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ENERGY DISPERSIVE X – RAY ANALYSIS OF BOVINE BONE

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Abstract: This paper reports data on elements present in bovine bones namely femur, tibia, rib and scapula. For this purpose, Energy dispersive X - ray spectrometer is employed which gives percentage of elements. The variation in the percentage of elements suggests inhomogeneity in molecular composition (both inorganic and organic) of these bones.
Keywords: Bovine, Femur, Tibia, Scapula, Rib, Calcium Phosphate, EDXA.

1. Introduction

Bone is a dense and constantly changing structure that grows, shrinks and adapts during the entire life time of animals. Bone tissues are classified into two types, compact and cancellous bones. Femur and Tibia are the examples of compact bones and scapula and rib are examples of cancellous bones. The anabolic and catabolic process that takes place in the bone helps in the regulation of mineral metabolism and in the maintenance of the skeleton. Energy dispersive spectroscope is used to analyze elements or Characterization of a given sample. In this study elemental analysis of bone sample is done by comparing X-rays emitted by the sample with that of the X-rays emitted by the charge particles. The principle on which the Energy dispersive spectroscope works is that X-rays are characteristics of atomic structure which in turn is unique for each element.

Joschek, et. al., [1] studied the properties of porous hydroxyapatite ceramics produced by the sintering of bovine bone. They concluded that ceramics are highly crystalline and porous and have an advantage of high interconnecting pore system and a better drug processing ability.

Gangadhar, et.al., [2] published a paper on elemental analysis of ovine scapular cartilage and reported that 13 different elements are present in which percentage of Carbon, Oxygen and Nitrogen is more and molecular composition in is inhomogeneous.

SreenivasaRao, et.al., [3] made studies on human hair by inductive coupled plasma –atomic emission spectrometry and reported that human hair contains iron, lead, cobalt, nickel, manganese, zinc, copper, calcium and lead.

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Jayanand Manjhi, et.al., [4] studied the Effect of extremely low frequency magnetic field in the prevention of spinal cord injury-induced osteoporosis. They investigated the effect of extremely low frequency (ELF) magnetic field (MF) by electron microscopic study, which revealed the enhancement of microstructural composition and compactness in cortical and trabecular parts of treated bones.

Jeevan Kumar, et.al., [5] made studies on identification of trace elements in bovine metacarpus bone by Spectro - chemical analysis In their studies Analytical methods are described for the determination of major, minor, and trace elements in bone. Ca, Mo, Pb, Fe, Zn, Cu, Mg, Al, P are identified in the bovine metacarpus bone as major trace elements and 16 more elements are identified as minor trace elements i.e., Os, Sc, Y, K, Mn, La, Cd, Pd, Ru, Na, Sn, Pt, Bi, As, Si and Co.

2. Materials and Methods

Bovine bones of the present study were purchased from beef shop after about 5 hours of slaughtering. The samples were cleaned with water. Flesh attached to them was removed and then allowed to be sun dried. Specimens were prepared by cutting them in flat rectangular shape, suitable for the EDX instrument.

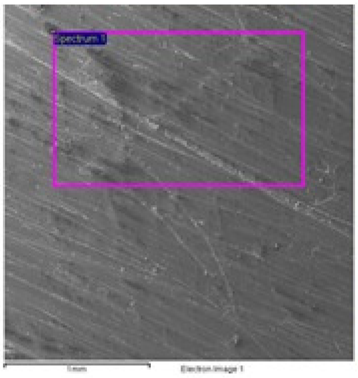
Specimens were mounted on aluminum stubs using double adhesive tape, coated with gold in vacuum evaporated Hitachi HUS – 5GB and EDX studies were carried out on OXFORD-LINK-ISIS EDX fitted to Hitachi S-520 scanning electron microscope.

The Spot Mode operation was used for elements suspected to be concentrated in very small regions. For this purpose, spots were selected. Figs. 1.1-1.4 show scanning electron micrographs (SEM) and Figs. 2.1-2.4 show spectraof bovine femur, tibia, scapulaand rib bones. The area in which measurement of elements was made can be seen in Figs. 1.1 to 1.4. Table 1 reports data on 18 different elements present in bovine bones understudy. The concentration of the elements is in weight percentage.

