

REGULAR ARTICLE

Meat levels of 25-hydroxyvitamin D3 in Moroccan one-humped dromedary camels (*Camelus dromedarius*)

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Abstract

The aim of this study was to determine the 25-hydroxyvitamin D3 (25-OH-D3) amounts in meat and serum of the Moroccan one-humped camels. The obtained results showed that the 25-OH-D3 amounts in serum (ng/mL), liver, kidney and muscle (ng/g) were 390±45; 7.071±1.003; 6.154±1.067 and 4.241±1.045 respectively. Values in liver were significantly higher ($p < 0.05$) than those of muscle. Serum 25-OH-D3 levels in camels were very higher than those of ruminant species. Meat of camel was rich in water and ash, and the amounts of 25-OH-D3 in its various analyzed tissues were similar to those reported for this constituent in the corresponding tissues of bovine species and slightly higher than those measured in other domestic animals.

Key words: 25-hydroxyvitamin D3, Dromedary camel, Ash, Meat, Morocco

Introduction

Meat is a food eaten by man since time immemorial. It stands for strength, health and wealth (Williams, 2007). The camel is an important source of red meat production especially in arid and semi-arid areas which adversely affect the performance of other meat animals. Any time, this source is limited by modest growth rates of the species and traditional extensive livestock systems. In the one-humped camel muscles, bones and fat represent respectively 57%, 26% and 17% of the mass of the carcass of the animal and lean meat contains about 78% water, 19% protein, 3% fat, and 1.2% ash with a small amount of intramuscular fat, which renders it a healthy food for humans (Kadim et al., 2008). Camel meat is also a good source of potassium, phosphorus, sodium, magnesium and calcium, and is therefore a high quality mineral intake in arid and semi-arid areas and contains less cholesterol compared to beef

or lamb (Kadim et al., 2008), which could play an important role in preventing atherosclerosis, controlling obesity and cholesterol, and reduce the risk of cancer in human. In addition, the camel meat is regarded in many countries and regions have significant effects of fight against several diseases, including hyperacidity, hypertension, pneumonia and respiratory dysfunctions (Kurtu, 2004).

In man, diet is an important determinant of circulating vitamin D concentrations which are lower in vegetarians than in meat and fish eaters (Crowe et al., 2011). One of the most important roles of vitamin D is to maintain skeletal calcium balance by promoting calcium absorption in the intestines (Holick, 2007) and a lack of vitamin D causes rickets in children and exacerbation of osteoporosis and the development of osteomalacia in adults. Moreover, several research showed that vitamin D plays an important role as an agent preventing or delaying the onset of certain autoimmune (diabetes type I) and proliferative diseases (solid cancers, leukemia, psoriasis) (Tissandié et al., 2006). Thus, highlighting physiological role of this hormone justifies its growing interest. However, the information available on nutritional value of camel meat is very limited, and to our best knowledge, there is no report evaluating the vitamin D3 amount in meat of camels. Therefore, this study was undertaken to

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determine the 25, hydroxyvitamin D3 levels in serum and tissues of camel. In addition, water and ash levels in muscle were analyzed.

Materials and Methods

Blood and tissues collection

In municipal slaughterhouse of Casablanca, samples of blood, muscle (*longissimus thoracis* between the 10th and the 13th rib of the left side), liver and kidney were collected from ten 4–5-year-old male Moroccan dromedary camels (*Camelus dromedarius*) weighing 300–350 kg.

During the slaughter blood was taken around 5 to 7 am in dry tubes of 5 ml. After the veterinary inspection, samples of tissues were performed at about 10 am using a sharp knife at a depth of 2 to 3 cm. The blood and tissue samples were taken aseptically at 4°C in a cooler to the laboratory of Molecular Genetics and physiopathology in faculty of Sciences Ben Sik in Casablanca. The blood was centrifuged at 4000 rpm for 10 min, and the serum was divided into aliquots and stored at - 20°C until assay of 25-OH-D3. Tissues were divided into 2 parts: one to measure the water content and ash and the other to extract and analyze the 25-OH-D3.

