condensed tannins, which decreases the availability of protein (Ramirez and Lara, 1998). No research information is avaiable concerning the effect of feeding such halophytic plants on meat quality of one humped camels.

The present study was undertaken to evaluate the effect of feeding fresh *Acacia saligna, Atriplex nummulana*, ground date stones and olive cake as feedstuffs offered to young male camels on the physical, sensory and chemical properties of camel meat.

MATERIALS AND METHODS

The present work was a continuation of the frist part of this series of experiments (Shehata, *et al.*, 2005). The animals used, thein managements and dietary treatments were the same which can be summarized as follows:-

Animals and Management

The study was carried out at Maryout Research Station, 35 km. South of Alexandria, Desert Research Center, Ministry of Agriculture and Land Reclaimation, Egypt. Twelve growing male one-humped camels (*Camelus dromedarius)* aged 10 – 12 months with average body weight 250.23 ± 3.27kg were used. Some non-conventional feeds, which are available in the local area were used instead of conventional feeds for feeding the growing camels. The study lasted for 240 days. Camels were divided into four equal groups (3 each) and similar in average body weight. They were individually housed in closed pens throughout the experimental period and randomly assigned to the four experimental rations.

Treatments

Camels of the first group (control) were fed traditional concentrate mixture (TCM), that consists of soybean meal, 15%; yellow corn, 25%; barely grains, 30%; wheat bran, 25%; molasses, 3%; lime stone, 1%, and common salt, 1%), while the other three groups were fed untraditional concentrate mixture (UCM) by including both ground date stones and olive cake (20 and 10%, respectively) as shown in Table (1) to completely replace wheat bran and partly barley grains, while soybean meal and yellow corn were increased.

Table (1): Feed ingredients of the experimental rations (% on fed basis).

Feed ingredients	Experimental Rations[1]			
	BH	AS	AN	AS-AN
Concentrated mixture:				
Soybean meal (SM)	15	20	20	20
Yellow corn grains (YC)	25	27	27	27
Barley grains (BG)	30	18	18	18
Olive cake (OC)	-	10	10	10
Ground date stones (GDS)	-	20	20	20
Wheat bran (WB)	25	-	-	-
Molasses	3	3	3	3
Lime stone	1	1	1	1
Common salt	1	1	1	1
Experimental roughages:				
Berseem hay (BH)	+	-	-	-
Acacia saligna (AS)	-	+	-	+
Atriplex nummularia (AN)	-	-	+	+

1, The experimental rations, BH, Berseem hay; AS, *Acacia saligna*; AN, *Atriplex nummularia*; AS-AN, were offered separately.

Both concentrate mixtures were offered to camels at the level of 125 % of maintenance requirements (Farid *et al.*, 1990). In addition to the concentrates, all camels were fed roughages of different sources *ad libitum*. The control group was offered berseem_hay (BH), while the other three groups were offered fresh *Acacia saligna* (AS), *Atriplex nummularia* (AN), or *Acacia saligna* along with *Atriplex nummularia* (AS-AN, were offered separately).

Slaughter Data

At the end of the experiment, all camels were slaughtered after 24 hrs fasting. Carcasses were then allowed to chill at 4^0 C for 24 hrs, and samples of *Longsimus dorsi* (LD) and *Biceps femores* (BF) muscles were sliced out from the left side of the carcass to evaluate the sensory, physical and chemical properties of the camel meat.

Sensory Evaluation

Camel meat samples from the eye muscle (*Longsimus dorsi*) just after slaughtering were boiled in tap water for 45 minutes. After cooking, samples were judged for sensory evaluation by serving to nine panelists in

Maryout Research Station to evaluate aroma, flavour, tenderness, juiciness and palatability. Each trait was scored on a scale from 1 to 5 representing the grades of very poor, poor, fair, good and very good, respectively according to Dawood (1995). Sensory data means were used for statistical analysis.

Physical analysis and pH

Water holding capacity (WHC) and plasticity of camel meat were estimated by the method of Wierbicki and Deatharage (1968) using the following equations:

$$\mathbf{WHC = A_2 - A_1}$$

Where:

A_1 = Inner area or plasticity (area of meat after pressing) cm^2

A_2 = Outer area (area of meat plus area of free water after pressing) cm^2

Both areas were determined using a planimeter.

Cooking loss % of meat samples was determined after their boiling in tap water for 30 minutes according to Bouton and Harris (1989). Cooking loss % was calculated as follows:

$$\textbf{Cooking loss \%} = \frac{\textbf{Fresh sample weight} - \textbf{Boiled sample weight}}{\textbf{Fresh sample weight}} \times 100$$

Shear force for boiled samples from the eye muscle (LD) was measured by using the Warner – Bratzler shear machine to test tenderness. After cooking at room temperature, three samples (2 cm long X 1 cm width X 1 cm thickness) from each carcass were sheared. Shear force values were determined by the averaging of three samples (Dawood, 1995). The pH value of meat was determined by using a pH meter (Portable Digital Waterproof HANNA Model HI 9025).

