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RESEARCH PAPER

Measurement of the trace element concentration in some livestock and poultry bone samples using X-ray fluorescence.

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A B S T R A C T:
Element concentration (ppm) in some samples of livestock and poultry bones have been measured using X-ray fluorescence (XRF) technique. The study included evaluation of the concentration of more than 20 elements in bone samples It has focused on the impacts of freezing process on the concentration of elements The results demonstrated that the element concentrations were reduced by freezing. The higher effects were on the concentration of (Cr, Al, Zn, Sr, Mg, K, Ca, Cu, Fe, S, and P) for the bones of cow and sheep, where the most effects were in cow's bone samples. Maximum and minimum ratio of element concentration (cow and sheep livestock samples/ cow and sheep freezing samples) were 54.5 ± 12.2 ppm (element of Cr) and 0 ppm (element of Ba, Mn, Ti, Sn, and Rb), respectively. The results indicated that the high element concentration was in bone samples of livestock chicken (organic) compared with the poultry chicken (fresh and freezing)

KEY WORDS: XRF; Bone; Livestock; Poultry; Trace elements; freezing meat
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1. INTRODUCTION:

Trace elements are chemical elements in minute quantities that are known to accumulate in the bone, and it is considered as the storehouse for essential minerals for the body. The most widespread nutritional deficiency worldwide is potassium, coliseum, zinc, and iron deficiency (Zhuang et al., 2014). Livestock and poultry consider the main source of food, so it is necessary to identify the element's contents of each one, and deficiency of elements can lead to some blood disease (Victor et al., 2018).

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An X-ray fluorescence (XRF) is an x-ray instrument used widely for routine, relatively non-destructive chemical analyses of rocks, minerals, teeth, sediments, eggs, and fluids (Abdullah et L., 2017; Victor et al., 2018; Korish and Attia, 2020; Sabri 2020, Ismail et al., 2021; Ismail and Harki 2022). XRF works on wavelength-dispersive spectroscopic standards that are comparative to an electron microprobe (William 2013).

XRF does not apply to examinations at the little spot sizes commonplace of work (2-5 microns), so it is regularly utilized for bulk investigation of bigger divisions of geographical materials (Goldstein 2003; Egerton 2005). The reason why we use an X-ray spectrometer, in this case, because it is a common, affordable, and durable way to analyze trace elements in rock, teeth, bones, minerals, and sediment (Pushie et al., 2014; Zeynep and Yılmaz 2021).

The problems of healthy nutrition have become a risk and world problem, where societies suffer from mineral deficiencies that are important for body development and preventing disease due to the poor of it in animal products foods. This study aimed to identify some important and essential Trace elements in different types of bones using X-ray fluorescence (XRF) spectrometer.

