

## Research Article

# Estimation of heavy metals in muscle tissues of *Anas* species in Al-Hawizah marshes, southern Iraq

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**Abstract:** In the present study, concentrations of Cadmium (Cd), lead (Pb), chromium (Cr), nickel (Ni), cobalt (Co), and manganese (Mn) were estimated in muscle tissues of two economic bird species of *Anas platyrhynchos* and *Anas crecca* from Al-Hawizah Marshes, southern of Iraq during the autumn 2021 and winter 2022. The results showed that Cd concentration in muscle tissues were 1.27 and 8.073ppm in females of *A. platyrhynchos* in winter and autumn, respectively. Pb values were 0.075 and 0.23ppm in winter in males and females of *A. platyrhynchos*, respectively. Cr values varied from 0.21 to 4.65ppm in females of *A. crecca* during winter and autumn, respectively. Ni values were 0.013 and 1.609ppm in females of *A. platyrhynchos* and *A. crecca* in winter and autumn, respectively. Co concentrations were 0.05 and 1.611ppm in the males of *A. crecca* and females of *A. platyrhynchos* in autumn and winter, respectively. Mn values ranged from 0.08 to 3.17ppm in males and females of *A. crecca* during autumn and winter respectively. In this study, concentrations of Cd, Ni, Cr, and Mn were more than the permissible limits, and those of Co, Mg, and Pb were within permissible limits according to FAO. According to the results and since they occupy the higher trophic levels of the food chains, the studied birds can serve as useful bioindicators for environmental monitoring in marshes.

**Keywords:** Migratory bird, Bioaccumulation, Heavy metals, Muscle.

**Citation:** Hussein, S.M.; Najim, S.S. & Jazza, S.H. 2023. Estimation of heavy metals in muscle tissues of *Anas* species in Al-Hawizah marshes, southern Iraq. Iranian Journal of Ichthyology (Special Issue 1): 118-124.

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## Introduction

Living organisms have recently become more vulnerable to the adverse impacts of heavy metals which are attributed to anthropogenic activities such as increased industrial activity, agricultural products, mining operations, fossil fuel burning, and fertilizers, in addition to natural activities like runoff, atmospheric deposits, erosion, and volcanic eruptions that have increased levels of heavy metals in the aquatic ecosystem (Xia et al. 2011; Markowski et al. 2014; Jazza et al. 2022). Birds are one of the most important indicators for determining the levels of heavy metals in the environment. They are more exposed to pollutants because of occupying the higher trophic levels in the food chain and are more sensitive to minor changes in the ecosystem. When birds are exposed to these elements for a long period

leads to many health problems such as stress and behavioral changes or maybe their death (Abbasi et al. 2015, Burger & Gochfeld 2016; Kirubhanandhini et al. 2019). Birds are exposed to the pollutants through direct contact with water and food and accumulate in their tissues such as muscles. In addition to its harmful impacts on humans such as cadmium, lead, and chromium even in low concentrations and some essential elements that lead to serious risks in high concentrations such as zinc and copper (Melamed et al. 2003; Abbasi et al. 2015).

Bird species are excellent indicators of environmental pollution because of feed at various trophic levels, having wide geographic distribution, and long-life spans. They are not only useful to monitor regional pollution but migratory species can also be used to compare exposures in various regions

(Rothschild & Duffy 2005). Due to the lack of local studies for estimating heavy metals concentrations in the tissues of some economic bird species in the marshes of southern Iraq, which are an important food source for the human in this region, therefore this work aims to estimate the concentrations of some heavy metals in muscle tissues of two economic bird species of *Anas platyrhynchos* and *A. crecca* in the Al-Hawizah marshes to determine the ability of these animals to accumulate these elements in their tissues to knowledge its suitability for human consumption according to the international permissible limits.