Chemical Analysis

Representative samples of *Longsimus dorsi* and *Biceps femores* muscles were taken for determining moisture, protein, fat and ash contents according to the Association of Official Agricultural Chemists (A.O.A.C.,2000).

Statistical Analysis

Results were statistically analyzed by one-way analysis of variance according to SAS (1995). The sensory and physical traits were statistical analyzed using the following model:

$$Yij = \mu + Fi + Eij$$

Where:

Yij = the observation on the ij^{th} trait,

μ = general mean,

Ri = effect due to the i^{th} type of feeding i=1-4,

Eij = random error.

While, the chemical composition was statistical, analyzed using the following model:

$$Yij = \mu + Mi + Fj + (MF)\ ij + eij$$

Where:

Yij = the observation on the ij[th] trait,
μ = general mean,
Si = effect due to the i [th] muscle i=1-2,
Hj = effect due to the i [th] type of feeding j=1-4,
(MF) ij = effect due to the interaction between muscles and type of feeding.
eij = random error.

Duncan's Multiple Range Test was used to compare the differences among the four experimental groups.

RESULTS AND DISCUSSION

Sensory Properties

Data of sensory properties, aroma, flavour, tenderness, juiciness and palatability of cooked camel meat are presented in Table (2).

Significant differences (P < 0.01) for the aroma, flavor, tenderness and juiciness were observed between feeding groups. Panelists were able to detect differences among samples of meat. The meat of camels fed BH and AN had higher score in meat acceptability than those from the other groups. The sensory properties of samples from camels fed AS and AS-AN agreed with those reported by Dawood (1995) However, the values of samples from camels fed BH and AN groups were higher than those reported by the same author.

Table (2): Least square means of sensory scores (Flavour, Aroma, Tenderness, Juiciness and Palatability) for meat (LD) from camels fed different types of forages.

Item	BH	Type of forages[1]			± SE
		AS	AN	AS-AN	
Flavor	4.33^{a}	3.83^{ab}	4.17^{ab}	3.67^{b}	0.17
Aroma	4.33^{a}	3.50^{b}	4.17^{a}	$3\ 92^{a}$	0.13
Tenderness	4.17^{a}	3.50^{b}	3.92^{ab}	3.67^{ab}	0.13
Juiciness	$3\ 83^{ab}$	3.50^{ab}	4.17^{a}	3.50^{b}	0.12
Palatability	4.17^{a}	3.59^{b}	4.15^{a}	3.69^{b}	0.08

1, BH, Berseem hay; AS, *Acacia saligna*; AN, *Atriplex nummularia*; AS-AN, were offered separately. A and b: Means followed by different superscripts within each row are significantly different (P ≤ 0.05).

Physical Properties and pH

Results in Table (3) show the effect of halophytic plants feeding on some physical properties of camel meat. Results indicated significant differences (P < 0.01) in cooking loss (%), shear force (Lb), water holding capacity (cm^2) and plasticity (cm^2) due to type of feeding. The range of cooking loss (40.80 - 42.96%) for the experimental groups indicated that the percentage cooking loss of camel meat was close to the range of 40.57 - 43.03% found by Dawood (1995) and higher than (33.23 - 37.95%) that was reported by Babiker and Yousif (1990). Such difference might be due to type of feeding, weight at slaughter, age, sex, carcass weight and degree of fattiness and /or cut (shalash, 1988). Meat samples from camels fed BH and AN groups had higher values in shear force (9.23 and 9.00 Lb, respectively) than those from the AS, AN groups (8.87 and 870 Lb, respectively). The present values of shear force were close to results shown by Dawood (1995) and higher than those reported by Babiker and Yousif (1990). The means of WHC were 10.59, 8.37, 10.89 and 9.58 (cm^2), while plasticity means were 2.15, 2.95, 2.65 and 2.68 (cm^2) for meat of camels fed BH, AN, AS and AS–AN, respectively. These results were higher than those reported by Babiker and Yousif (1990).

Table (3) : Least square means of physical characteristics (cooking loss percentage, shear value, water holding capacity and plasticity) and pH value for meat (LD) from camels fed different types of forages.