2. MATERIALS AND METHODS

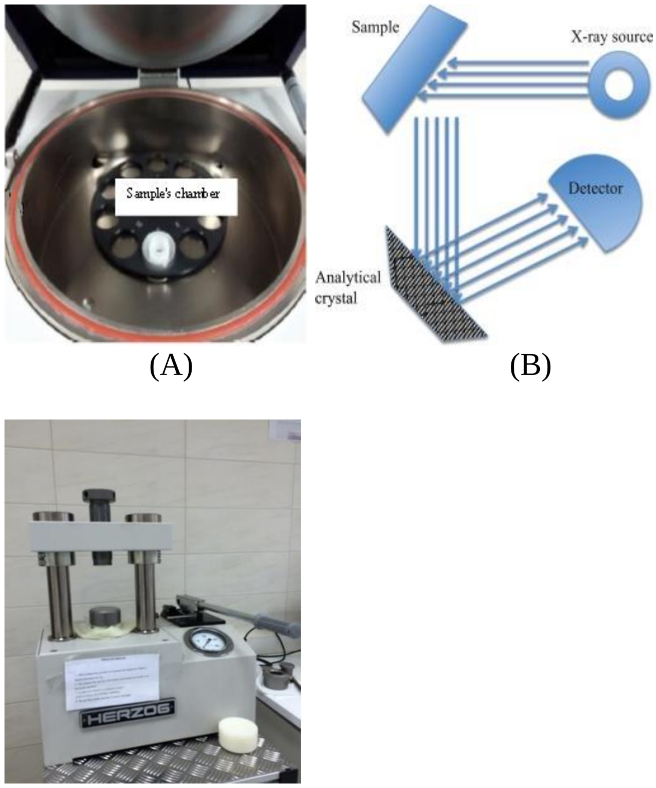
2.1 MATERIALS AND EQUIPMENT

2.1.1 X-ray fluorescence spectrometers (XRF)

Element contents in the bone samples of livestock and poultry were evaluated using X-ray fluorescence spectrometers (XRF) technique (X-MET8000 optimum) at the Physics Lab, Koya University/ Erbil governorate. The example chamber has an inside distance across 380 mm and a stature of 100 mm, and a huge example can be dissected. At the point when the driving component inside the spectrometer is inactivity, the catch is bolted and the example chamber spread doesn't open. At the point when an investigation is to be made in a vacuum mode is set, the entire example chamber is emptied. Inside the example chamber has test cups (sample holders); we can utilize a 10-example changer for enormous examples size and we utilize a 15-example changer for little examples size. In this research, the size of the 15-example changer was utilized because of the little size of the tried examples (Fig.1A). Reflecting and incident X-ray process with the target is displayed in Fig.1(B).

2.1.2 Press Machine

The manual press TP 60/2D: MANUAL PELLET PRESS machine (TP HERZOG) has been used, which has 200 KN maximum load (pressure); 200KN=20ton=20 000Kg (Fig.2C). The TP is a manually operated bench top pelletizing press used to produce pressed powder sample tablets for XRF or X-Ray Diffraction XRD analysis. The machine can be used in conjunction with steel rings; aluminum cups or frees pressing (Allwood et al, 2016; Stan et al., 2018). In this work, we use free pressing for all powdered samples. The powder should be very fine and homogeneous grain size.



(A) (B)

(C)

Fig.1: (A): Displaying of the sample's chamber within an exchange of sample holder of XRF machine, (B): Analytical crystals incident and reflected display of XRF, and (C): Press machine (TP HERZOG)

2.2 Experimental Procedures

2.2.1 Sample collection

The data collection (bone samples) in the present study covered samples from the Iraqi Kurdistan region. Procedures of the bone collection included different types of livestock (cattle) and poultry. Bone samples of livestock were collected from the slaughterhouses and meat-selling places directly, and the bone samples of freezing poultry were collected from the markets. The bone samples were included 500±3 grams of each sample (Cow, sheep, and chickens; for chicken there were three types (Fresh livestock, fresh poultry, and freezing poultry).

2.2.2 Sample Preparation

The collected samples were dried in an oven at 110 ^{o}C for about 12 h and powdered. The homogenized sample was grouped; 300 gm of each sample was placed in three aplastic chambers (100gm for each one). The inner lid was placed in and closed tightly with the outer cap. The chambers were sealed hermetically and externally using cellophane tape and kept aside for about a month to ensure equilibrium (Ismail et al., 2021).

3. RESULTS AND DISCUSSION

Trace element concentrations (ppm) in bone samples of livestock and poultry (Cow and sheep) are listed in Table 1. There was a high variation of the results of element concentrations between livestock and poultry (for both cows and sheep). The values of element concentrations in bones of livestock were high compared with its values in bone samples of poultry (cows and sheep), and this is in agreement with the essential factors that effects bone health throughout life, such as diet and physical activity (Rasmussen et al., 2020).

