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ASSESSMENT OF HEAVY METALS CONCENTRATIONS IN MIGRATORY BIRD TISSUE (*GALLINULA CHLOROPUS*) IN SOUTHERN IRAQ

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ABSTRACT

Marshlands are important habitats for migratory birds but they have been damaged by many human-induced factors such as heavy metal contamination. So, birds occupying wetlands can be exposed to pollution, furthermore, birds will accumulate organic and inorganic materials in their bodies over time and at risk of harmful and sub-lethal effects. Common moorhen (*Gallinula chloropus*) is one of the migratory birds that migrate during the winter to marshes in southern Iraq and hunted as food. Existing work aims to determine the concentrations of various toxic metals and trace elements in bird tissues such as: heart, liver, and feathers. Metal concentrations were measured using MS ICP spectrometry. Result found Liver of common moorhen was accumulate high concentration of S, Na and P compared with other metals. The concentrations respectively exceeded 124.4,70.5,22.9 ppm. The concentration of metals in quill feathers came in sequence Ca > Mg > Fe > K > AL > Zn. Although in bird's heart the concentration of these metals was in the following order: Ca > K > Mg > Fe > Zn > Al. The four tissues of common moorhen were accumulated low in concentration of Mn, Cu, Sr, Pb, Zr, Ti, Cr,Ni, Hg, Ba and Cd, their concentration ranged between 0.33 ppm to 0.001 ppm. Good positive association between Mg and Fe and k(r=0.762,0.761). Zn is related differently to Fe, K, Mg, Na and S(r=0.87,0.74,0.86.0.64 and 0.933 respectively). Clear connection between Al , Cr and Mn (r=0.840.811, respectively). There was also a negative correlation between Ca and Fe and K in bird tissues.

KEY WORDS : Heavy metals, Tissue, Common, Moorhen

INTRODUCTION

The pollution of heavy metals in the environment has drawn considerable attention due it's to toxicity, large sources and non biodegradable properties. Heavy metals can be deposited in the wetland environment by animals via the food supply chain, resulting in negative effects (Hong *et al*., 2020; Salamat *et al*., 2014). However, essential trace elements in certain concentrations have various effects physiologically on animals and plants (Burger *et al*., 2015). Metals are amongst the most dangerous sources of ecosystem pollutants. It is estimated that at least 20 metals are dangerous and about half of these metals are released to the ecosystem, which is detrimental to the environment in addition to human health (Burger, 1993).

The common moorhen (*Gallinula chloropush*) has a widespread range and is present in North and Southern America, Africa, and Asia and Europe's cold and temperate zone. This bird favors large, growing, high grassy habitats peppered with ponds and canals of leafy plants (Aazami *et al*., 2010; Hamitia *et al*., 2015). It normally flies in the night with limited capacity and is able of local migration (Sirgrist, 2006). Additionally, It is a popular breeding species in marshes habitats and well-vegetated lakes. Populations in regions where the waters freezing can migrate to more temperate climates like south Canada, northern of USA and east Europe. The birds have a short round wing and are slow fliers but normally they travel great distances. The common moorhen especially migrate from the colder parts of Siberia, from some of its breeding

areas, migrating at night (Martin, 2018). Such birds are omnivorous, eating plants material and small animals, During the breeding season they are fiercely territorial but are often sometimes found in large flocks on the shallow, vegetated lakes they favor (Martin, 2018).

The bird uses its beak as a lure, flapping the head from side to side with beak partly submerged in the water to draw small prey. The Common Moorhen will feed on its own or in groups of up to six individuals, include offspring (Wallau *et al*., 2009). Many study deal with water birds as biomonitoring to environment, you will note a range of benefits and drawbacks of birds as biomonitors. Since birds are high in the food web, they may be especially suited as monitoring of any signals that accumulates via the chain, but they can also be responsive to several different factors that influence the food chain (Zhang and Zhang, 2011). Birds are numerous, popular and are long-lived in some cases. Not only can birds track local food chains, but they can also be used to contrast distribution in different regions if they are migratory, making them useful as environmental pollution biomonitoring (O'Halloran, 2003).

At the same time as, migration patterns habits may make birds less appropriate as biomonitors, since individuals can vary to an uncertain degree in their migrations and make it difficult to establish the spatial level they reflect (O'Halloran, 2003; Malik, 2009). Marshes are considered to provide significant habitats for both native and migrating birds in southern Iraq. Common Moorhen exist within different zones in marches south of Iraq (Fazaa *et al*., 2017). This type of migratory bird is illegibly hunted during the winter when it is present in marshes regions and sold on food markets. The current research therefore aims to establish the concentrations of various toxic metals and trace elements in bird tissues, including: liver, heart and feathers to offer basic information of the dissemination and accumulation in various tissues.