### Materials and Methods

**Study area:** Al-Hawizah Marsh is located in southern Iraq and is characterized by great environmental importance as it represents habitats for biodiversity and its economic, recreational, and cultural importance (Ochsenschlager 2004). It is the main station for migratory birds between Siberia and Africa (Richardson & Hussain 2006). It extends east from the Tigris River into Iran. It is fed by two main branches of the Tigris River, Al-Mushrah and Al-Kahlaa. Al-Hawizah Marshes are characterized by enormous diversity and are the main source of natural hydrology in the Middle East. The swamps consist of permanent and seasonal water bodies in addition to reeds, papyrus, mudflats, and plains that are flooded seasonally and provide resources for local human communities and important habitats for migratory birds (UNEP 2001).

**Sampling:** Bird samples were collected using a fishing net, and placed in a crushed ice box until transferred to the laboratory. Two migratory economic birds (male and female) viz. *Anas platyrhynchos*, and *A. crecca* were selected for this study. After removing the muscles of the chest area, they were dried under the sun, ground by an electric grinder, dried again by the drying oven, ground again by a ceramic mortar, sifted by a sieve 0.3 mm, and placed in small polyethylene containers.

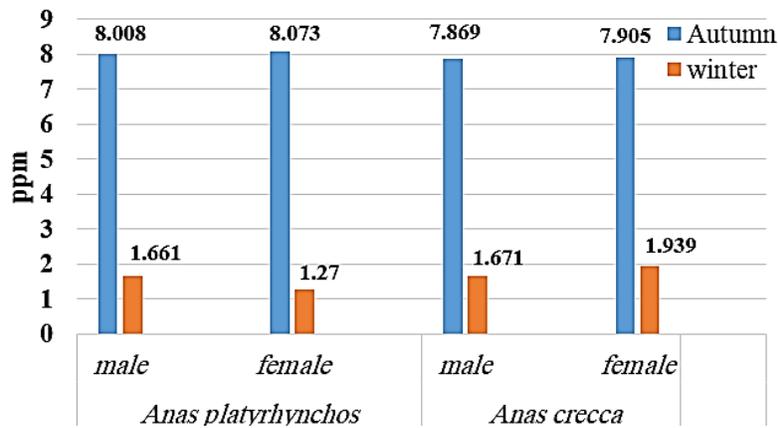
**Samples digestion:** 0.5gr of dried and ground muscle

tissue weighed in a 50ml conical flask, and 6ml of concentrated HClO<sub>4</sub> and HNO<sub>3</sub> mixture (1:1) was added to it. The samples were shaken gently to mix well and kept for 12-16 hours to complete the initial digestion in the fume hood. The samples were transferred to a water bath at 70°C for 30 minutes, put on the hot plate to complete the digestion process until the mixture became clear, filtered with a filter paper, and collected in a volumetric flask of 50ml filled to the mark with deionized water. Samples were kept in polyethylene containers (Jeffrey 2003). Concentrations of heavy elements (Cadmium, Lead, Chromium, Nickel, Cobalt, and Manganese) were determined by a Flame Atomic Absorption Spectrometer (AI-1200 Aurora).