Humidity and Ash

Moisture tissue was determined by desiccation of a test sample in an oven at 105 °C for 24h until a constant weight. The rate of moisture (% water) or solids (%S) was determined by the difference of weight.

$$S\% = (\text{sample mass} / \text{dry mass of fresh sample}) \times 100.$$

$$\text{Water \%} = 100 - S\%.$$

The rate of total ash was obtained by incineration. After baking at 105 °C for 24h the meat samples were incinerated in a muffle furnace (1h at 600°C). The ashes were evaluated by the difference in weight.

$$\text{Total ash \%} = (\text{ash mass} / \text{mass of dry sample}) \times 100.$$

25-hydroxyvitamin D3 analysis

Meat samples (1.5 g) were cut into thin slices with a scalpel and extracted with 2.5 ml of

acetonitrile diluted with distilled water (10v/4v) for 3h. The samples were shaken vigorously every 30 min to facilitate extraction. The extracts obtained were subsequently centrifuged for 5 min at 4000 rpm and the supernatant was aliquoted and stored at -20°C until analysis of the 25-OH-D3.

Serum and meat levels of 25-OH-D3 were analyzed by radioimmunoassay method in the National Center of Science and Nuclear Technical Energy in Maamoura, Morocco, using kits marketed by DIAsource Immunoassays SA (Nivelles-Belgium). Validation for 25-OH-D3 assays included limits of detection, and precision in standard curve following sample dilution, inter- and intra-assays.

Values were expressed as mean and standard error ($X \pm \text{SEM}$) and analyzed by the Student test for comparison between samples, and $P < 0.05$ was regarded as statistically significant.

Results and Discussion

Levels of Water, dry matter and ash in meat

In our animals, the muscle content (%) of water, dry matter and ash was respectively 78.58 ± 7.1 , 21.42 ± 2.4 and 1.12 ± 0.10 (table I). These results were similar to those reported by numerous studies in camelidae species and higher than those found in sheep and beef (Table 1).

The rate of water and ash in meat can judge it's richness or it's poverty in minerals. In the work reported here, camel meat is richer in water compared to that of Sheep (Sen et al., 2004) and Beef (Mills et al., 1992). Moreover, the outcome of Elkady and Fahmy (1984) confirmed that camel meat contains more water than the buffalo. This richness is due to moisture changes in several parameters, including: race, gender, individual, age, health status, diet and slaughter conditions (Craplet, 1966) and preslaughter water deprivation (Vogel et al., 2011). The ash rates in muscle of our camels were comparable to those found in several species but lower than those measured in Lama (Table 1).

Table 1. Muscle content (%) in water and ash in some species.

Species	Water	Ashes	Muscle	Reference
Camel	74.07	1.10	<i>Longissimus</i>	Salvá et al., 2009
	78.58 ± 7.1	1.12 ± 0.10	<i>Longissimus</i>	Our study
Lama	73.9	2.43	<i>Longissimus</i>	Cristofanelli et al., 2005
Alpaga	73.6	2.5	<i>Longissimus</i>	Cristofanelli et al., 2005
Beef	71.5	0.9	<i>Longissimus</i>	Mills et al., 1992
Sheep	68.9	1.2	<i>Longissimus</i>	Sen et al., 2004
Goat	76.5	0.87	<i>Longissimus</i>	Marinova et al., 2001
Duck	76.8	1.0	<i>Pectoralis</i>	Baeza et al., 2002

Table 2. Levels of circulating vitamin D3, 25-hydroxyvitamin D3 (25-OH-D3) and 1,25-dihydroxyvitamin D3 [1,25(OH)2D3] in domestic animals.

