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Use of Two Aquatic Snail Species as Bioindicators of Heavy Metals in Tigris River-Baghdad

Harith Saeed Al-Warid*, Hayder Z. Ali, Ammar Jaffar, Ghassan Nissan, Abbas Haider, Ahmed Yosef

Department of Biology, College of Science, University of Baghdad, Baghdad, Iraq

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Abstract

Thirty individuals of *Bellamya bengalensis* and *Physella acuta* were collected and identified from the Tigris River in Baghdad during the period between October to November 2017. The efficiency of bioaccumulation of the two species as bioindicators for aquatic heavy metal pollution with Cd, Ni, Pb and Cu was investigated. Both snail species had the ability to accumulate heavy metals. The mean of Ni concentration in soft tissues of both snails was 1.53 ppm while the mean concentration of other heavy metals was significantly lower; they reached 0.51 ppm, 0.36 ppm and 0.29 ppm, respectively. While no significant differences between *B. bengalensis* and *P. acuta* were noticed in the ability to accumulate the heavy metals. It is concluded that both snails shared the features of good bioindicators due to their sensitivity to pollution.:

Keywords: *Bellamya bengalensis*, Bioindicator, heavy metals, *Physella acuta*, Tigris River

استعمال نوعين من القواقع المائية كمؤشرات حيوية للعناصر الثقيلة في نهر دجلة-بغداد

حارث سعيد الورد*, حيدر زهير علي, عمار جعفر, غسان نيسان, عباس حيدر, احمد يوسف

قسم علوم الحياة, كلية العلوم, جامعة بغداد, بغداد, العراق

الخلاصة

هدفت الدراسة الحالية الى التحقق من كفاءة التراكم الحيوي لكل من *Bellamya bengalensis* و *Physella acuta* كمؤشرات حيوية للتلوث بالعناصر الثقيلة في البيئة المائية. تم جمع ثلاثون فردا من نوعي القواقع المشمولة بهذه الدراسة و مواقع (15) قوقع لكل نوع من نهر دجلة في بغداد للفترة من تشرين الاول الى تشرين الثاني من عام 2017. اشارت النتائج الى قابلية النوعين على مراكمة العناصر الثقيلة في انسجتها. بلغ معدل تركيز النيكل في كلا النوعين 1.53 جزء المليون مقارنة مع باقي العناصر المشمولة بالدراسة (نحاس, رصاص و كاديوم) والتي كانت معدلاتها اقل ويفرق معنوي. بلغت 0.51 و 0.36 و 0.29 جزء بالمليون على التوالي.

لم تسجل اي فروق معنويه بين كل من *Bellamya bengalensis* و *Physella acuta* في قابليتها على مراكمة العناصر الثقيلة. كلا النوعين من القواقع يشتركون بخصائص المؤشرات الحيوية الجيدة لان كلاهما له حساسيه واضحة للملوثات.

Introduction

Snails are considered as suitable bioindicators since they live in a wide assortment of ecological niches [1]. Snails are slow-moving or sedentary and often have long life spans [1, 2]. Species that are

*Email: harithalward@scbaghdad.edu.iq

commonly available and used as a food source are particularly valuable models for ecological researches [3]. Because some species of snails accumulate high amounts of metal and reflect the level of bio-available metals in their ecosystem, these species are frequently used as indicators of metal pollution [4]. The importance of assessing heavy metals accumulation in snails and other invertebrate species is to announce the significant links about shifting these metals from producers to consumers [5]. This is also essential due to the alterations in the ecophysiology of metals, experimental procedure, species modification, or food chains, so that biomagnifications of metals are not general to all ecological niches [6]. Several researchers have identified the importance of snails as good bioindicators for monitoring heavy metal pollution, although the abnormally high environmental heavy metal concentrations affect several biological processes involved in developing and sustaining snail populations, such as growth, feeding, reproduction, physiological activity and maturity [7]. The aim of the study is to establish the current status of some heavy metals' (Nickel, Cadmium, Lead and Copper) pollution in some areas within the Tigris River using snails as bioindicators.

Materials and Methods

Snail collection

The collection of snails was conducted throughout the period between October to November 2017 from Tigris River near Attaifia District. Forty five snails were collected using mesh scoop made up of a metal ring of 20 cm length and 15 cm diameter attached to a wire net of 16 meshes per inch. The metal ring allied to a metal handle with a total length of 2 meters. Snails were kept in appropriate plastic bags containing some water and vegetation from their original habitat. In the laboratory, they were kept in a glass aquarium which was continuously aerated. Some vegetation were placed to keep the water clean for a longer period.

Snails Identification

All collected snails were identified to the lowest taxonomic level using available keys [8-10].