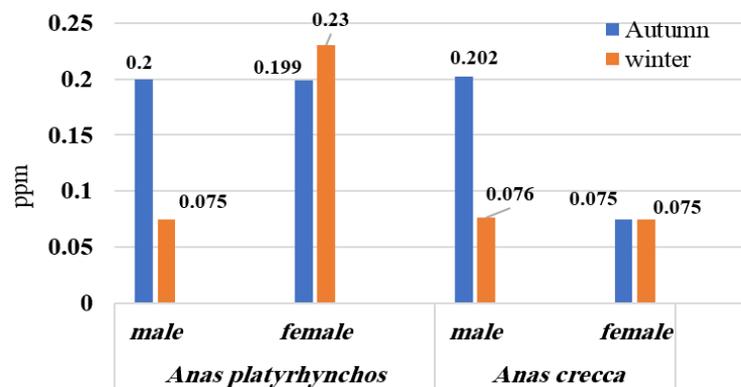
### Result and discussion

The concentrations of Cd in muscle tissues of *A. platyrhynchos* ranged from 8.008 to 8.073ppm in autumn, and 1.270 to 1.661ppm in winter in females and males, respectively. In *A. crecca*, it ranged between 7.869 and 7.905ppm during autumn, and 1.671 and 1.939 ppm during winter in males and females, respectively (Fig. 1). The ability of the bird species to accumulate Cd in muscle tissues varies during seasons this may be attributed to environmental factors, physiological factors, feeding habits, sex, weight and age of birds. Cd is transferred to birds through environmental pollution, especially human activities (Peakall & Burger 2003; Kosma et al. 2004; Pollock & Machiu 2009). This metal is a highly toxic element even in a few concentrations where it leads to mutagenic and carcinogenic impacts in living organisms (Kushwaha 2016). The results of our study showed that Cd levels in muscle tissues for both species were more than the permissible limit (0.2ppm) (FAO 1985).

Lead concentrations in the muscle tissues of *A. platyrhynchos* and *A. crecca* are shown in Figure 2. The results of the current study revealed seasonal variations in Pb levels and this may be due to differences in weight, age, sex of birds, and feeding habits of other aquatic organisms (Douterelo et al.



**Fig.1.** Seasonal variations of Cd levels (ppm) in muscle tissues of the studied birds.



**Fig.2.** Seasonal variations of Pb (ppm) in muscle tissues of the studied birds.

2004; Idan & Jazza 2022). Also, aquatic birds are exposed to lead through food as they pick up small stones to help them digest solid grains to facilitate digestion in the stomach (Pain1 992). Then enters the blood and accumulates in their tissues (Mateo et al. 2007). After reaching humans through the food chain, lead is a nonessential element for living organisms, therefore it will cause health risks (Kalisińska & Salicki 2010). Pb is a toxic element even in little concentration and causes reproductive weakness and reduction of bird weights (Kler et al. 2014). Lead values in this study were within the permissible limits (5ppm) for human consumption (FAO 1985).

Chromium concentrations in muscle tissues of *A. platyrhynchos* had the highest values in autumn (3.253 and 3.581ppm in males and females, respectively), and the lowest range (0.021 and 0.04ppm in males and females, respectively) in

winter. In *A. crecca*, the highest values were recorded in autumn (4.388 and 4.65ppm in males and females, respectively), whereas, in winter, the values were 0.021ppm in males and females. The results of the current study showed that bird species are exposed to different levels of Cr during their migration between their breeding areas, and there are differences in Cr levels between both genders, although females are known to excrete some elements in eggs during the breeding period (Rimmer et al. 2005). Accumulation of heavy metals in eggshells has been controversial by Burger (2007) who explained that female birds generally show higher levels of heavy metals as different foraging habits (Holmes 1986). A decrease in Cr values in winter may be attributed to the dilution factor after rains, which reduces the levels of Cr in the water and reduces the pollutants on birds (Olu et al. 2019). Cr is an essential element for living organisms for their physiological functions, but the

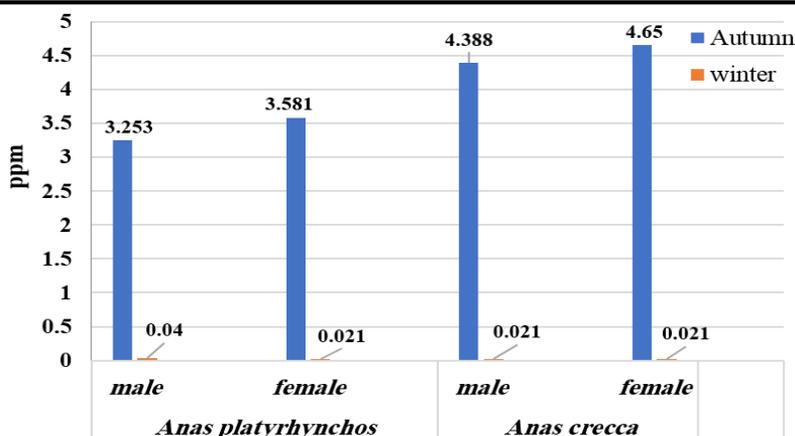


Fig.3. Seasonal variations of Cr concentration (ppm) in muscle tissues of the studied birds.

