

Heavy metal concentration in the components of golden apple snail (*Pomacea canaliculata*) and pond snail (*Filopaludina martensi*)

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Abstract

The objective of this research was to analyze heavy metal bioaccumulation (Cd, Pb, Hg and As) in shell, meat and internal organs of golden apple snail (*Pomacea canaliculata*) and pond snail (*Filopaludina martensi*) by Atomic Absorption Spectroscopy (AAS). The result presented the accumulation of Cd, Pb, Hg and As from *Pomacea canaliculata* shell as 0.0043, 0.0660, 0.6342, 2.5827 mg/g respectively, from meat as 0.0004, 0.0173, non-detected, 0.1693 mg/g respectively and internal organs as 0.0012, 0.0357, 0.0494, 1.0377mg/g respectively. While, the concentration of Cd, Pb, Hg and As in the shell of *Filopaludina martensi* was 0.0039, 0.0567, 0.5933, 2.4663 mg/g respectively, in the meat was 0.0007, 0.0313, 0.0224, 0.2870 mg/g respectively and internal organs was 0.0014, 0.0360, 0.0948, 0.9900 mg/g respectively. The heavy metal accumulations from snail shell are more than meat and internal organs because the major component of shell has CaCO₃ which is exchange of ion between Ca²⁺ with positive ion of heavy metal.

Keywords: heavy metal, bioaccumulation, golden apple snail, pond snail

Article history: Received 18 January 2017, Accepted 27 July 2017

1. Introduction

Golden apple snails are freshwater snail, belonging to Mollusca phylum, Pomacea genus and scientific name is *Pomacea canaliculata*. They are operculum snail with large and smooth shell. The shape and size of golden apple snail is like apple snail (Ampullariidae) as shown in Figure 1. Golden apple snails have a dextral shell, the adult of that snail has a height of 80 millimeters and 112 grams of weight. The snail can move on soil under water by foot or float on surface water. Golden apple snails are omnivores that can consume any type of water plant such as duckweed, water fern, water lettuce, swamp morning glory, water mimosa and algae including animal carcasses in the water [1, 2, 3, 4]. The residents in North and Northeast of Thailand are popular in cooking delicious dishes with golden apple snails such as grilled golden apple snails and spicy salad golden apple snails [5].

Pond snail are freshwater snail same as golden apple snail but they are smaller in size. They belong to Mollusca phylum, with scientific names as *Filopaludina* genus and *Filopaludina martensi*. They are hermaphrodite, having reproductive organs normally associated with both male and female sexes. The snails live in freshwater such as canal, marsh, swamp and river. Pond snails can consume both plant

and animal carcasses [8]. Currently, pond snails are popularly cultivated as crop of the local people because they generates income and easy to breed [9].

Metals and other elements can be naturally present in food or can enter food as a result of human activities such as industrial and agricultural processes. The metals of particular concern in relation to harmful effects on health are arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb). These metals are in part due to the fact that they accumulate in biological tissues, a process known as “bioaccumulation” [10]. Arsenic can lead to chronic arsenic poisoning, skin lesions and skin cancer [11]. Mercury is associated with a wide spectrum of adverse health effects including damage to the central nervous system (neurotoxicity) and the kidney. The toxic effects of lead, like those of mercury. Short-term exposure to high levels of lead can cause brain damage, paralysis (lead palsy), anaemia and gastrointestinal symptoms. Longer-term exposure can cause damage to the kidneys, reproductive and immune systems. Cadmium is toxicity to the kidney, although it has also been associated with lung damage (including induction of lung tumours) and skeletal [10].

