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Analysis of Heavy Metals in Archachatina Marginata and Achatina Fulica Found in Southern Nigeria

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ABSTRACT

The bioaccumulation of heavy metals copper, iron, zinc, cobalt, manganese, nickel, cadmium and lead were determined in the shell and flesh of biota, the African giant snails Archachatinamarginata and Achatinafulica purchased in some markets in southern Nigeria. The snail samples were oven dried, digested and analysed for heavy metals using Atomic Absorption Spectrophotometer (AAS). The results from AAS shows that copper for both shell and flesh in all locations exceed the threshold limit (0.06 mgkg-1). Samples from Iheagwa-Owerri, Imo state was observed to have the highest level of iron (608.34 mgkg-1) in shell while samples from Abak market, Akwa-Ibom state had the highest also in iron (25.76 mgkg-1) but in flesh. Some heavy metals like copper, zinc, and manganese had higher values in flesh while the others had higher values in shell. Zinc concentration were recorded very high for both flesh, and shell values were within threshold limit (15 mgkg-1), this might be as a result of Brass production common in the eastern part of the country. Cobalt was not observed in both shell and flesh in all the locations except for the samples from Osogbo market, Osun state, same is the trend for Nickel. The threshold value for lead and cadmium (0.1 mgkg-1 and 0.06mgkg-1) were exceeded in majority of the shell and flesh. Samples from Iheagwa-Owerri, Imo state showed the highest value of manganese in the flesh which indicates exceeding pollution due to welding activities. The range for the heavy metals analysed for the shell are 5.96 to 67.24 mgkg-1, 41.09 to 608.34 mgkg-1, 0.00 to 4.48mgkg-1, 0.00 to 1.14 mgkg-1, 1.28 to 23.00mgkg-1, 0.00 to 5.28mgkg-1, 0.00 to 1.14mgkg-1, and 0.00 to 3.60mgkg-1 for copper, iron, zinc, cobalt, manganese, nickel, cadmium, and lead respectively. Sample from Iheagwa-Owerri, Imo state showed the highest value of contaminant in the manganese (333.30mgkg-1) which may be an indication of welding activities within that area. It is obvious that the pollution of the environment with heavy metals through improper treatment of waste before discharging into the environment, use of inorganic agrochemicals, and emission from vehicles has increased the level of contamination and thus increases the risk as introduced into the food chain through biota (snail). Therefore, it is highly recommendable that sources of snails must be scrutinized before consumption and snails should possibly be reared in an isolated farm free from pollution so as to reduce the level of contamination and its toxicity owing to its high demand due its medicinal and nutritive value.

Keywords: Heavy metals; *Archachatina Marginata*; *Archatina Fulica*

Introduction

Snails are widely consumed by most of the ethnic groups in Nigeria and rejected by few due to ethnic or traditional belief [1]. Snail farming is yet to become popular in Nigeria, most snails consumed are usually collected in forests and transported to nearby markets. The rapid industrialization and other technological activities within the last 20 – 30 years have resulted in heavy pollution of the environment [2].

Heavy metals contained in the soil find their way into organisms of various trophic levels through detritivores or plants. Although, their accumulation in predatory vertebrates has been confirmed [3], the levels of accumulation for vertebrates do not depend directly on the trophic level or the body size [3, 4]. The metal level is believed to probably be associated with the physiological properties of the species rather than with the trophic level [5].

Terrestrial snails found in the trophic region of Nigeria with the scientific nomenclature Archachatinamarginata, Achatinafulica are air breathing pulmate gastropods of the phylum molluska [6]. Snails are among the gastropod that experience "Torsion" (anatomic twisting or rotation of the visceral mass, mantle and shell to 180°, thus bringing the mantle cavity and anus to anterior position above the head) [7]. During snail's early growth or development in life, it is protected by the shell that is a form of exoskeleton for protection from predators, sun, mechanical damage and muscle attachment [8].

Consequently, snails deposit its excretory products inside the looped shell due to the torsion unlike how it was released outside during the early growth before torsion [6, 8]. The shell of the snails like other gastropods is typically made of calcium carbonate which is secreted by the snail's body part known as mantle [7]. They are known to grow up to 20 cm long and can live to about 10 years. Terrestrial snails are hermaphrodites that hibernate during dry season or drought by covering its body with a dry mucus layer called epiphragm and may estivate during rainy season. Snails that are unable to hibernate during an unfavourable condition can die or its species may even go extinct [6, 8].

"Congo meat" as it is popularly called is a delicacy in high demand in Southern Nigeria and in some West African States because of its rich in protein and iron [1]. Little value was attached to snail before now as a good source of proteinous meat, until it was discovered to have low cholesterol [1, 9]. The low fat and cholesterol content makes snail meat good for use as an antidote for vascular diseases, such as heart attack, cardiac arrest, stroke, and hypertension including whooping cough [10]. Other uses include, elongation of life expectancy, increase in sperm count and testicles size as well as being useful as anti-ageing creams. Mineral composition in other meats like beef, broiler, goat meat, pork, etc have been found to be lower than its occurrence in snails and as such recommended for reduction of constipation, labour pain, blood loss and for diabetic treatment [1, 9].