Snail dissecting and heavy metals assessment

Snail dissecting and heavy metals assessment was performed according the procedure described by Park and Presley [11]. The snails were washed with distilled water. The shell was cracked with a hammer. Before analyzing heavy metals, the body was washed with distilled water again and stored at -18°C . Samples (5 g of soft tissue) were digested at 130°C in 10 ml HNO_3 . Then 10 ml HNO_3 and 2 ml HClO_4 were added till the liquid became clear. The digest was gradually evaporated till near dryness, then dissolved in HNO_3 (1M), filtered through Whatman No 1 filter paper (pore size $11\mu\text{m}$), and diluted to about 25 ml with 1M HNO_3 . The resulting solution was analyzed for Cd, Ni, Pb and Cu graphite furnace atomic absorption spectrophotometry.

Control procedure was performed to ensure that the results are reliable. Analytical blanks were prepared in a similar procedure at all metal determinations. All glassware were soaked for two days in a 10% solution of nitric acid, followed by deionized water rinsing.

Statistical analysis

One and two way ANOVA were used for contrasting the differences between the accumulation of Cd, Ni, Pb and Cu in both snail species. The analyses were done by using Statistical Package for the Social Sciences (SPSS Inc, Chicago IL, USA) with values of $P < 0.05$ considered statistically significant.

Results and Discussion

Out of 45 collected snails, only 30 were identified to the species level. Results of identification showed that 15 of them were *Bellamya bengalensis* and the other were *Physella acuta*. Both species were previously recorded in Baghdad [12]. Over the past two decades, the contamination of water with a wide variety of heavy metals has become a matter of considerable concern and many studies have been carried out on heavy metals at all levels of the aquatic ecosystem [13-15]. The concentrations (part per million) of heavy metals (Cd, Ni, Pb and Cu) in the soft tissues of both snails collected in this study are shown in Table-1. Both snails had the ability to accumulate heavy metals (Cd, Ni, Pb and Cu). The mean of Ni concentration in soft tissues of both snails was 1.53 ppm while the mean concentration of Cu, Pb and Cd were 0.51, 0.36 and 0.29 ppm respectively. Statistical analysis showed that the concentration of Ni was significantly ($p < 0.05$) higher than the concentration of other elements.

The presence of high levels of some elements in the soft tissues of the snails could be due to their central roles as components of metabolically important bio-molecules, including some enzymes, metallo-enzymes and respiratory pigments [16]. Specifically, the snail's soft tissues could be the target

structures for Cd, Ni, Pb and Cu as their concentrations surpassed the environmental concentration, suggesting the occurrence of the bioaccumulation process [17]. Aquatic gastropods generally accumulate and store some heavy metals and use it in the synthesis of some pigments. While the total concentration of metals in the snail's soft tissues may be an indicator of metal bioavailability from both anthropogenic and natural sources [18]. Their distribution in different snail soft tissues is more evident in the form that the target organ being sensitive, selective and unique to metal accumulation [19].

Concentrations reported from other aquatic systems cannot be matched with those reported here. The wide variations in metal concentrations observed are a result of seasonal changes, sampling locations, and chemical and physical characteristics [20].

Statistical analysis indicated no significant differences between *B. bengalensis* and *P. acuta* in the ability to accumulate the heavy metals Cd, Ni, Pb and Cu (Table-2). Both snails shared the features of being good bioindicators due to their sensitivity to pollution. These results agree with other studies which showed the *B. bengalensis* and *P. acuta* can be used as good bioindicator for pollution by trace elements in aquatic ecosystem [21- 24]. Finally, it is concluded that both *B. bengalensis* and *P. acuta* can be considered as bioindicator species among aquatic ecosystems. In order to estimate their potential as sentinel animals for heavy metal contamination in aquatic habitats, further studies are still required to investigate the impact of heavy metal contamination on biochemical parameters and fine structure.

Table 1-The average concentrations of heavy metals (Cd, Ni, Pb and Cu) in the soft tissues of both *Bellamyia bengalensis* and *Physella acuta* (n=30) collected from Tigris River.

Groups	Average	Variance
Ni	1.53	0.56
Cd	0.29	0.02
Pb	0.36	0.06
Cu	0.51	0.1

Table 2- The average concentrations of heavy metals (Cd, Ni, Pb and Cu) in the soft tissues of *Bellamyia bengalensis* (n=15) and *Physella acuta* (n=15) collected from Tigris River.

<i>Bellamyia bengalensis</i>	Ni	Cd	Pb	Cu
Count	15	15	15	15
Sum	22.8	5.01	6.32	7.85
Average	1.52	0.334	0.42	0.52
Variance	0.57	0.043	0.08	0.1
<i>Physella acuta</i>	Ni	Cd	Pb	Cu
Count	15	15	15	15
Sum	23	3.765	4.59	7.44
Average	1.53	0.251	0.31	0.5
Variance	0.6	0.004	0.04	0.11

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