Therefore, this research aims to analyze the accumulation of heavy metal in the components of golden apple snail and pond snail which can be useful

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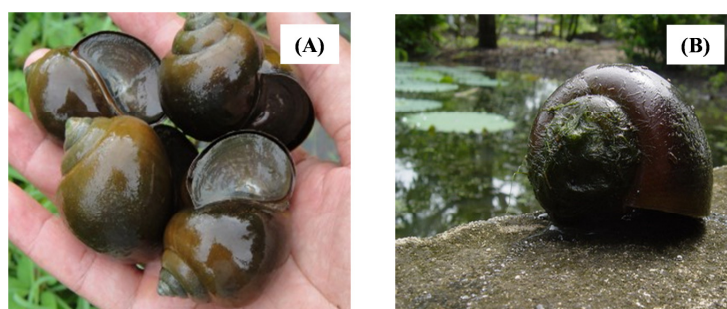


Figure 1 Two types of freshwater snail: (A) Golden apple snail [6] and (B) Apple snail [7]

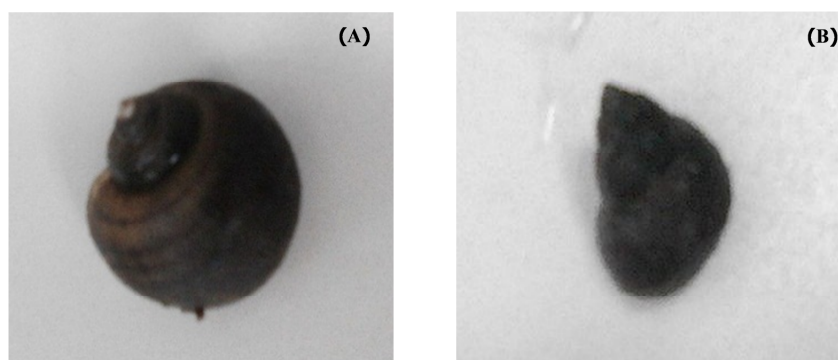


Figure 2 Samples of freshwater snail: (A) Golden apple snail and (B) Pond snail



Figure 3 Location for sampling (Si Racha district, Chon Buri province) [13, 14]

as it provides information for freshwater snail consumer.

2. Research objectives

2.1 To analyze heavy metal in components of golden apple snail and pond snail. 2.2 To compare the concentration of heavy metal from 2 types of freshwater snail with CODEX general standard for contaminants and toxins in food and feed.

3. Methods

3.1 Sampling

This research focus in 2 types of freshwater snail including golden apple snail (*Pomacea canaliculata*) and pond snail (*Filopaludina martensi*) as shown in Figure 1.

Ten golden apple snails and thirty pond snails were collected from paddy field in Si Racha district, Chon Buri province (Figure 2) by large sieve and foam box as shown in Figure 4. They were kept in laboratory at Faculty of Environment and Resource



Figure 4 Large sieve and foam box for collecting the samples



Figure 5 “Powder samples” of freshwater snail: (A) Golden apple snail and (B) Pond snail

Studies, Mahidol University for analyzing heavy metal in each of the specimen component.

3.2 Sample preparation

The samples of golden apple snail and pond snail were made unconscious by anesthesia and decapitated for separating the composition to shell, meat and internal organs. The fresh sample were dried in the oven at 80°C for 24 hours and mashed to powder as shown in Figure 5.

3.3 Heavy metal analysis

The dried composition from each type of snail was digested by mixed solution (65% of HNO₃ concentration + 30% of H₂O₂ concentration) in 2 steps such as: 1) digested at 200°C for 10 minutes 2) digested at 200°C for 15 minutes [12]. The sample solution was analyzed to find the concentration of As, Cd, Hg and Pb by Atomic Absorption Spectroscopy (AAS).

3.4 Analysis of variance (ANOVA)

All information of this research was analyzed by ANOVA Variation at 95% of confidence level.