Item	BH	Types of forages[1]			± SE
		AS	AN	AS-AN	
Physical Characteristics:					
Cooking loss (%)	42.96[a]	40.80[c]	42.16[b]	41.57[b]	0.18
Shear force (Lb)	9.23[a]	8.87[ab]	9.00[ab]	8.70[b]	0.11
W.H.C (cm^2)	10.59[b]	8.37[d]	10.89[a]	9.58[c]	0.01
Plasticity (cm^2)	2.15[c]	2.95[a]	2.65[b]	2.68[b]	0 05
pH value:					
pH	5.81[a]	5.55[d]	5.74[b]	5.6[c]	0.02

1, BH, Berseem hay; AS, *Acacia saligna*; AN, *Atriplex nummularia*; AS-AN, were offered separately. a, b,c and d: Means followed by different superscripts within each row are significantly different (P ≤ 0.05).

The effects of treatments on the pH of camel meat (eye muscle) were also determined (Table 3). The pH values of camel meat differed significantly (P< 0.01) by type of feeding. The pH value of camel meat ranged from 5.55 to 5.81. The present values were in agreement with results of Babikar and Yousif (1990); and Al-Sheddy *et al* (1999).

Chemical Composition

Results given in table (4) show the chemical composition of fresh camel meat as affected by both type of muscle and type of feeding. The moisture content in camel meat showed significant differences (P< 0.01) due to type of muscle, type of feeding and their interactions. The *Biceps femores* (BF) muscle contained higher moisture (74.17%) than *Longsimus dorsi* (LD) muscle (69.16%), which could be attributed to high fat content in LD. Irrespective of type of muscle, the average moisture in camel meat of BH, AS, AN, AS-AN groups were 73.44, 71.22, 70.81 and 71.23%, respectively. Results were similar to those reported by Dawood and Alkanhal (1995) where the moisture values were lower in rib eye (69.555) and higher in leg cut

(74.57%). Meat of camels fed AN had the lowest moisture content among muscles than the other experimental groups. The low moisture content of the AN group meat was due to its higher fat content. The mean of 69.18 and 74.17% for LD and BF muscles, respectively, were lower than the values, 75.09 – 78.00 % reported by Shalash (1988); El-Faer *et al.*(1991); El-Gasim and Alkanhal (1992); and Al-Sheddy (1999)

Table (4): Least square means of Chemical composition of *Longissimus dorsi* (L.D) and *Biceps femoris* (B.F) muscles of camels fed different types of forages.

Item	Types of forages[1]				Mean	±SE		
	BH	AS	AN	AS-AN	M	M	T	M*T
Moisture								
L .D	71.69^{a}	69.12^{b}	67.71^{c}	68.18^{c}	69.18	0.09	0.12	0.17
B .F	75.20^{a}	73.91^{c}	73.32^{b}	74 25^{b}	74 17			
Mean T	73.44	71.22	70.81	71.23				
Protein								
L .D	20.40^{c}	22.07^{a}	21.36^{b}	21.98^{ab}	21.45	0.11	0 15	0.21
B .F	20.21^{b}	22.10^{b}	20.33^{a}	20.10^{b}	20.64			
Mean T	20.31	21.20	21.73	21.04				
Fat								
L .D	6.86^{d}	7.68^{c}	9.86^{a}	8.83^{b}	8.31	0.11	0.16	0.23
B .F	3.49^{c}	3.96^{bc}	5.23^{a}	4.60^{ab}	4.32			
Mean T	5.18	6.46	6.91	6.72				
Ash								
L .D	1.06^{ab}	1.10^{a}	1.09^{ab}	1.01^{b}	1.06	0.01	0.02	0 03
B .F	1.10^{ab}	1.04^{a}	1.12^{ab}	1.01^{b}	1.07			
Mean T	1.08	1.06	1.11	1.01				

1, BH, Berseem hay; AS, *Acacia saligna*; AN, *Atriplex nummularia*; AS-AN, were offered separately. M, SE of muscles mean. T, SE of ratios mean. M*T, SE of interaction between muscles and rations. a, b and c: Means followed by different superscripts within each row are significantly different ($P \leq 0.05$).

The Protein content in camel meat differed significantly ($P < 0.01$) by type of muscle and type of feeding. The overall means ware 21.45 and 20.64% for LD and BF muscles, respectively. These findings were close to the 19 – 20% range reported by El-Faer *et al.*(1991); El-Gasim and Alkanhal (1992); and Dawood and Alkanhal (1995) and higher than (18.7%) that was reported by Kamoun (1995). Also, the present values were in agreement with those reported (21.63%) by Babiker and Yousif (1990) and Al-Sheddy (1999).

The fat content of camel meat differed significantly ($P < 0.01$) by type of muscle and type of feeding. The LD muscle had higher percentage of fat (8.31%) than the BF muscle (4.32%). There is an inverse relationship between fat and the moisture content of camel meat. Meat of camels fed AN had higher fat content in both muscles (9.86, and 5.23 % for LD and BF, respectively) than the other groups. Irrespective of type of muscle, the averages of fat in camels fed BH, AS, AN, AS-AN were 5.18, 6.46, 6.91 and 6.72%, respectively. The present values of fat percentage for fresh muscle were higher than those reported by El- Fear *et al.* (1991); Babiker and Yousif (1990); EL-Gasim and Alkamhal (1992); Dowood and Alkamhal (1995); and Al-Sheddy (1999).