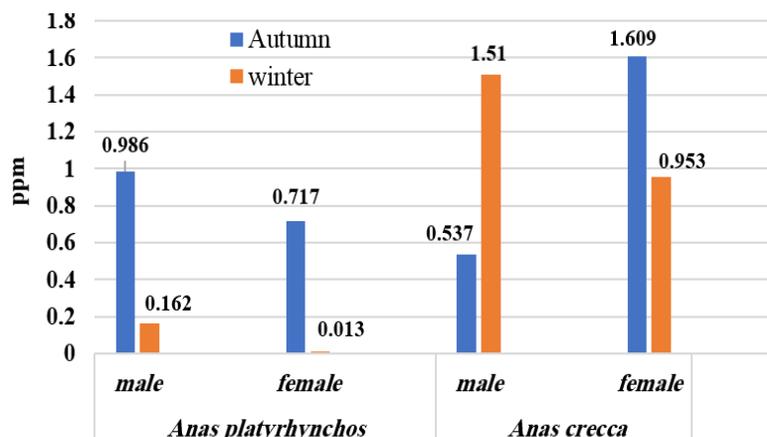


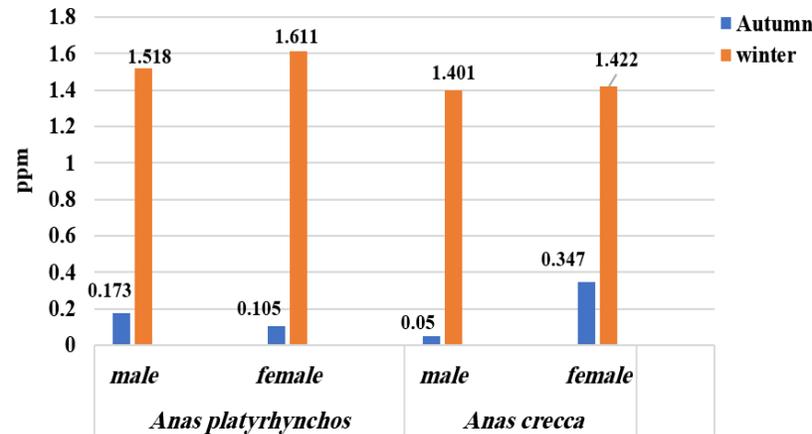
Fig.4. Seasonal variations of Ni (ppm) in muscle tissues of the studied birds.

accumulation of high amounts of Cr is toxic and impacts early embryonic development (Kertesz & Fancs 2003). Levels of Cr during autumn were more than the permissible limits (0.1ppm) according to FAO (1985).

