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Proximate composition, amino acids and inorganic mineral content of Arabian Camel meat: comparative study

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The proximate composition, amino acid and inorganic mineral contents of the Arabian Camel (*Camelus dromedarius*) meat were investigated and compared with other red and white meats (beef, lamb, goat, chicken and fish). Camel meat had more moisture, less fat, less ash and similar protein contents to beef, lamb, goat and chicken. The highest moisture and the lowest protein contents were found for fish (*Epinephulus chlorostigma*). Accordingly the moisture to protein ratios (M/P) of the camel and fish were higher than those of beef, lamb, goat and chicken. Except for Na, camel had a similar elemental composition (Zn, Ca, K, Mg, Cu and Mn) to beef but was superior to that of fish. For the six species studied, the ratio of essential to non-essential amino acids (ESAA/ NEAA) ranged between a high of 0·90 for goat and a low of 0·81 for fish. Camel had a similar ESAA/NEAA value to beef (0·85). Based on its possible contribution to the Recommended Dietary Allowances (RDA), the nutrient density of camel meat is quite comparable to that of beef; however, the two species are poor sources of Ca.

INTRODUCTION

Camels belong to the family *camelidae* and genera *Camelus* and *Lama* (Mugerwa, 1981) with two and four species in each genus respectively. These species are *Camelus bacterianum, Camelus dromedarius, Lama ilama, Lama pucos, Lama guanicoe* and *Lama vicugna.*

The world population of the dromedary and bacterianus camels is estimated to be 17 million. Dromedary camels constitute about 91% of this figure and are concentrated mainly in the Arab world, particularly in the Arabian countries of Africa. In addition the ability of the Arabian camel (dromedary camel) to withstand the hot and harsh environmental conditions is not matched by any other red meat animal species. In spite of its potential, the contribution of camel meat to the per capita meat consumption in the Arab world is not impressive. This can be attributed to the fact that camel meat is the least studied type of meat and is wrongly believed to be of lower nutritive value and quality than other types of red meat.

Few scientific studies have been devoted to camel meat (Khatami, 1970; Knoess, 1977; Williamson & Payne, 1978; Wilson, 1978; Elgasim & Elhag, 1990). Elgasim *et al.* (1987) concluded that the carcass characteristics of the Arabian camel are comparable to those of the other red meat animal species.

In view of the fact that camel meat potential is not fully exploited and the possibility that it could make a greater contribution to the growing need for meat in developing countries, the aim of the current study was to shed light on the chemical composition, amino acid profile and possible contribution of camel meat to the Recommended Dietary Allowances (RDA) compared to some other red and white meats.

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MATERIALS AND METHODS

Materials

Six camels (*Camelus dromedarius*) were purchased from Al-Hasa market, transferred to KFU Agricultural Experimental Station and kept in confinement for 32 days prior to slaughter. The camels were approximately 2 years old and weighed about 248 kg. Five steers (7 months old with an average live weight of 162 kg), five lambs (6 months old and weighing about 41 kg) and three male goats (5 months old and weighing about 25 kg) were obtained from KFU Agricultural Experimental Station. The animals were slaughtered at Al-Hasa Slaughter House and their carcasses were chilled for 48 h. In addition three chickens (1.5 kg live wt) and three Hamoor fishes (*Epinephulus chlorostigma*) were purchased from a local market. The chickens were slaughtered and chilled. The freshness of the fishes was checked objectively with a G. R. Torry meter and fishes with a freshness score of 10 or above were used.

Methods

Samples for the proximate analysis (protein, fat, ash and moisture content) were obtained from two different locations (i.e. leg and loin) from each of the four red meat species (camel, beef, lamb and goat). The data from these two locations were combined and their average was taken as the chemical composition of each species. Moisture, protein (N × 6·25), fat, and ash were determined according to the Standard Methods (AOAC, 1984). The chicken and fish samples were removed from the breast and fillet, respectively, for proximate analysis and analysed according to the AOAC (1984) procedures. The ash content of each location was further analysed for the mineral contents mainly calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), copper (Cu), manganese (Mn) and iron (Fe), using a Perkin Elmer Model 2380 Atomic Absorption Spectrophotometer.

Amino acid analysis

Samples for amino acid analysis were obtained from the camel, young steers, lambs, goats, fish and chickens. Meat samples were homogenized with a tissue mixer in distilled water in a ratio of 1:5. Aliquots of the homogenized samples were hydrolysed for 22 h in evacuated sealed ampules with 6N HCl at 110°C in a toluene bath. Amino acid content (g/16 g N) was determined in duplicate using an LKB Amino Acid analyser (Model 4150 ALPHA). The protein content of each sample used in the amino acid analyser was determined and expressed on a dry matter and defatted sample basis.