Compound	Value	Source	Reference
Vitamine D3 (ng/mL)	4.015 ± 0.79	Cow serum	Cho et al., 2006
	3.34 ± 1.43	Calf plasma	Foote et al., 2004
	88 ± 7.1	Cow serum	Cho et al., 2006
	62.66 ± 16.74	Calf plasma	Foote et al., 2004
25-OH-D3 (ng/mL)	35.2 ± 7.8	Beef serum	Rivera et al., 2005
	40 – 50	Heifer plasma	Carnagey et al., 2006
	10 ± 6.7	Cow serum	Cho et al., 2006
	390 ± 45	Camel serum	Our study
1,25(OH)2D3 (pg/mL)	143.14 ± 20.08	Calf plasma	Foote et al., 2004
	33.3 ± 8.83	Beef serum	Rivera et al., 2005
	65 ± 14	Heifer plasma	Carnagey et al., 2006

Ould El Hadj et al. (2002) showed that the muscle solid content of camel increases with the age. It was an average of 22.93; 23.92 and 25.20% respectively for the three age groups studied: under 2 years, 2 to 5 years and over 5 years to 20 years. According to these authors, the rate of the dry matter depends on the water content of meat, which was inversely proportional to the dry matter. The average water content of muscle was: 77.07, 76.08 and 74.8% respectively for age groups: under 2 years, 2 to 5 years and over 5 years to 20 years.

Serum 25-hydroxyvitamin D3

Serum levels of 25-OH-D3 in camels used in this experimentation were 390 ± 45 (ng/mL). Compared to other domestic ruminants, these values are 10 to 15 times higher (table 2).

In previous studies we have reported in camel, that circulating levels of 25-OH-D were higher in summer than those measured in winter (El Khasmi et al., 2011) and didn't show any variation under preslaughter stress conditions such as road transportation (El Khasmi et al., 2010) nor with age (El Khasmi et al., 2009).

Meat levels of 25-hydroxyvitamin D3

In our camels, the content of 25-OH-D3 (ng/g) in muscle, liver and kidney were respectively 4.241 ± 1.045; 7.071 ± 1.003 and 6.154 ± 1.067 respectively (Table 3).

Our values were close to those reported for meat of cattle (Foote et al., 2004; Cho et al., 2006)

but slightly higher than those reported in other domestic species (Table 4).

The content of vitamin D in meat was generally low, difficult to measure and had not been indicated at the beginning of food composition in any meat. However, recent studies have been conducted in New Zealand, reported that the values (mg/100g) of vitamin D3 and 25-OH-D3 were respectively about 0.10 and 0.45 in beef and 0.04 and 0.93 in sheep (Cali et al., 1991). These studies have estimated that for an individual aged 51 to 70 years including adequate vitamin D was 10 mg/d, 12% and 25% of this vitamin intake could be covered by 100 g of cooked beef after respectively or lamb (Windaus et al., 1936). According to Heaney et al. (2009), in an adult woman of 70 kg total vitamin D is 14,665 IU, 65% in the form of vitamin D and 35% as 25-OH-D. Nearly three-quarters of vitamin D found in fats, while the 25-OH-D in the body was divided as follows: 20% in muscle, 30% in serum, 35% fat and 15% in other tissues. Circulating 25-OH-D was considered as a biomarker of vitamin D status of man and it was closely linked with the consumption of oily fish, margarine and foods with added vitamin D and exposure to sunlight (Zerwekh, 2008). The prevalence of vitamin D deficiency (serum 25-OH-D < 25 nmol/L) was 36.5% in Morocco, Turkey 41.3% and 19.3% in Nederland (Van der Meer et al., 2008).

Table 3. Serum and meat levels of 25-hydroxyvitamin D3 in Moroccan dromedary camel.

Serum	Muscle	Liver	Kidney
390 ± 45 ng/mL	4.241 ± 1.045 ng/g	7.071 ± 1.003 ng/g	6.154 ± 1.067 ng/g

Table 4. Meat levels of 25-hydroxyvitamin D3 (ng/g) in domestic animals.