The table shows that the presence of some elements in the bones of cows was not found (zero concentration) in bones of sheep such as; Ti and Au. As well as, there were some elements in bone samples of sheep that was not found (zero concentration) in the bone of cows such as; Br, and Hf. During the comparison between livestock and poultry (for both cows and sheep) one found that the concentration of some important elements (Ba, Mn, Ti, Sn, Au, and Rb) have high value in the livestock (cows and sheep) bones samples, but their values are zero in the poultry bone samples (Table 1). The reason already was referred on the livestock nutrition and the external physical parameters (FAO, 1992 and 1994). As well as, bone collagen suffered denaturation proportionally to temperature decrease and to freezing duration. These alterations compromised the morphology of tissues after freezing (Andrade et al., 2008). So, the cells necrosed during freezing, contributing to reducing element concentration in the bone samples, relatively.

Table 1: Element concentration in bone samples of fresh and freezing cow and sheep meat

No.	Components (element trace)	Bone codes: CL (livestock Cow) and CP (poultry/ Freezing cow)			Bone codes: SL (Livestock sheep) and SP (poultry/ Freezing sheep)		
		Results of CL (ppm)	Results of CP (ppm)	Ratio (CL/CP)	Results of SL (ppm)	Results of SP (ppm)	Ratio (SL/SP)
1	O	809000	502000	1.61	909000	509000	1.78
2	Cl	141000	98000	1.44	130000	98000	1.32
3	Ca	110000	12500	8.8	105000	14200	7.39
4	P	23100	10100	2.28	37700	12300	3.1
5	S	5300	1700	3.11	23100	5600	4.12
6	Fe	5130	1560	3.29	4730	1300	3.63
7	K	4090	382	10.7	3180	1010	3.14
8	Mg	1850	175	10.57	2040	198	10.3
9	Sr	665	47	14.14	734	76.5	9.6
10	Zn	525	25.2	20.83	157	28.5	5.5
11	Ni	94	22.4	4.2	143	85	1.68
12	Cu	88.2	11.6	7.6	88.2	51	1.73
13	Al	86.9	3.4	25.55	87.8	16.5	5.32
14	Cr	65.4	1.2	54.5	32.3	11.5	2.8
15	Ba	47.6	0		143	0	
16	Mn	32.9	0		26.4	0	
17	Ti	28.7	0		0	0	
18	Sn	25.4	0		27.2	0	
19	Au	2.26	0		0	0	
20	Rb	1.44	0		1.9	0	
21	Br	0	0		11.4	2.5	1.91
22	Hf	0	0		8.63	2	1.74

Figures 2 and 3 show the ratio between element concentration in bone samples of livestock and poultry cows and sheep, respectively. It is clear that the most important elements were at low concentration for the poultry bone samples for cows and sheep. The maximum and minimum ratios of the elements in cows were at Cr (54.5) and Cl (1.2) (Fig2). As well as, Fig.3 shows that the maximum and minimum ratio of the elements in sheep were at Mg (10.3) and Cl (1.44)