The ash content of camel meat differed significantly ($P< 0.01$) by type of feeding, however, the effect of muscle type has no significant effect. The mean ash of LD and BF muscles were 1.06 and 1.07%. Irrespective of type of muscle, the averages ash of camel meat of BH, AS, AN, AS-AN groups were 1.08, 1.06, 1.11 and 1.01%, respectively. Results were similar to those of Babiker and Yousif (1990); Dowood and Alkanhal (1995); kamoun (1995); and Al-Sheddy (1999). These results indicated that although halophytes contain high % ash they had no effect on ash content of camel meat.

On the basis of these overall data, camel meat appears to be similar in chemical composition to other red meats. Comparable results were found for lamb, beef, and veal El-Gasim and Alkanhal (1992). Generally, the nutrient content of camel meat is similar to those reported from other red meat except that eye muscle (*Longsimus dors*) and meat of AN group have higher levels of fat. The differences in chemical composition between camel meat and other red meat could be due to a variety of factors, such as age or weight at slaughter, type of cut and feeding.

According to the present results, the untraditional concentrate mixture (UCM) and edible parts of the halophytic plants in feeding growing camels can be successfully used in feeding growing camels for a period eight months without adverse effects on their meat quality characteristics.

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صفات الذبيحة وجودة اللحم فى ذكور الإبل المغذاة على نباتات ملحية مختلفة:
٢- الخواص الطبيعية والكيميائية والحسية للحوم الإبل

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استخدم فى هذه الدراسة عضلتى *Longissimus dorsi* and *Biceps femoris* لعدد ١٢ من ذبائح ذكور الإبل النامية عمر ١٠ –١٢ شهر بمتوسط وزن ٢٥٠,٢٣ كجم بعد تغذيتها على العلائق المختبرة لمدة ٢٤٠ يوم بهدف دراسة تأثير التغذية على بعض العلائق غير التقليدية من النباتات الملحية (القطف الملحى، الأكاسيا) والتى تنتشر فى منطقة الساحل الشمالى الغربى وبعض المخلفات (نوى البلح المجروش وتفل الزيتون) على الخصائص الحسية والطبيعية والكيماوية للحوم الأبل.

قسمت حيوانات التجربة إلى أربعة مجموعات ، غذيت المجموعة الأولى على علف مركز تقليدي مع دريس برسيم بينما المجموعات الثلاثة الأخرى فقد غذيت على عليقة مركزة غير تقليدية (مكونة من نوى بلح مجروش، تفل زيتون، شعير مجروش، ذرة صفراء و كسب فول صويا) بينما اختلفت فى نوعية العلف المالئ حيث غذيت المجموعة الثانية على نبات الأكاسيا ، المجموعة الثالثة على نبات القطف الملحى بينما غذيت المجموعة الرابعة على كل من القطف الملحى والأكاسيا.

وتم ذبح الجمال فى نهاية التجربة وأخذت البيانات الخاصة بالذبيحة وبعد التبريد تم أخذ العينات اللازمة للتحليل. وأوضحت النتائج أنه توجد فروق معنوية فى الصفات الحسية (الطعم ، النكهة والطراوة والعصيرية) بين المجموعات التجريبية المختلفة حيث حققت المجموعة المغذاة على القطف ومجموعة الكنترول درجات أعلى فى الخصائص الحسية.

كما توجد فروق معنوية فى الصفات الطبيعية للحم (النسبة المئوية للفقد بالطهى ، وقوة القطع ، وقدرة اللحم على الإحتفاظ بالماء) فتتراوح نسبة الفقد بالطهى من ٤٠,٨٠ – ٤٢,٩٦ % بين المجموعات التجريبية المختلفة حيث حققت المجموعة المغذاة على القطف ومجموعة الكنترول درجات أعلى فى قوة القطع.

أما بالنسبة للتركيب الكيماوى للحم الإبل فقد تأثر معنويا بكل من نوع العضلة المستخدمة فى التحليل ونوع التغذية المقدمة للحيوانات وأظهرت بيانات التحليل الكيماوى أن لحم الجمال مشابه للحوم الحمراء الأخرى باستثناء العضلة العينية والمجموعة المغذاة على القطف فقد سجلت مستويات أعلى من الدهن

وبناء على نتائج هذه الدراسة فأنه يمكن استخدام النباتات الصحراوية خاصة القطف مع بعض مخلفات التصنيع الغذائي فى تغذية الإبل النامية (لمدة ٨ شهور) دون التأثير على درجة جودة لحومها.