Materials and Methods

Area of Sampling

A total of 46 snail specimens of varying sizes and ages were purchased from selected markets in southern Nigeria. The selected markets are: Cele Market in Lagos, Ore market in Ondo, Effurun Market in warri, Delta State, Osogbo Market in Osun, Yenagoa Market in Bayelsa, Abak Market in Akwa-Ibom, Nkwegu market in Ebonyi, Benin by-pass market in Edo and Ihiagwa-owerri in Imo State. Snail samples were purchased and transported with High-Density Polyethylene (HDPE) sample containers (rectangular boxed bowel) between January and February 2014. They were purchased from the selected market because they are easily consumed in the area without any religious or cultural restriction. Snail samples were collected without consideration of age or size [10-15].

Apparatus and Reagent

The apparatus used for the entire analysis from the preservation to the analysis are as follows, High-Density Polyethylene (HDPE) containers for the sample collection and transportation, refrigerator, indelible marker, laboratory oven, mortar and pistol, paper tape, glass beakers, conical flasks, foil paper, measuring cylinder, measuring flask, forceps, thermometer, laboratory hot plate, fume cupboard, analytical balance, Atomic Absorption Spectrophotometer (AAS), spatula, hand gloves, nose mask, whatman filter paper,

plastic funnels, High-Density Polyethylene (HDPE) sample containers, High-Density Polyethylene (HDPE) sample bottles, and wash bottle [15-20]. The reagents and solvent used include, distilled water, Sodium chloride (Nacl), concentrated hydrochloric acid (Hcl), and concentrated Nitric acid (HNO3).

Identification and Preservation

The specimens were identified as *Archachatinamarginata,* and *Achatinafulica*, belonging to the same family, *Achatinidae* in the Department of Zoology, Federal University of Agriculture, Abeokuta. They were washed with distilled water and preserved in the refrigerator with High-Density Polyethylene (HDPE) sample container to the temperature of -18°c after collection prior to digestion and analysis. The purchased samples were collectively labelled with alphabets according to the source of collection which are as follow: A – Cele market in Lagos State; B – Ore market in Ondo State; C – Iheagwa, Owerri, in Imo State; D – Effurun market, warri in Delta State and E – Osogbo market in Osun state. Other location include: F – Yenagoa market in Bayelsa state; G – Abak market in Akwa-Ibom state; H – Nkwoegu market in Ebonyi state and I – Benin by pass market in Edo state.

Analysis of Metals

The labelled High-Density Polyethylene (HDPE) bottle were then taken to laboratory for metal analysis using Atomic Absorption Spectrophotometer (AAS) equipment made by Thermo Fisher, USA. The following metals were analysed from the samples for both shell and flesh: cadmium (Cd), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Z)

Results

The mean values of heavy metals obtained from the analysed snails' Shell (S) are presented in Table 1, while that of Flesh (F) are presented in Table 2 with AS – IS and AF – IF representing the sampling locations respectively for shell and flesh.

Location	Cadinium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Zinc
AS	0.66	0.00	7.02	107.67	4.15	2.75	3.38	3.54
BS	1.14	0.00	12.49	174.73	14.38	0.00	0.22	3.28
CS	0.14	0.00	7.24	41.09	23.00	0.00	0.93	0.97
DS	0.93	0.00	15.69	174.73	12.40	5.28	0.31	3.38
ES	0.00	1.14	67.24	41.09	1.28	2.09	1.77	0.00
FS	1.05	0.00	8.25	91.86	10.40	0.00	0.00	2.16
GS	1.04	0.00	5.96	414.94	7.43	0.00	3.60	4.48
HS	0.00	0.00	10.55	64.48	5.25	0.00	0.00	3.43
IS	0.43	0.00	6.82	170.61	7.46	0.00	3.59	0.03

Where AS - Cele Market, Lagos; BS - Ore market, Ondo; CS - Iheagwa-Owerri, Imo; DS- Effurum market, Warri, Delta; ES - Osogbo market, Osun; FS - Yenegoa market, Bayelsa; GS - Abak market, Akwa-Ibom; HS - Nkwoegu market, Ebonyi; IS - Benin by pass market

Table 1: Concentration of Metal Elements in The Shell of African Gaint Snail in Mgkg