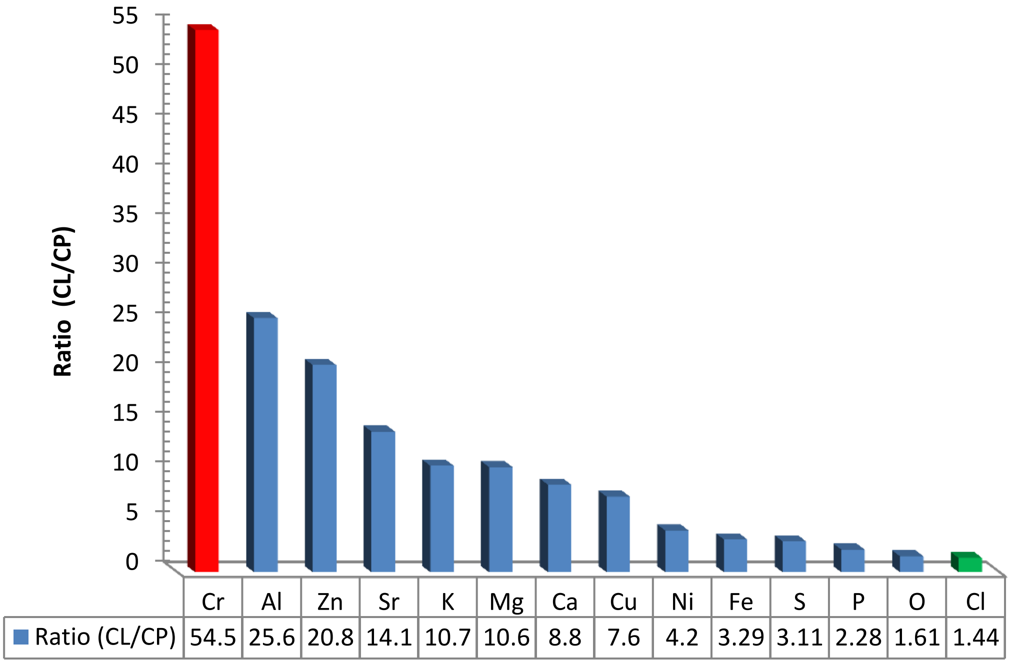


Fig.2: Ratio effects (CL/CP) of the element concentration (ppm) for fresh (CL) and freezing (CP) cow bone samples

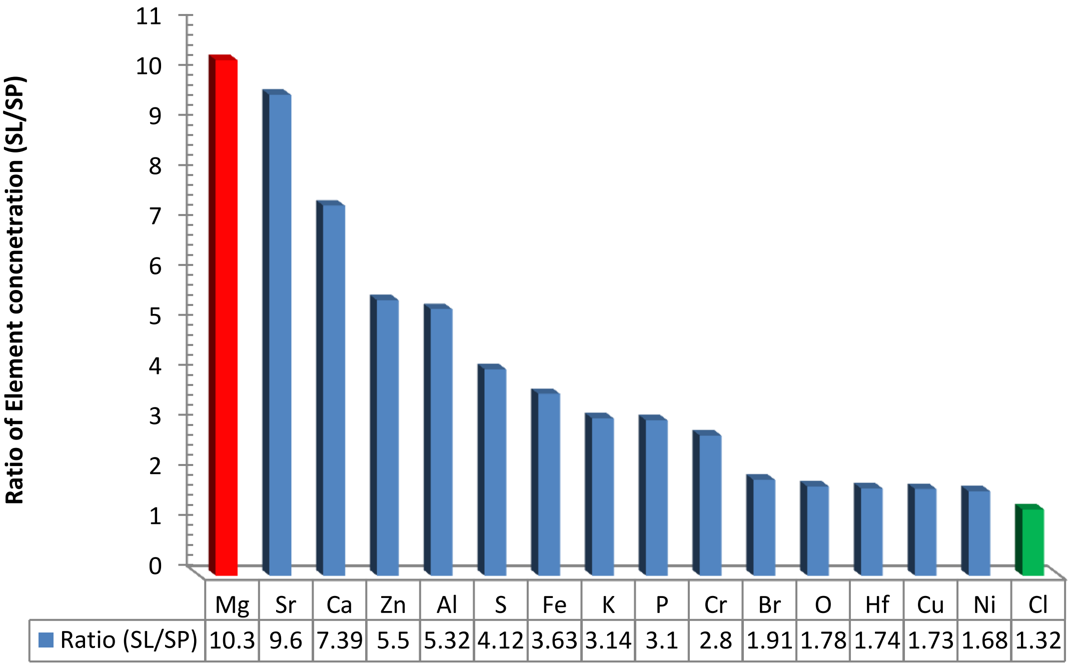


Fig.3: Variation of ratio element concentration in bone samples of fresh (CL) and freezing (CP) sheep

