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Determination of mineral elements (Ca and P) in the long bones of cattle, sheep, goats and Arabian camels living in a tropical area (Somalia)

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Abstract. ICP-OES was applied to the evaluation of mineral composition in the long bones of some domestic mammalians from Somalia, results highlighted different values of the Ca/P ratio in different animals (sheep, goats, camels and cattle) also depending on sex.

Key-words. Mineral composition, bones, ICP-OES.

1. Introduction. Especially in Arabian camels, metacarpus is very long, quadrangular in the upper 2/3, flat from front to back in the lower third. Its back face is converted into a sort of groove, concave from side to side because of the considerable rising of the two edges of the bone. The upper articular surface is divided in two parts by a large rough depression the internal part being on a higher level. The lower extremity is also split in two articular surfaces by a very deep socket: each surface is condyloidal in its fore part and similar to that of a horse in its backside (Gauthier-Pilates, Innis Dagg 1981).

Metatarsus has the same composition as the metacarpus, but it differs from it since, beside being usually longer, its upper articular surface is divided into 3 almost identical sections, 2 in front and one in the back. The former are diarthroidal and separated by a long deep groove, the latter is mainly rough and, in the middle of its back border, it is circumscribed by a 20 mm thick crest and it externally shows a groove that stretches for 25 to 30 mm along the bone diaphysis.

2. Physiology of calcium and phosphorus metabolism. Both calcium and phosphorus have essential func-

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tions for the organism, for example in the making of teeth and bones. Ca carries out many other functions, for example relating to hormones and blood coagulation. Phosphorus is essential for the formation of molecules that are basic for the energy and metabolism inside cells. The circulating levels of Ca and P are controlled by the absorption in the intestines and excretion through urine. A deficiency of P, even if rare, can cause loss of bone tissue, anorexia and pain. The balance of Ca and P in the organism can vary considerably. The diet is usually rich in Phosphorus and its absorption is generally limitless. Calcium, on the contrary, can be scarce in a diet and it is much less efficiently absorbed by the intestine. Even if 99% of calcium is found in the bones, the calcium circulating inside the body and in other tissues is vital for the functioning of cells, the transmission of nervous impulses and for muscular contractions.

In the bone, these elements (Ca and P) form mineral salts, above all tricalcium phosphate, disodium phosphate, trimagnesium phosphate, calcium carbonate, magnesium carbonate, calcium fluoride, which consequently form microcrystals of hydroxyapatite.

The composition of the mineral quota of the bone tissue may vary depending on age, species, type of bone and calcification degree (Pastoureau 1990).

Since the hardness and robustness of the examined bones of domestic animal species forced to live in dry and semi desert environments, a question arises about the possibility that this character is due to the high percentage of mineral salts in the bones composition.

For the analysis of Ca and P we used ICP MS (Inductively Coupled Plasma Mass Spectrometry), i.e. a particular kind of mass spectrometer able to evidence metals and some non-metals in concentrations so low as 1 part per trillion. This is obtained by ionizing the sample with ICP (Inductively Coupled Plasma) and then using a mass spectrometer to separate and quantify the ions. ICP can therefore be considered as a quartz torch, as plasma reaches a very high temperature, up to 10.000 K.

3. Experimental procedure. A devoted method was developed for this study.

3.1. Sampling. Between 2011 and 2012, we abstracted 111 sections from right and left metacarpus and metatarsus of sheep, cattle, goats and Arabian camels (dating 23-2-82, 7-4-82).

The following bones were sampled (each one with five replicates):

A Male Arabian camel metacarpus;
B Female Arabian camel metacarpus;
C Male bovine metacarpus;
D Male bovine metatarsus;
E Female bovine metacarpus;
F Female bovine metatarsus;
G Male sheep metacarpus;
H Male sheep metatarsus;
I Female sheep metacarpus;
J Female sheep metatarsus;
K Male goat metacarpus;
L Male goat metatarsus;
M Female goat metacarpus;
N Female goat metatarsus

Table 1. Concentration of Ca^2+ and P (both as mg/kg) in analysed samples.

Sample	*Ca2+ (mg/kg)*	*P (mg/kg)*	*Ca/P ratio*
A Male Arabian camel metacarpus	614.3	556.3	1.1
B Female Arabian camel metacarpus	560.3	447.7	1.3
C Male bovine metacarpus	576.0	491.7	1.2
D Male bovine metatarsus	581.7	489.3	1.2
E Female bovine metacarpus	581.0	486.7	1.2
F Female bovine metatarsus	568.7	462.3	1.2
G Male sheep metacarpus	539.0	394.3	1.4
H Male sheep metatarsus	531.7	379.3	1.4
I Female sheep metacarpus	543.7	399.9	1.4
J Female sheep metatarsus	540.3	400.7	1.3
K Male goat metacarpus	562.7	449.7	1.2
L Male goat metatarsus	567.7	452.3	1.2
M Female goat metacarpus	576.0	476.3	1.2
N Female goat metatarsus	566.7	458.3	1.2

3.2. Methods. The abstractions of the bones were effected in the centre of the bone diaphysis (measuring the bone length/2); they were about 1 cm thick and were reduced to powder through an IKA A 11 BASIC mill.

We actually obtained two sections using a handsaw and put the material obtained (secondary sexual character) into a marked envelope (male or female, metacarpus or metatarsus).

One of the two sections was used, after being easily ground in order to carry out digestion (process known as sample digestion) using 4 ml of nitric acid (Suprapur 65% p/p) and 1 ml of hydrogen peroxide (Suprapur 30% p/p) on 0.5 g of sample, which subsequently underwent a digestion programme through microwaves applying the following conditions: 250 W for 2 min, then 0 W 2 min, then 250 W 5 min and finally 450 W 6 min 700 W 5 min

All measurements were taken using a ICP-OES Spectro Cirios spectrometer and affected the lines of Ca and P.

Following the construction of calibration curves between 0 and 1000 µg kg^{-1} and eventual dilution of the samples. Each measurement was mediated by three analogous samples.

4. Results and conclusions. In Table 1 concentrations of the evaluated elements are reported; it is possible to observe that some differences occur between different species, although the number of samples does not permit a statistical evaluation of data.

Bearing in mind all this, it is also possible to see that in Arabian camel, only, the concentration of calcium is higher in male than in female.

In all other samples, calcium and phosphorus concentration does not differ so much between sex, this had been observed in rabbit (Barasa 1996).

In all samples, the ratio Ca^{2+} / P is

lower than the theoretical value that for hydroxyapatite is 2.15.
On the best of our knowledge, very poor and old information are available in literature on the studied topic, so that at this step of the research, we are not able to establish if this could depend on the sample preparation method or on the presence of different compound of phosphorous.

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