3. Results and Discussion

The elements present are C, N, O, Na, Mg, Al, Si, P, Ca, Ti, Cr, Mn, Fe, Z, Sr, Pb, Ba and Cd. The element Na is present in femur but not in other bones. The major elements are C, O, Ca, and P. The next is N. The other elements are in small quantity. The elements C, O and N are related to the major protein of the bone, called collagen.

The elements Ca and P constitute calcium phosphate apatite, which is the major inorganic material of the bone.The elements Mg, Sr and Zn are assumed to control and regulate deposition of calcium phosphate in the matrix of collagen of the bone, governed by the servo mechanism.



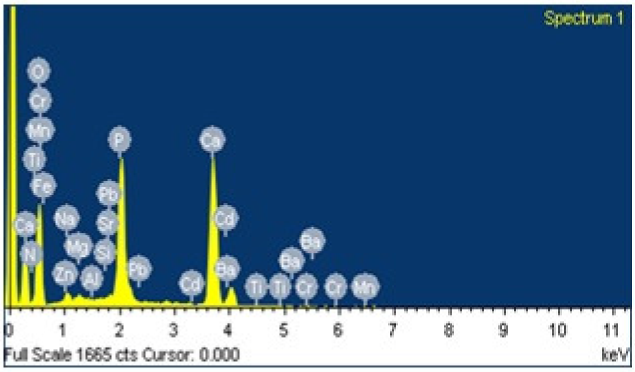
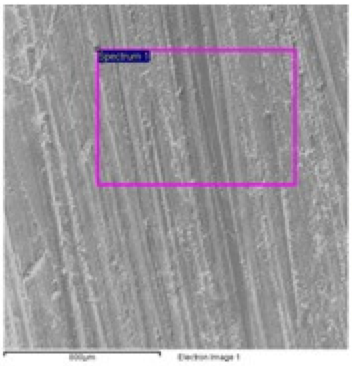


Fig. 1.1.SEM Micrograph of Bovine Femur Bone

Fig. 2.1.EDXA Spectrum of Bovine Femur Bone



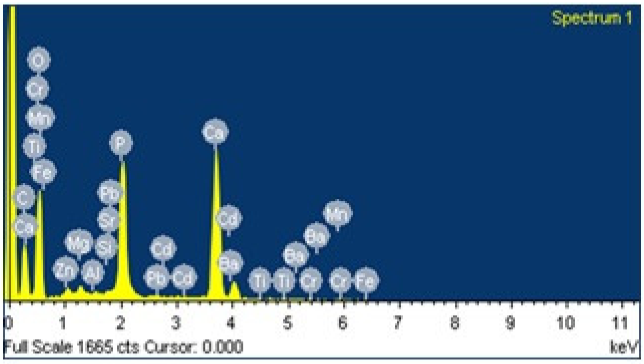
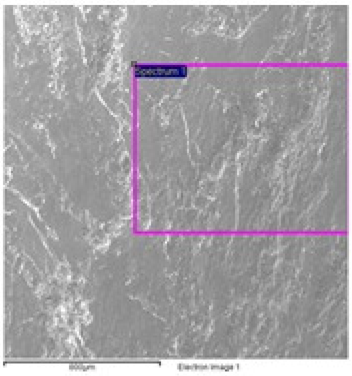