4. Results

This study analyzes the heavy metal concentration in the components of freshwater snail consisting of golden apple snail and pond snail which are collected from the paddy field at Si Racha district, Chon Buri province, Thailand. The shell of the snail is also included in the study as the shell is a good source of

calcium, which can be used for feeding animals. The results of the study are shown in Figure 6. The result found that concentration of Cd, Pb, Hg and As from golden apple snail shell was 0.0043±0.0001, 0.0660±0.0010, 0.6342±0.0015 and 2.5827±0.0030 mg/g respectively, from meat was 0.0004±0.0001, 0.0173±0.0021, non-detected and 0.1693±0.0006 mg/g respectively and internal organs was 0.0012±0.0001, 0.0357±0.0021, 0.0494±0.0013 and 1.0377±0.0015 mg/g respectively that shows the accumulation of heavy metal from snail shell are more than meat and internal organs due to the major component of shell of snail has CaCO₃ which is exchange of ion between Ca²⁺ with positive ion of heavy metal as shown in equation 1 [15]. Similarly, pond snail, are accumulated with Cd, Pb, Hg and As in shell was 0.0039±0.0002, 0.0567±0.0006, 0.5933±0.0043 and 2.4663±0.0015 mg/g respectively, internal organ was 0.0007±0.0001, 0.0313±0.0012, 0.0224±0.0009 and 0.2870±0.0040 mg/g respectively and internal organs was 0.0014±0.0001, 0.0360±0.0010, 0.0948±0.0021 and 0.9900±0.0017 mg/g respectively.



The result shows that bioaccumulations of heavy metal in freshwater snails shell are more than meat and internal organs. However, the amounts of As, Cd, Hg and Pb in meat and internal organs from