MATERIALS AND METHODS

Sample collection and preparation

Concerning 30 birds of moorhen (*Gallinula chloropush*) pursued from local markets in Basra city during winter of 2019/2020. birds was slaughtered liver, heart breast feathers and quill feathers(long feather obtain from tail and wing) were collected and washed carefully with de-ionized water . Feather sample were washed in de-ionized water, and alternating with acetone to eliminate external contaminations. Every tissue samples were dried in an oven at 80 ºC for 48 hour or awaiting a stable dry mass was attained. Then the dry sample ground by a mortar to fine particles. The feathers were homogenized using electric blender.

0.5 g of sample is weighted of each tissue. Then the tissue samples put in tube and add 70% nitric acid and 30% hydrogen peroxide (2:1), to be digested, according to method of analytic by Burger and Gochfeld (2001), The samples were totally digested in block thermostat (150 ºC) for 4 hours awaiting the solutions become clear. After cooling, the solution was completed to 50mL with de-ionized water. Concentration of heavy metals and trace elements were analysis using inductively coupled plasma-mass spectrometry. Each analysis was done in duplicate; samples were analyzed with standard and blank.

Statistical Analysis

All data was executed for Windows using SPSS (verses 18.0, SPSS Ltd.). The descriptive statistics (mean values, standard deviation) for metal concentration values evaluated by a one way variance analysis followed by the honestly relevant difference check from Tukey. Differences at the $p<0.05$ stage were deemed relevant. Spearman's correlation coefficient sig(2-tail) used to find the correlation among metals in different tissues.

RESULTS

Current study found that dissimilar tissues of common moorhen (*Gallinula chloropus*) are accumulated different concentrations of heavy metals and trace elements. Liver tissues were accumulated elevated concentration of S, Na and P compared with other metals. The concentrations respectively exceeded 124.4,70.5,22.9 ppm. Heart has significantly high level of S and less concentration of P. At the same time as breast feather have low concentration of S, Na and P. quill feather gathered high of S and less concentration of P (Table 1, Fig.1). Conversely, the additional metals in bird liver were arranged according to the following pattern Ca>Mg>Fe>K>AL>Zn Concentration of metals with minimal variability in the liver they ranged 15.4,14.7,14.5,11.5,2.7,2.5 ppm respectively Fig. 2.

Table 1. Concentration of heavy metals (mean ±SD) (ppm/dry weight) in tissues of common moorhen (*Gallinula chloropus*).

Metals		Breast feather	Quill feather	liver	heart
Al	Mean	.8640	.5483	2.1707	.9500
	Std. Deviation	.02506	.02466	.11154	.04359
Ba	Mean	.0913	.1653	.0180	.0113
	Std. Deviation	.12016	.13086	.00458	.00252
Ca	Mean	16.2667	17.2667	15.4000	14.3000
	Std. Deviation	.25166	.25166	.26458	.10000
Cd	Mean	.0213	.0188	.0183	.0033
	Std. Deviation	.01629	.02711	.01258	.00208
Cr	Mean	.0283	.0017	.0347	.0420
	Std. Deviation	.01258	.00208	.01501	.02307
Cu	Mean	.0510	.0487	.1717	.1600
	Std. Deviation	.00436	.00737	.00764	.01000
Fe	Mean	1.3967	.8457	14.5667	9.5400
	Std. Deviation	.16258	.01504	.35119	.22271
K	Mean	1.4767	1.8133	11.7833	13.8067
	Std. Deviation	.17156	.13317	.10599	.73242
Mg	Mean	3.3033	3.8133	14.7400	10.5133
	Std. Deviation	.25106	.16258	.07937	.07234
Mn	Mean	.1213	.1343	.3307	.1990
	Std. Deviation	.01804	.03247	.02532	.01015
Hg	Mean	.0117	.0133	.0133	.0130
	Std. Deviation	.00153	.00289	.00306	.00300
Na	Mean	20.2733	25.3667	70.5000	22.5333
	Std. Deviation	.19732	.35119	.45826	.15275
Ni	Mean	.0063	.0073	.0287	.0133
	Std. Deviation	.00153	.00153	.01193	.00289
Pb	Mean	.0533	.2270	.0563	.2180
	Std. Deviation	.00351	.28841	.00252	.27886
Sr	Mean	.0134	.1440	.1557	.1340
	Std. Deviation	.00197	.00346	.03690	.01735
Ti	Mean	.0339	.0093	.0075	.0052
	Std. Deviation	.02864	.00602	.00326	.00360
Zn	Mean	.4537	.4603	2.5767	1.5177
	Std. Deviation	.02173	.01266	.34948	.05006
P	Mean	17.2600	16.8533	22.7367	10.5833
	Std. Deviation	.23065	.14572	.26577	.12583
S	Mean	20.4333	64.8000	124.4667	111.3333
	Std. Deviation	.40415	1.56205	.75719	2.05508
Zr	Mean	.0093	.1680	.0463	.0180
	Std. Deviation	.00586	.01929	.01305	.01916