RESULTS AND DISCUSSION

The proximate composition of the camel meat compared to that of other red (beef, lamb and goat) and white meats (chicken and fish) is presented in Table 1. The moisture contents of camel and fish meats were higher than those of beef, lamb, goat or chicken. The importance of moisture in meats lies in its pronounced effects on the shelf-life of meat, its processing potential and sensory characteristics. Usually consumers prefer 'juicy' over 'dry' mouth-feeling meats. With the exception of camel and fish meats, the moisture to protein (M/P) ratios of all species investigated were similar (Table 1). Camel had a slightly higher M/P than beef or lamb. The M/P ratio is a reflection of the suitability of meat for sausage manufacturing (Forrest *et al.*, 1975). Camel meat has a protein content that is slightly less than that of beef, lamb, goat or chicken meats. Camel meat has a fat content (2·6%) that is higher than fish (2·3%) but less than that of beef (4·7%), lamb (6·2%), goat (3·3%) and chicken (5·4%) meats. In addition, the cholesterol content of camel meat was noted to be lower than that of beef or lamb (Elgasim and Elhag, 1990). At a time where fatty meats are implicated with heart disease such findings may favour camel meats over other red meats. Again camel meat has an ash content (0·9%) that is less than that of beef (1·5%), lamb (1·5%), goat (1·4%), chicken (1·3%) and fish (1·3%) meats. Zinn (1967) concluded that anatomical location of muscles and days on feed could affect the chemical composition of meat. Also Stansby (1976) noted that the chemical composition of fish varies according to sex, season, size and geographical location of the catch.

The concentration of minerals in the meat of the Arabian camel and beef is given in Table 2. Comparison of the mineral content (Ca, K, Mg, Na, Cu, Mn, Fe and Zn) of camel meat with beef meat does not reveal striking differences, although beef has slightly higher levels of Zn, Ca, K, Mg, Fe, Mn. The main differences between the two species was that the level of Na in the camel meat was considerably higher than

Table 1. Proximate composition of camel, beef, lamb, goat, chicken and fish meats.

Species	Moisture	Protein[a]	Fat	Ash	M/P[b]
	(g/100 g)				
Camel ($n=6$)[c]	77·2	19·3	2·6	0·9	4·0
Beef ($n=5$)	73·4	20·4	4·7	1·5	3·6
Lamb ($n=5$)	72·2	20·1	6·2	1·5	3·6
Goat ($n=3$)	74·5	19·8	3·3	1·4	3·8
Chicken ($n=3$)	73·2	21·2	5·4	1·3	3·5
Fish ($n=3$)	78·7	17·8	2·3	1·3	4·4

[a] Protein = $N \times 6{\cdot}25$.
[b] M/P = Moisture to protein ratio.
[c] n = No. of observations.

Table 2. Mineral levels in the meat of the Arabian camel (*Camelus dromedarius*), beef and fish.

Species	Concentration (mg/kg)							
	Zn	Ca	K	Mg	Na	Cu	Mn	Fe
Camel ($n=6$)[a]	141	218	10,000	778	2100	1·8	0·6	85
Beef ($n=5$)	153	262	10,425	931	1174	2·2	0·8	100
Fish ($n=3$)	17	180	3920	300	580	0·9	0·4	4

[a] n = No. of observations.

beef (2100 mg/kg versus 1174 mg/kg). It should be emphasized here that Na occurs naturally in meat and is added to meat products for flavouring or preservation purposes. However, sodium may represent a risk factor for some people. Meats from beef and camel were superior in mineral content to that of fish (Table 2). Differences between muscle mineral concentration due to breed, age or weight and diet have been reported by several investigators (Doyle, 1980; Doornenbal & Murray, 1982; Kotula & Lusby, 1982; Marchello *et al.*, 1984).

The amino acid composition of the camel meat was compared with that of other red meats (Table 3) and white meats (Table 4). The protein on a dry matter and defatted basis of camel meat is similar to that of beef (86·7%) and slightly less than that of lamb (90·8%), goat (90·2%), chicken (88·8%) and fish (90·6%) (Tables

Table 4. Amino acid composition of camel meat compared with that of chicken and fish (g/16 g N)

Amino acid	Species		
	Camel	Chicken	Hamour
Essential			
Lys[a]	8·95	10·2 (9·50)	10·2 (9·74)
Thr	4·84	4·25 (3·91)	3·80 (3·62)
Val	6·31	5·74 (5·32)	5·48 (5·22)
Met	3·46	3·97 (3·68)	3·29 (3·13)
Ileu	5·89	6·24 (5·78)	5·81 (5·53)
Leu	9·51	9·70 (9·00)	9·42 (8·97)
Phe	4·73	4·85 (4·50)	4·54 (4·33)
His	5·62	3·82 (3·54)	4·57 (4·35)
Subtotal	49·3 (46·21)	48·8 (45·29)	47·1 (44·9)
Non-essential			
Arg	7·10	6·52	7·40
Asp	10·8	10·9	10·5
Ser	3·18	3·05	2·48
Glu	18·6	17·0	17·2
Pro	3·87	4·34	4·07
Gly	6·11	6·58	4·93
Tyr	3·81	3·79	3·29
Ala	3·85	6·80	7·99
Subtotal	57·4 (53·79)	59·0 (54·7)	57·8 (55·1)
Total	107	108	105
Protein %[b]	86·7	88·8	90·6
ESAA/NEAA[c]	0·85	0·82	0·81

[a] Values in parentheses indicate content per 100 g of amino acid residues.
[b] On dry and fat free basis.
[c] ESAA/NEAA = Essential to Non-essential Amino Acid ratio.