The freezing of chicken had satisfied impacts on the element concentrations in the chicken bone samples, and the results are listed in Table 2. The results were varied regarded the chicken lifestyle (with the type and condition of the chicken). The element concentrations in livestock chicken bone were very significant compared with its concentration in poultry chicken bone samples. As well as, the element concentration in bones of poultry fresh was higher than its freeze samples, as is shown in Fig.4. Figure 5 shows the concentration (ppm) of some important elements in the bone samples of three types of chickens: Chicken livestock, Chicken poultry, and Chicken poultry freezing. High values of the Fe, K, Mg, and Zn in the Chicken livestock bone make it important for health. As well as, low values of the mentioned important elements in the other samples (Fresh and freeze poultry chicken consider a critical point for healthy nutrias.

Table 2: Element concentration (ppm) in bone samples of three types of chickens; Chicken livestock, Chicken poultry, and Chicken poultry freezing

Components (element trace)	concentration (ppm) (Chicken livestock bone)	concentration (ppm) (Chicken poultry bone)	concentration (ppm) (Chicken poultry freezing bone)
O	501000	303000	201000
Cl	115000	96000	62000
Ca	96000	84000	6450
P	17100	12400	8220
S	5800	4100	1300
Fe	4450	3650	125
K	3420	2850	845
Mg	1600	1100	390
Sr	1100	890	28.2
Zn	725	540	35
Ni	485	415	16.2
Cu	125	105	4.4
Al	370	285	0
Cr	58.6	42.8	0.9
Ba	65.4	58.2	0
Mn	54.4	28.6	0
Sn	22.8	6.2	0
Rb	6.5	0	0
Ti	32.6	15.4	0