And in the bird's heart the concentration of these minerals was in the following order: Ca > K > Mg > Fe > Zn > Al (Figure 2). We may see high concentrations of Ca in the breast and quill feather compared significantly with other concentrations of metals such as. Mg, K, Fe, Al, and Zn

Fig. 3 show The four tissues of common moorhen were accumulated low concentration of Mn, Cu, Sr, Pb, Zr, Ti, Cr,Ni, Hg, Ba and Cd their concentration ranged between 0.33 ppm to 0.001 ppm. Liver and heart have high concentration of Mn (0.33,0.19 ppm, respectively), and less levels of Cd (0.01.0.003ppm, respectively).

concentration of heavy metals in heart tissue, the following trend follows :Mn>Cu>Sr> Cr> Pb> Ni> Ba> Hg> Zr> Ti> Cd. Quill feathers gathered high Cu concentration and low Cd and Cr concentration in order: Cu > Zr > Mn > Sr > Ba > Hg > Ni> Cd > Cr. Breast feathers have a high concentration of 0.12 ppm of Mn followed by Pb at 0.05 ppm and a lower concentration of 0.009 ppm of Zr.

The study found a positive correlation between

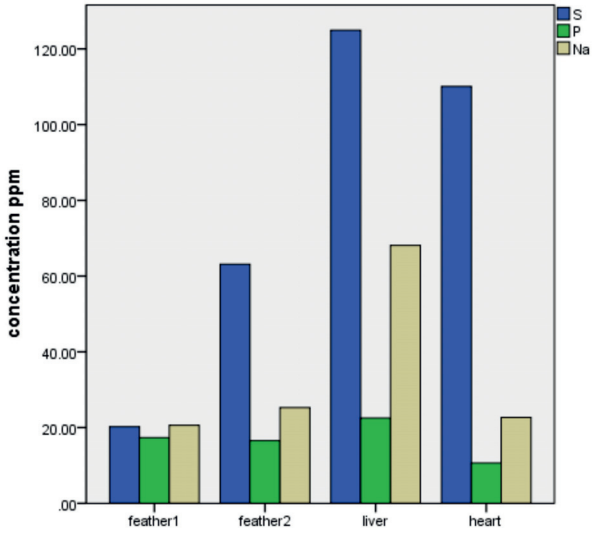

Fig. 1. Concentrations of metals (S,P and Na) in tissues of common moorhen,(feather 1=breast feather, feather 2=quill feather).

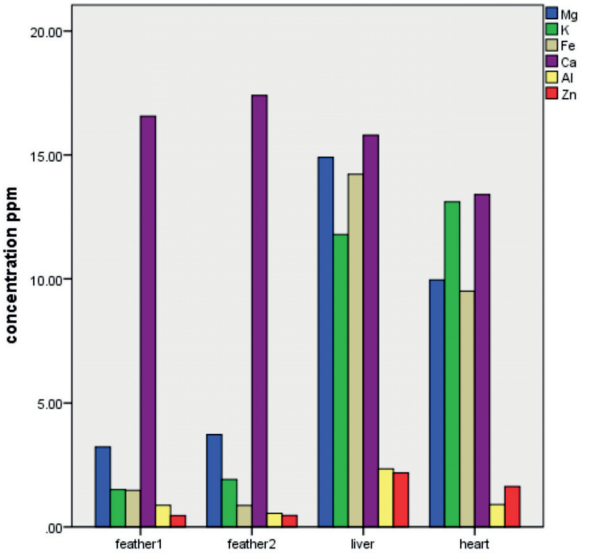

Fig. 2. Concentrations of metals (Mg ,K , Fe, Ca, Al and Zn) in tissues of common moorhen,(feather 1=breast feather, feather 2=quill feather).