Table 3. Amino acid composition of camel meat compared with that of beef, lamb and goat (g/16 g N)

Amino acid	Species			
	Camel	Beef	Lamb	Goat
Essential				
Lys[a]	8·95 (8·39)	9·13 (7·96)	8·54 (8·00)	10·9 (10·15)
Thr	4·84 (4·53)	5·48 (4·78)	4·24 (4·00)	4·35 (4·04)
Val	6·31 (5·91)	6·61 (5·76)	5·85 (5·53)	6·80 (6·3)
Met	3·46 (3·24)	2·65 (2·30)	3·27 (3·09)	3·88 (3·6)
Ileu	5·89 (5·52)	6·53 (5·69)	5·84 (5·53)	6·04 (5·60)
Leu	9·51 (8·92)	10·7 (9·34)	9·63 (9·10)	7·86 (7·29)
Phe	4·73 (4·43)	5·65 (4·92)	4·86 (4·59)	6·51 (6·04)
His	5·62 (5·27)	6·21 (5·41)	5·90 (5·58)	4·71 (4·37)
Subtotal	49·31 (46·21)	53·0 (46·26)	48·1 (45·42)	51·1 (47·39)
Non-essential				
Arg	7·10	7·05	6·85	7·05
Asp	10·8	10·8	10·3	10·8
Ser	3·18	4·22	2·98	3·56
Glu	18·6	16·5	17·9	15·6
Pro	3·87	4·54	3·81	3·82
Gly	6·11	6·23	5·49	5·21
Tyro	3·81	4·10	3·51	5·92
Ala	3·85	7·74	6·73	4·69
Subtotal	57·4 (53·8)	61·2 (53·8)	57·6 (54·6)	56·6 (52·61)
Total	107 (100)	115 (100)	106 (100)	108 (100)
Protein %[b]	86·7	86·5	90·8	90·2
ESAA/NEAA[c]	0·85	0·86	0·83	0·90

[a] Values in parentheses indicate content per 100 g of amino acid residues.
[b] On dry matter and fat free basis.
[c] ESAA/NEAA = Essential to Non-essential Amino Acids ratio.

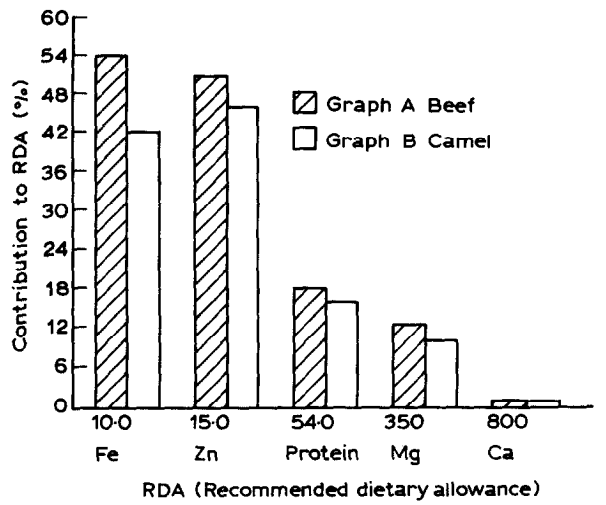

Fig. 1. The contribution of camel meat to the Recommended Dietary Allowances (RDA).

3 and 4). The essential amino acid content of camel meat is similar to that of beef, higher than that of lamb or white meats (fish and chicken) but less than that of goat meat. Relatively, camel meat had a higher methionine content than beef. Its leucine and histidine contents are also higher than that of goat meat; however the latter is superior in lysine content (Table 3). Again the histidine content of camel meat is better than that of chicken or fish meats (Table 4). Relatively camel meat was lower in alanine but higher in glutamic acid than all the red (Table 3) or white (Table 4) meats investigated.

The contribution of selected nutrients in 50 g of raw camel or beef meats to the Recommended Dietary Allowances (RDA) is shown in Fig. 1. The nutrient density of camel meat with respect to protein, Ca, Mg and Zn compares favourably with that of beef. With regard to iron, beef contributes more to the RDA than camel meat. Iron is considered to be the most important trace mineral in meat and is known to be in a highly utilizable form (Monson *et al.*, 1978). Also it appears to assist in the absorption of iron from non-haeme sources. Both camel and beef meat contribute only small amounts of calcium to the human requirements.

In conclusion, camel meat is nutritionally as good as that of the major sources of red or white meats. It may even have an edge over beef or lamb due to its low intramuscular fat and cholesterol contents. However, its high Na content may represent a risk factor for some people. In view of the above and its unique adaptability to the harsh environmental conditions, the value of the Arabian camel as a source of meat should not be underestimated.

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