Location	Cadinium	Cobalt	Copper	Iron	Manganese	Nickel	Lead	Zinc
AF	1.07	0.00	43.84	101.95	136.62	0.00	1.29	80.62
BF	14.74	0.00	78.94	90.44	311.81	0.00	3.91	71.99
CF	3.08	0.00	73.00	113.73	333.3	0.00	2.81	82.24
DF	0.03	0.00	67.28	139.12	229.71	0.00	4.13	56.86
EF	2.62	0.00	63.33	153.69	123.6	0.00	4.02	75.44
FF	3.23	0.00	73.23	327.11	85.47	0.00	4.27	48.14
GF	1.42	0.00	93.58	25.76	308.35	0.00	0.23	93.77
HF	0.06	0.00	66.57	144.43	204.25	0.00	1.53	164.00
IF	1.98	0.00	76.58	119.55	145.54	0.00	12.78	55.50

Where AF - Cele Market, Lagos; BF - Ore market, Ondo; CF - Iheagwa-Owerri, Imo; DF - Effurun market, Warri, Delta; EF - Osogbo Market, Osun; FF - Yenegoa market, Bayelsa; GF - Abak market, Akwa-Ibom; HF - Nkwoegu Market, Ebonyi; IF - Benin by pass market

Table 2: Concentration of Metal Elements in The Flesh of African Gaint Snail in $Mgkg^{-1}$

Discussion

Heavy Metal Concentration of Snails' Shell Samples

From the result, copper recorded the highest value of 67.24 mgkg-1 and lowest of 5.96 mgkg-1 in samples purchased from Osogbo market, Osun state and Abak market, Akwa-Ibom.

Out of all metals analysed for, Iron recorded the highest value of 608.34 mgkg-1 in sample from Iheagwa-Owerri, Imo state, while 41.09 mgkg-1 was observed for sample from Osogbo market, Osun state.

The range values of Zinc concentration are 0.00 - 4.48 mgkg-1 observed for samples from Osogbo market, Osun state and Abak market, Akwa-Ibom state respectively as seen in Table 1.

However,Cobalt concentrations for all the locations which were not significant except for samples from Osogbo market, Osun state which recorded 1.14 mgkg-1.

Meanwhile, mean values of Manganese range between 23.00 mgkg-1 for samples from Iheagwa-Owerri, Imo state and 1.28 mgkg-1 for samples from Osogbomarket, Osun state.

The mean values of Nickel concentration in snail shell samples. Samples from Effurun market, Warri, Delta state, Osogbo market, Osun state and Cele market, Lagos state are 5.28 mgkg-1, 2.09 mgkg-1 and 2.75 mgkg-1. It was observed that other locations recorded 0.00 mgkg-1.

Meanwhile, the highest value of 1.14 mgkg-1 of Cadmium was recorded for samples from Ore market, Ondo state while 0.00 mgkg-1 was recorded for both samples from Osogbo market, Osun state and Nkwoegu market, Ebonyi state.

Taking a cue from Cadmium concentration shown above, samples from Osogbo market, Osun state and Nkwoegu market, Ebonyi state also recorded 0.00 mgkg-1 for Lead while samples from Abak market in Akwa-Ibom state recorded 3.60 mgkg-1.

Heavy Metal Concentration in Snails' Flesh Samples

The highest value of 93.58 mgkg-1 and lowest of 43.84 mgkg-1 were observed in samples purchased from Abak market, Akwa-Ibom state and Cele market, Lagos state.

For Iron concentration. It can be observed that samples purchased from Yenegoa market, Bayelsa state gave the highest value of 327.11 mgkg-1 while that of Abak market, Akwa-Ibom state being the lowest is 25.76 mgkg-1.

However, for Zinc concentration, samples from Yenegoa market, Bayelsa state yielded least value of 48.14 mgkg-1 while the ones from Nkwoegu market, Ebonyi state yielded highest value of 164.00 mgkg-1 as shown in Table 2.

All locations flesh samples gave no significant value with respect to Cobalt and Nickel concentration as presented on Table 2.

A totally different trend is observed for Manganese as shown on table 2. The highest value of 333.30 mgkg-1 is recorded from the sample purchased from Iheagwa-Owerri, Imo state and the lowest is 85.47 mgkg-1 for samples from Yenegoa market, Bayelsa state. Meanwhile, the range of Lead concentration is 12.78 mgkg-1 – 0.23 mgkg-1 for Benin by pass market, Edo state and Abak market, Akwa-Ibom state respectively according to Table 2.

Conclusion

There is growing concern on effects of heavy metals on human health and hence this has led to increase in research upon the flora and fauna upon which humans feed [21-23].

The results of this study have confirmed that:

The concentration of heavy metals in flesh samples were higher than in shell samples for copper, zinc, manganese, lead, and cadmium. This implies that the aforementioned heavy metals have bioaccumulate in the snails' flesh while for other heavy metals concentration for shell samples were higher.

The highest concentration was found in shell samples from Effurun market, Warri, Delta. This might be as a result of activities taking place in that part of the country. It is to be noted that although, iron is very essential but at this very high concentration it is toxic.

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