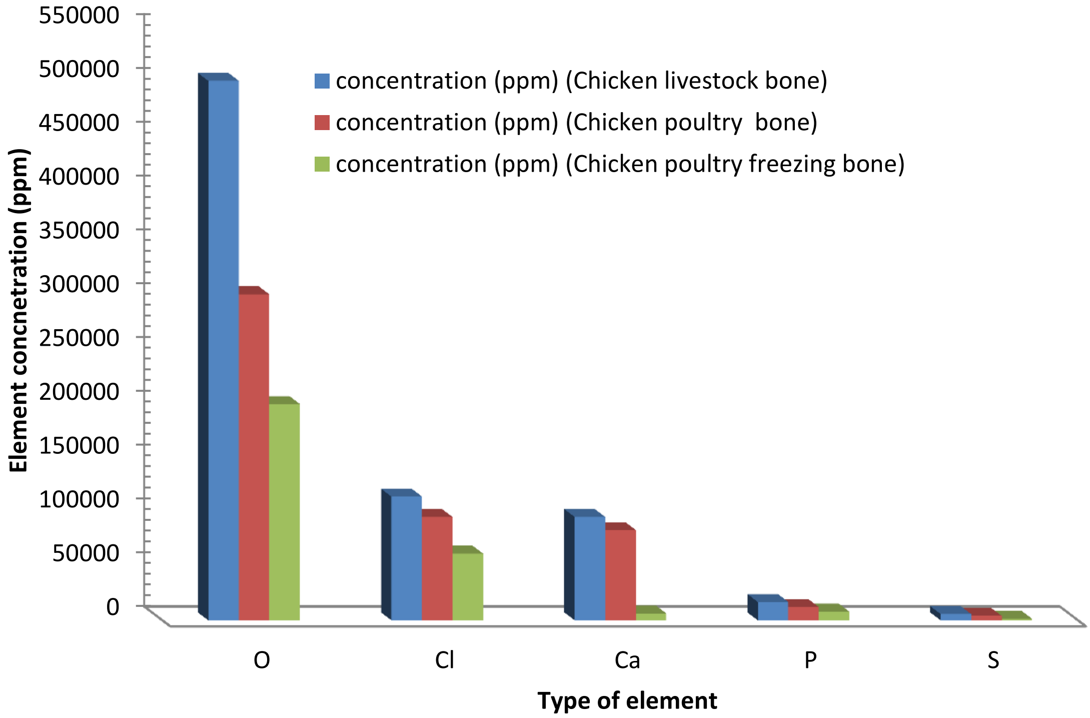


Fig.4: Variation of element concentration in different chicken bone samples

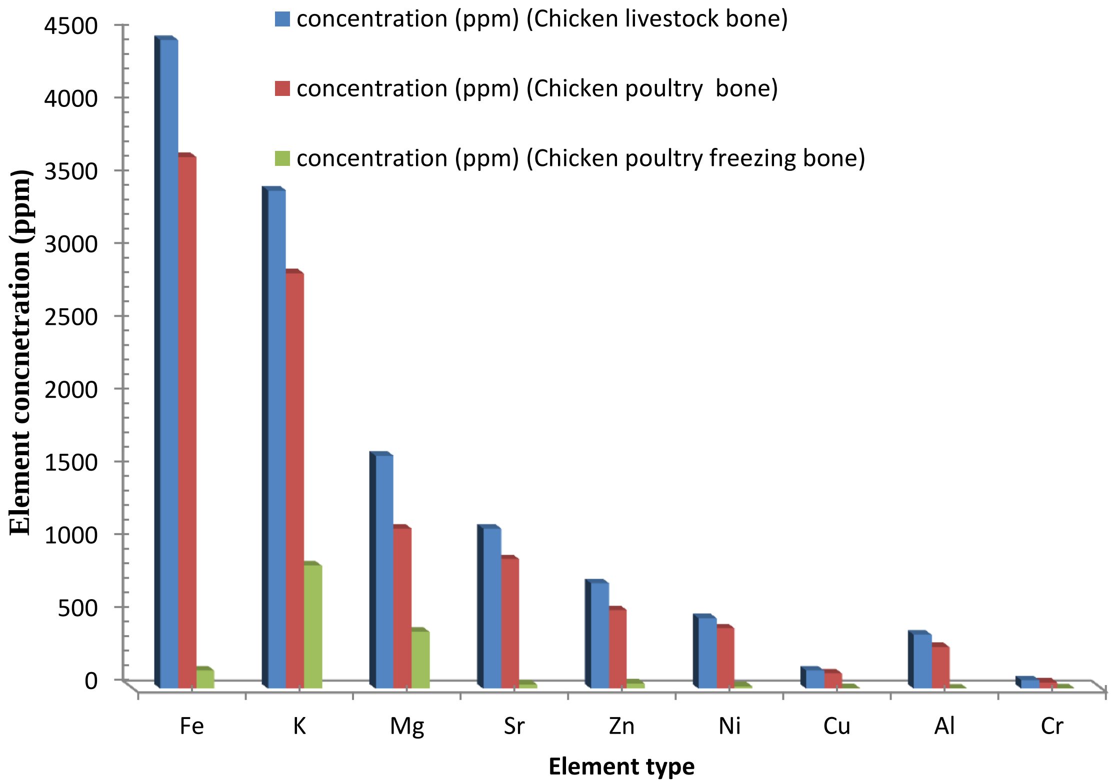


Fig.5: The concentration (ppm) of some important elements in the bone samples of three types of chickens: Chicken livestock, Chicken poultry, and Chicken poultry freezing

4. CONCLUSIONS

The concentration of the elements in some livestock and poultry bone samples in Iraqi Kurdistan region was evaluated using XRF technique. The high levels of the important elements were found in livestock cow, sheep and chicken bone samples with a very high ratio. Also, the study proved that freezing chicken (poultry chicken) has a high impact to reduce the ratio of element concentration in the bone samples. The concentration of some important elements (Ba, Mn, Ti, Sn, Au, and Rb) have high value in the livestock (cows and sheep) bones samples, but their values are zero in the poultry bone samples

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