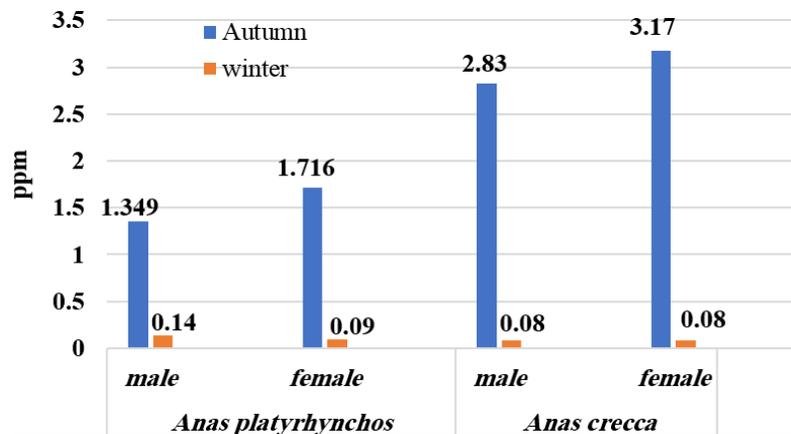
Nickel concentrations in muscle tissues of *A. platyrhynchos* and *A. crecca* during winter and autumn are shown in Figure 4. The differences in Ni values in both species may be returned to the amount of Ni ingested in polluted water and food, and to the duration and method of exposure (CET 1993). Dauwe et al. (2004) demonstrated that Ni concentrations in birds are lower in soft tissues such as the liver and muscles, and increases in the bones. The age factor also plays an important role, thus Ni accumulates more in the tissues of adult birds compared to young ones. Al-Salman et al. (2013) explain that the Ni exists in several forms in the

aquatic ecosystems, therefore it will be able to move between the layers of water to reach the different levels in the food chains including birds, to accumulate in their tissues which poses a threat to other consumers. Ni is a toxic element and exposure to its high amounts leads to DNA defects, vomiting, asthma, and fetal deformities (Pannu & Kler 2018). Our results showed that levels of Ni element were more than permissible limits (0.2 ppm) (FAO 1985).

The concentrations of Co in *A. platyrhynchos* and *A. crecca* during the study period in both genders are shown in Figure 5. The gender, weight, and age of birds affect the accumulation of Co. Although most of the excretion processes are similar for both genders, females can excrete pollutants from their bodies in the eggshell and embryos (Burger & Gochfeld 2004; Burger 2007; Squadrone et al. 2016). The adsorption of minerals on the surface of the



**Fig.5.** Seasonal variations of Co (ppm) in muscle tissues of the studied birds.



**Fig.6.** Seasonal variations of Mn (ppm) in muscle tissues of the studied birds.

sediment grains reduces their levels in the water, thus reducing the chance of birds being exposed to Co and this may explain its low concentration during the autumn (Bentivegna et al. 2004). Co is an important component of some enzymes and coenzymes. However, high concentrations of it are harmful and cause many human health risks (Leyssens et al. 2017). The results of this study revealed that Co values were within permissible limits (2ppm) (FAO 1985).

The highest values of Mn in *A. platyrhynchos* were recorded in autumn and the lowest in winter. In *A. crecca*, the highest values ranged from 2.83 to 3.17ppm in autumn in males and females, respectively, and the lowest values were 0.8 in winter in both sexes (Fig. 6). Bioaccumulation of Mn in muscle tissues of both species may be attributed to the tendency of this element to internal deposition in

various tissues because Mn is one of the important minerals for metabolism and growth (Naccari et al. 2009). The amounts of Mn in aquatic ecosystem changes over time depending on levels of untreated waste which discharge into the water bodies (Kraemer & Hering 2004; Abdulnabi 2016). The metabolic activities of the plant increase with the increase in temperature, thus increasing the biological absorption of Mn from the aquatic plant can transmit to birds during their feeding on polluted plants, and this explains seasonal variations of Mn levels in both species (Irzogy et al. 2022). Mn is an essential element and its decrease or increase causes harmful impacts such as hyperactivity or insufficiency thyroid gland, biochemical changes, and weak immunity (Ahmed & Abdrabo 2016; Islam et al. 2019). Mn values in this study were more than the permissible limits (0.2ppm) during autumn (FAO

1985).

In a conclusion, the present study showed seasonal variations in the levels of six heavy metals (Cd, Pb, Cr, Ni, Co, and Mn) in muscle tissues of two studied bird species. In addition, the results show that these birds have the ability to accumulate metals in their muscle tissues. The levels of Cd, Ni, Cr, and Mn in muscle tissues (edible part) were more than the permissible limits, and those of Co and Pb were within the permissible limits.

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