Value	Source	Reference
0.27-0.53	Cow's liver	Koshy et VanDer Slik, 1977
4.5±2.6	Cow's liver	Cho et al., 2006
2.59±0.73	Calf's liver	Foote et al., 2004
0.44	Pig's liver	Mattila et al., 1995
0.51-0.98	Cow's Kidney	Koshy et VanDer Slik, 1977
4.2±2.0	Cow's Kidney	Cho et al., 2006
3.02±1.13	Calf's Kidney	Foote et al., 2004
0.15-0.34	Cow's muscle	Koshy et VanDer Slik, 1977
1.83±0.24	Cow's muscle	Cho et al., 2006
0.6±0.1	Heifer's muscle	Carnagey et al., 2006
1.68±0.37	Calf's muscle	Foote et al., 2004
0.9-0.10	Beef's muscle	Wertz et al., 2004
4.24±1.04	Camel's muscle	
7.071±1.003	Camel's liver	Our study
6.154±1.067	Camel's kidney	

It is largely known that vitamin D plays a major role in bone mineralization and Ca balance and a deficit in vitamin D is associated with rickets in children and osteomalacia in adults, osteoporosis and fractures, often synonyms in elderly loss of autonomy. The vitamin D may also play a protective role against hypertension, cardiovascular disease and some cancers and be an important modulator of the immune system (Bell et al., 2010).

Vitamin D is mainly produced endogenously by the action of ultraviolet light at wavelengths between 270 and 300 nm on the epidermal strata of the skin. Vitamin D3 production is greatest in the stratum basal and stratum spinosum of most vertebrate animals, including humans and the peak synthesis occurs between 295 and 297 nm (Crissey et al., 2003).

In the liver, vitamin D is converted into 25-OH-D which may then be converted into 1,25-dihydroxyvitamin D or calcitriol, the biologically active form of vitamin D, either in the kidneys or by monocyte-macrophages (Adams and Hewison, 2010; Courbebaisse et al., 2010). After the final converting step in the kidneys, calcitriol is released into the circulation as a hormone, then transported to various target organs by binding to vitamin D-binding protein (VDBP), a carrier protein in the plasma (Tissandié et al., 2006). This hormone regulates the Ca and P levels in the bloodstream and promotes the healthy growth and bone turnover. It also affects neuromuscular function and inflammation, and regulates the proliferation, differentiation and apoptosis of cells by modulating the action of many genes (Tissandié et al., 2006).

The physiological effects of calcitriol are mediated by the Vitamin D Receptor (VDR), which is principally located in the nuclei of target cells. When the calcitriol binds to the VDR, this later acts

as a transcription factor by modulating the gene expression of transport proteins (such as TRPV6 and Calbindin), which are able enhance the intestinal Ca absorption (Bouillon et al., 2003).

It has been observed that low levels of serum 25-OH-D seem to be associated with rickets, osteoporosis, heart diseases, cancers, diabetes, immune deficiency, depression, neuro-degeneration and chronic pain (Holick and Chen, 2008). However, a few number of foods (fish, meat and offal, milk, eggs and dairy products) may naturally contain vitamin D, and the circulating levels of 25-OH-D are more influenced by several other factors (vitamin D supplementation, degree of skin pigmentation, and amount and intensity of sun exposure) than diet (Holick and Chen, 2008). According to an (U.S.) Institute of Medicine Committee, a serum 25-OH-D level of 20 ng/mL is required for normal bone metabolism and overall health (DRI, 1997). In desert areas, the camel meat may contribute with no negligible exposure to sun to provide 25-OH-D in order to satisfy the demand of normal phosphocalcic metabolism in individuals living in these environments.

Conclusion

The camel is an important source of red meat production especially in arid and semi-arid areas, characterized by high temperatures, solar radiation, lack of water, rugged terrain and vegetation very poor which adversely affects the performance of other meat animals. Its meat rich in water and minerals may have nutritional benefits to human health. Despite the circulating levels of 25-OH-D3 very higher in camels than those of domestic animals, the amounts of 25-OH-D3 in the various tissues of the camel are similar to those reported for this constituent in their corresponding tissues. Our

findings show that camel meat may replace that from other animals and may be implicated in dietary source of vitamin D in man, and considered as indicators of an osteoblast activity very adapted in camel to survive in arid and semi-arid conditions.

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