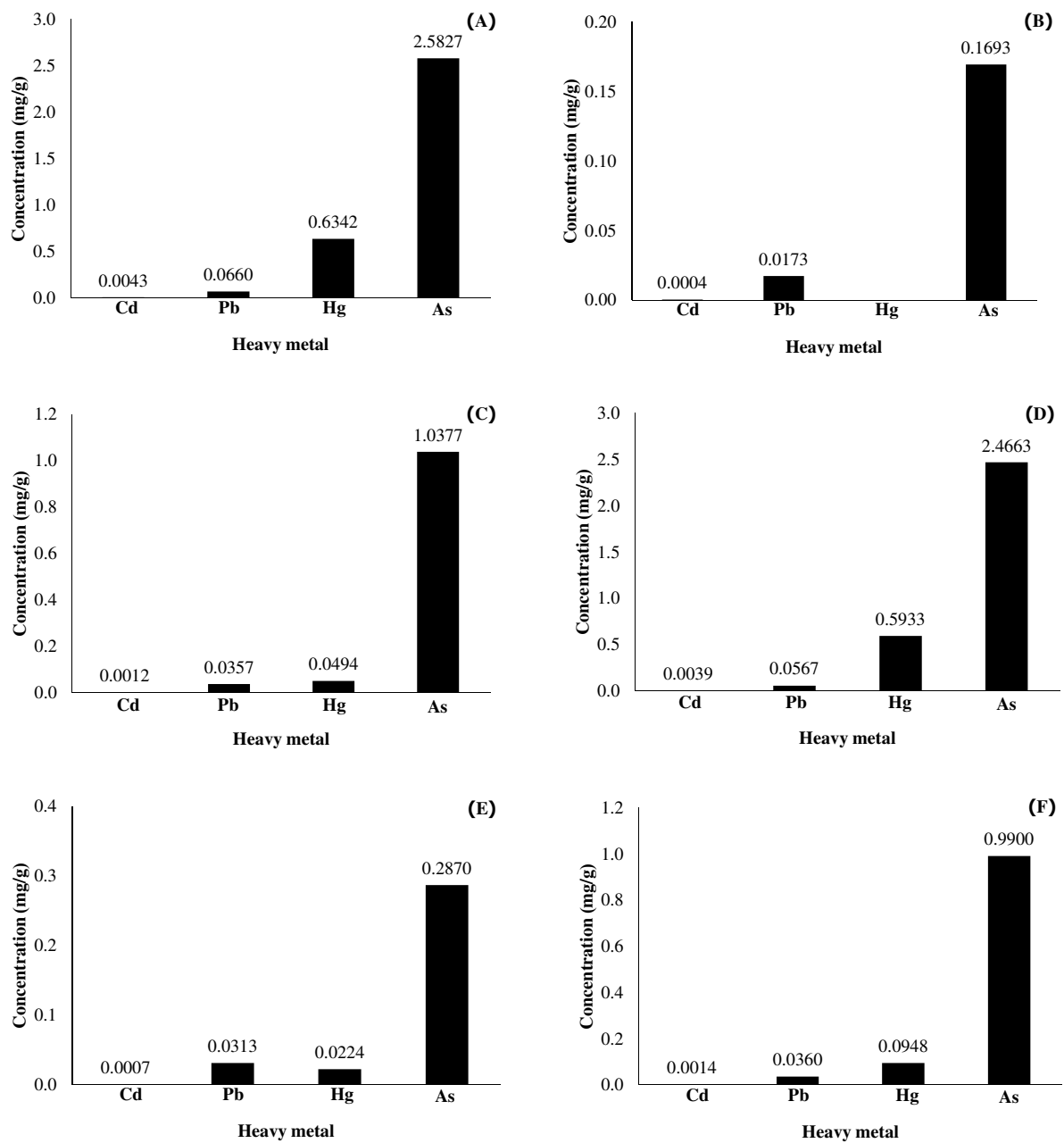


Figure 6 Heavy metal concentration from freshwater snail: (A) Shell of golden apple snail, (B) Meat of golden apple snail, (C) Internal organs of golden apple snail, (D) Shell of pond snail, (E) Meat of pond snail and (F) Internal organs of pond snail

Table 1 ANOVA tested of Cd

Source	Sum of squares	df	Mean square	F	p-value
Snail	1.389E-8	1	1.389E-8	2.083	0.175
Composition	4.286E-5	2	2.143E-5	3214.583	0.000

Table 2 ANOVA tested of Pb

Source	Sum of squares	df	Mean square	F	p-value
Snail	1.250E-5	1	1.250E-5	6.081	0.030
Composition	0.004	2	0.002	1046.676	0.000

Table 3 ANOVA tested of Hg

Source	Sum of squares	df	Mean square	F	p-value
Snail	1.474E-5	1	1.474E-5	2.673	0.133
Composition	1.087	2	0.543	98558.121	0.000

Table 4 ANOVA tested of As

Source	Sum of squares	df	Mean square	F	p-value
Snail	0.020	1	0.020	3624.253	0.000
Composition	17.536	2	8.768	1594186.949	0.000

freshwater snail are above the CODEX general standard for contaminants and toxins in food and feed, that is, the concentration of Cd, Pb, Hg and As must be less than 0.0005, 0.0020, 0.0001 and 0.0005 respectively [16, 17, 18]. This is because the habitats of freshwater snails according to Kiatsayomphu and Chaiklieng found the accumulation of Pb in golden apple snail and pond snail from fishery resource in the overflow marsh [19]. In addition, Thongra-ar (2013) found the Cd accumulation in *Pectinidae* from seacoast in Rayong province is higher than standard for contaminants in food [20].

From Table 1 to Table 4, it can be seen that there is no significant difference with regard to the presence of Cd and Hg between golden apple snail and pond snail but significant difference at 95% of confidence level is found in case of Pb and As. The accumulation of all heavy metals in the shell of golden apple snail are more than pond snail but heavy metal concentration from meat and internal organs of pond snail are more than golden apple snail. In addition, freshwater snails (golden apple snail and pond snail) have all heavy metal concentration with a significant difference ($p\text{-value} < 0.05$) in each of the component.

5. Conclusions

From the above analysis of heavy metal in components of golden apple snail and pond snail, it is found that there is high heavy metal concentration in fresh water snail shell, which is much more than meat and internal organs. However, there is no significant differences with regard to the accumulation of Cd and Hg between golden apple snail and pond snail but significant difference exist with regard to the accumulation of Pb and As. Finally, the study

concluded that heavy metal concentration from meat and internal organs of pond snail are more than golden apple snail.

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