Table 2. Spearman's correlation among trace elements concentrations in common moorhen tissues

	Ca	Cu	Fe	K	Mg	Na	Sr	Zn	P	S
Ca	1.000									
Cu	.186	1.000								
Fe	-.622-*	.221	1.000							
K	-.706-*	.413	.566	1.000						
Mg	-.469-	.455	.762**	.762**	1.000					
Na	.120	.667*	.394	.394	.761**	1.000				
Sr	-.039-	.481	.210	.490	.567	.635*	1.000			
Zn	-.575-	.429	.870**	.740**	.863**	.643*	.344	1.000		
P	.210	-.144-	.378	-.385-	.217	.394	-.098-	.281	1.000	
S	-.462-	.578*	.769**	.797**	.951**	.775**	.525	.933**	.168	1.000

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Spearman's correlation among heavy metals concentrations in common moorhen tissues

	Al	Ba	Cd	Cr	Mn	Hg	Pb	Ni	Ti	Zr
Al	1.000									
Ba	-.069-	1.000								
Cd	.359	.431	1.000							
Cr	.840**	-.278-	.353	1.000						
Mn	.811**	-.459-	.240	.871**	1.000					
Hg	.139	.043	.664*	.267	.351	1.000				
Pb	-.119-	-.249-	.189	-.098-	.056	.296	1.000			
Ni	.436	-.167-	.367	.686*	.694*	.556	-.022-	1.000		
Ti	.443	.499	.938**	.417	.231	.450	.032	.311	1.000	
Zr	-.382-	.205	.046	-.342-	-.128-	.470	.400	.381	-.119-	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

trace elements in moorhen tissues. Table 2 showed a strong positive correlation between Mg and Fe and k(r=0.762,0.761

Zn has different relation to Fe, K, Mg, Na and s(r=0.87,0.74,0.86.0.64 and 0.933 respectively). However, S has major correlation with Cu, Fe, K, Mg and Na. On the other hand, negative correlation between Ca with Fe And K has been found.

Table 3 shows various associations between heavy metals in bird tissues, positive correlation between Al and Cr and Mn (r=0.840, 811, respectively). Interestingly strong correlation between Cr and Ni and Mn, strong correlation between Cd and Hg and Ti (r=0.664.0.93 respectively).

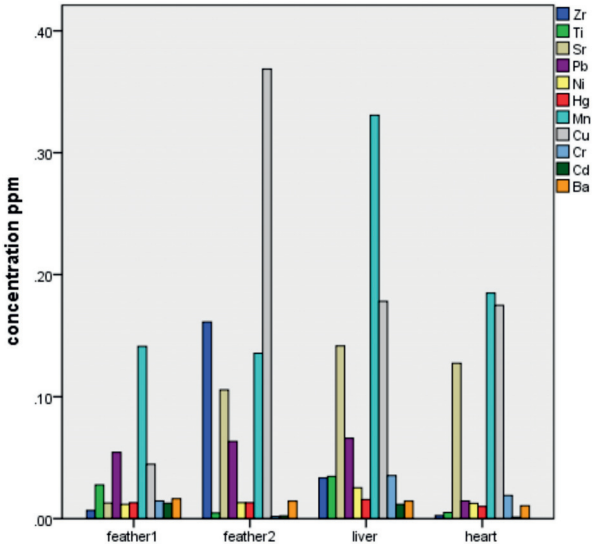

Fig. 3. Concentrations of metals (Zr, Ti, Sr, Pb, Ni, Hg, Mn, Cu, Cr, Cd and Ba)in tissues of common moorhen,(feather 1=breast feather, feather 2=quill feather).

DISCUSSION

Tissue amounts of metals may be an indicator of the biologically active portion of the product in the environment (Johansen *et al*., 2006). Result of the present study determined high concentrations of elements such as S, Na and P in tissues of moorhen. Levels of certain elements are highly regulated in bird tissues like S, P, Na, Fe, Ca, Mg, Zn, though variations of others metals could indicate diet and environment, accumulation of amounts deposited or binding in tissues, or current nutritional, dermal, or respiratory exposures to anthropic contaminants. Ca, K and Fe occur in high concentration in breast and quill feathers, Metals deposition in rising feathers is considered to be an effective approach of detoxification or excretion, and may account for a large amount of total body burden (Burger, 1993; Agusa *et al*., 2005),or may reflect the pollution in this region especially concentration of Al, Pb, Cd,Hg and Ni . Metals level in feather can also be used as an indication of bird toxicity and possible impacts (Burger and Eichhorst , 2007). Feather are used effectively as industrial pollution monitoring even though the ratio of pollutants in the body to the amount found in the feathers for each xenobiotic is fairly steady and there is a strong correlation between the levels of pollutants in bird food and those in feathers (Jaspers *et al*., 2019). They mention, to three various methods of transmitting contaminants to feathers, through feathers growing by relation to the bird's blood flow, during clean in preen oil, and via interaction with the atmosphere.