Fig. 1.2.SEM Micrograph of Bovine Tibia Bone

Fig. 2.2. EDX Spectrum of Bovine Tibia Bone



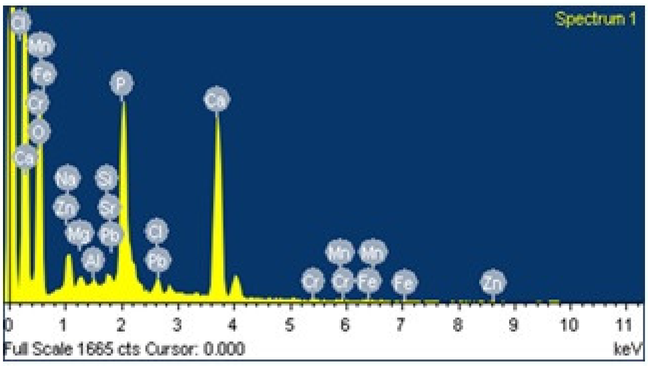


Fig. 1.3. SEM Micrograph of Bovine Scapula Bone

Fig 2.3. EDX Spectrum of Bovine Scapula Bone

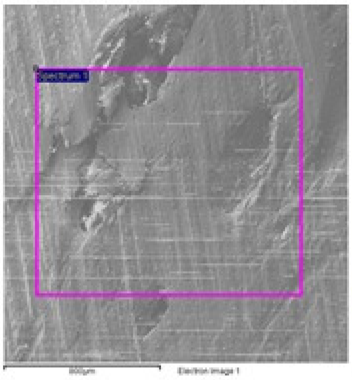


Fig. 1.4. SEM Micrograph of Bovine Rib Bone

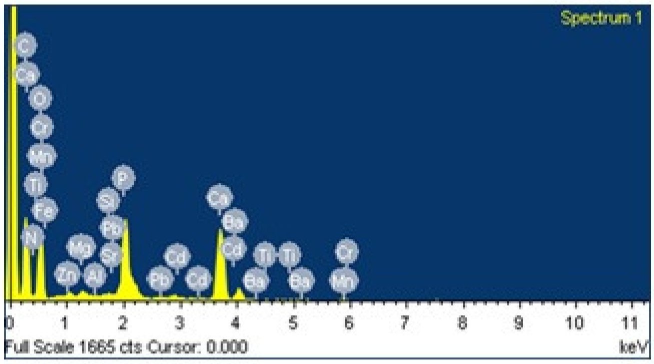


Fig. 2.4. EDX Spectrum of Bovine Rib Bone

Table 1 – Data on elements of bovine bones in weight percentage

Element	Weight (%)			
	Femur	Tibia	Scapula	Rib
C	25.00	22.70	26.10	44.68
O	34.00	38.02	38.04	39.63
N	3.40	3.12	3.75	3.36
Na	0.74	-	-	-
Mg	0.36	0.54	0.54	0.59
Al	-0.02	-0.03	-0.03	0.01
Si	0.10	0.22	0.22	0.16
P	12.03	11.88	11.55	9.32
Ca	23.27	22.24	21.41	18.38
Ti	-0.16	-0.17	-0.16	0.27
Cr	0.12	0.04	-0.04	0.07
Mn	-0.08	0.10	0.10	0.37
Fe	0.03	-0.16	-0.16	0.46
Zn	0.34	0.93	1.03	0.77
Sr	0.92	0.92	0.90	0.24
Pb	-0.28	-0.52	-0.52	0.86
Ba	0.54	0.44	0.43	0.09
Cd	-0.34	-0.20	-0.19	0.49
Ca/P	1.93	1.87	1.85	1.97

The negative value means that the elemental signal level is even lower than the back ground noise (i.e. continuum X-rays - Brehmsstrahlung).

It is interesting to note that the concentration of Mg and Zn is significantly more in tibia, scapula and rib, when compared to femur bone. But Sr is more in rib bone than that of other bones of the study. The Ca/P ratio has been considered to be good index of bone quality. The loss of bone apatite can be attributed to lowered Ca/P ratio. In the present study, Ca/P is in the range of 1.85 – 1.97 for the bovine bones studied.

4. Conclusions

The skeletal Ca/P ratio can be a good index of bone quality. As now a days one can measure bone Ca/P ratio in vivo for the use as a clinical indicator, such measurements could also be useful for the treatment of the bone diseases in which, along with bone loss, the bone quality is affected.The overall socio - economic benefit derived from early diagnosis and prevention of bone disorders is important because it improves the quality of life of a large number of patients and minimizes the cost of treating the severe disabilities caused by these diseases.

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