The results of this study recorded significantly high concentrations of several metals in breast feathers compared to quill feathers such as Al, Cd, Cr, Cu, Fe and Ti , Burger (1993) revealed that breast feathers to be more indicative of metals exposure. In addition feathers using as non-destructive way of measuring heavy metals contamination. Because many benefits for feathers as monitor devices, firstly, they are simple to acquire and be able to monitored for an extended time, so feather is valuable for longer-term study; secondly, if great numbers of specimens are required, there are few harms to the species survival of the community(Burgur *et al*., 2015).

Pb was high in quill feathers compared to Cd and Ni, as Ni has a lower concentration. This finding is in line with Gushit *et al*. (2016), who studied feathers of several species of birds.

Alternatively, this study found quill feathers accumulated high concentration of several metals involved Ba, Ca, Na, Pb, S and Zr than breast feathers. Breast feathers allowed critical for measuring level of metals in birds. They are also considered to be more reflective of metals levels than flight feathers (Doi and Fukuyana, 1996; Furness *et al*., 1986). Such breast feather rapidly regrow and their elimination may not affect the flying or thermoregulatory capacity of the bird (Movalli, 2000). Nighat *et al.* (2013) was detected several heavy metals in the breast feather of many species of birds returning to the Accipitridae family, Zn concentrations were found to be higher than other metals such as Ni, Cu, Pb and Cd, Similar foundation in the current study. Birds can obtain

heavy metals by food consumption, drink, and habit. The level of metals absorption in the environment varies based on the physiology of the organisms, the metals content, and bioavailability. Metals accumulate in the body after ingestion, are excreted or stored in different body tissues or insulate in feathers. (Furness *et al*., 1986).

Internal tissues, particularly softer tissues, are widely used as bioindicators for many research studies; one or more muscle, liver, kidney, heart, lung, tissues are usually used to examine the heavy metal levels in the environment(Zhang and Zhang, 2011).

Most of the 20 metals in this sample occur at high concentrations in moorhen liver except for Ba, Ca, Pb and Zr, which are found in quill feather this result be in agreement with Jayakumar and Muralidharan (2011), they reported high concentration of cooper in liver of little egret and cattle egret than other tissues of birds .Another study by Danczak *et al*. (1997) detected high concentration of Pb, Cd, Zn except of Cu in liver of anseriform birds than other tissues. Zn and Fe concentration were higher in liver compare with there in heart of moorhen, same founding by Carpene *et al*. (1995) We assume the Fe, Zn and Cu values could be related to the physiological function these metals play(Gaur *et al*., 2018). Iron is commonly used in oxidation systems as heme protein and in non-heme enzyme by molecular structures; its biochemical function needs a fine-tuned control since the free forms are still very toxic. Although the concentrations of Cd recorded in bird tissues studied were comparatively low, the same was confirmed by Carpene *et al* (1995) study. The concentration of Zn, Ni, and Cd accumulated in moorhen liver at a small high level than other tissues, and the Salamat *et al.* (2014) analysis also found elevated levels of these metals in moorhen liver.

Various physiological and biochemical factors, such as dietary habits, development, age, fertility, molting, and migrations, can affect bird concentration and redistribution of metals (Kim *et al*., 2007). Mercury value in moorhen liver was 0.013ppm,its increased to value stated in moorhen liver by Zamani *et al.* (2009). The Cd threshold is considered to be above 3 ppm and 2ppm Pb (Burgat, 1990; Pain *et al*., 1995). According to the current analysis, concentrations of Cd and pb in bird liver are less than. So these values in bird liver may be healthy for consumption.

In fact, migrating birds did not just reflect the pollution of the sampling field,. While pollution in their breeding grounds may be minimal, metal exposure may have a negative effect on their subsequent reproductive activity in their wintering land or in layover sites (Kunisue *et al.,* 2003).

CONCLUSION

In general, this study detected 20 namely elements (Al, Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Hg, Na, Ni, Pb, Sr, Ti, P, S, Zn and Zr) in four tissues of common moorhen which hunted in southern Iraq. The study found various tissue values of trace elements and heavy metals, liver was accumulated high concentrations of several elements, such as Al, Fe, Cu, mg, Mn, Ni, Zn, P, and S. Feather have high concentration of Ca, Na and Ba. Toxic metals like Cd, Pb and Hg found in low concentration of bird tissues. However, heart accumulated high level of Cr and K.

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