IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 3 Ser. II (March 2021), PP 27-35
www.iosrjournals.org

Heavy Metals and Parasites in African Giant Snail (*Achatina achatina*) from Three Communities in Ogoni, Rivers State, Nigeria.

Eze, Chinwe N. and Ohanele, O. O,
Department of Animal and Environmental Biology, Faculty of Science
University of Port Harcourt. PMB5323, Port Harcourt, Rivers State, Nigeria.

Abstract
African Giant snail (Achatina achatina)adelectable source of protein, good accumulator of heavy metals and a host to number of parasites was investigated to assess the parasite infestation and level of heavy metal concentration (Zn, Cr, Cd, Pb) in three communities located in Ogoni. Thirty (30) A. achatina were handpicked from June to October 2019. Their intestine, reproductive and head regions were examined for presence of parasites. The snail samples were also analysed for heavy metals. Seven types of parasites were identified and 80% of the snails examined were infected with parasites. Snails picked from Luubaara community had the highest prevalence of infection with 44% followed by Eeken with 31%, and Kaani with 25%. Cestodes where the most prevalent parasites being 67%, followed by nematodes 30% and arachnida 3%. Distribution of the parasite shows thatDiphyllobothrium latum had the highest prevalence of 53%and the least was Mite egg with 3%. The examined regions had the intestine with 50% of parasites, followed by the head region with 28% and the reproductive system with 22%. Zinc(Zn) had the highest concentration across the communities, followed by Chromium(Cr), Cadmium(Cd) was below detection limit (<0.001) while Lead(Pb) was not detected at all. The results showed that the metals were within the permissible safe limits of FAO/WHO. The high level of parasites infections could pose a serious problem to consumers of snails. Proper preparation of snails before consumption and continuous monitoring of heavy metals on edible snails are highly recommended.
Keywords: *African giant snail (Achatina achatina), parasite infestation, heavy metals.*

Date of Submission: 10-03-2021 Date of Acceptance: 25-03-2021

I. Introduction

Achatina achatina, one of the edible land snails found across Nigeria, has over the years been a source of food and protein to humans. It also serves as host to some pathogenic parasites, serving as their food and shelter. Increase in the consumption of snail is on the rise in Nigeria, because people are looking for ways to live and stay healthy cutting down on red meat [1]. *Achatina achatina* which offers an optimum amount of protein required by man, is low in fat and has comparatively good iron (Fe) content [2]. Most snails sold and consumed in Nigeria are mainly obtained from the bushes, forest or handpicked around the environment, very few are reared, hence making them good host in harbouring parasites. Daily increase in consumption of snails especially when undercooked or eaten raw could be a transmission route where man can be infected with parasites [3].

The link between African Giant snail *(Achatina achatina),* its parasites and heavy metals found in the soil is through feeding activities and skin contact of the snail with the soil surface [4,5]. The parasites and heavy metals are taken in by the snails during feeding through consumption of dead plants, litters, fungi and soil or through their epithelium. Studies have shown that African giant snail has been used as biological indicator in areas polluted with heavy metals. They have been noted to concentrate and accumulate high level of metals in their organs when found in polluted areas, mostly in the hepatopancreas [4,5].

Being a phytophagous gastropod, it can be a good biological indicator of heavy metals in crop plants and soil, for heavy metals like cadmium(Cd) to which the general population is exposed mainly through the food chain [6]. It is therefore of great importance that the metal concentrations in agricultural crops are kept in check. Also, from the parasitology and public health standpoint, *Achatina achatina* is of significance since it is potentially an intermediate vector in the life cycle of the common rat lungworm *Angiostrongylus cantonensis*, which is a causative organism of human Eosinophilic *meningoencephalitis* [7]. It also serves as a host to the Rhabditid nematode, *Rhabditis axei*[1].

It had been previously documented that some nematode parasites have a great bioaccumulation efficiency of metals, whereas others have a low efficiency of absorbing metals [8]. This variability in the rate of accumulation may be linked to the proximity of tissues to toxic medium, physiological state of the tissues, structural and function of organs and the presence of ligands in tissues of organs having a natural attraction to the heavy metal [9,10, and 11]. Until recently, little was known regarding the accumulation of toxins within parasites [12].It has been reported that chronic exposure to pollutants over a period of time causes physiological, behavioural and biochemical host changes that can ultimately influence the prevalence and intensity of parasitism [13].

Therefore, the study is designed to investigate the different types of parasites inhabiting *Achatina achatina*, the level of infection and to assess the concentration of heavy metals in the tissues of the African giant snails collected from three communities in Ogoni, Rivers State, Nigeria.

II. Materials and methods

Study Area

Ogoni land is located in Rivers State on the coast of the Gulf of Guinea, East of the City of Port Harcourt. UNEP (2011) recorded a population close to 832,000 and they live in a 404-square-mile (1,050 km2) in the South-East of the Niger Delta Basin. The present study was conducted in three (3) communities in Ogoni landLuubaara Community (Longitude 04 °38.733" N, Latitude 007 °27.227" E)Eeken Community (Longitude04 °47.433" N,Latitude 006 °58.605" E) Kaani Community(longitude 04 °41.018" N, latitude 007 °22.160" E).

Sample collections

Sampling was carried out from June to October 2019 and a total of 30 *Achatina achatina* were collected, 10 snails eachwere randomly handpicked from the three (3) communities, (Luubaara, Eeken and Kaani) in Ogoni, Rivers State. The snails were conveyed to the laboratory using small containers with good aeration.

Plate 1.*Achatina achatina* before it was dissected.

Plate 2.*Achatina achatina* after the removal of shell.

Snail Identification and Dissection

The snails were sorted and identified to specie. A total of ten (10) snails each where selected from the three (3) different communities. Their shells were removed to expose the foot, the soft tissues and visceral materials. Various region of the gastro-intestinal tract such as the intestine, the reproductive tract and the head region were isolated in petri dishes that contained 0.9% normal saline. The dissecting needle was used to open up the separated organs which were teased inside the petri dishes to release the parasites into the normal saline and persevered in 5% formalin for further preparation and examination.

Parasitological Investigation

Wet Mount Technique

A pipette was used to transfer a drop of the sample to a slide, then a cover slip was carefully placed over the drop. The microscope was set on the low magnification power (10x) and the slide was placed on the microscope stage, the condenser was adjusted to lower the light and resolution, at this magnification parasite were barely discernible. Then high dry-lens magnification (40x) was used, with the light and focus carefully increased till parasite size, shape and motility could be seen. Then observations were recorded, [14].

Formal-Ether Concentration Technique

The previously preserved samples were sieved through a sieve collecting the suspension in a beaker, then transferred into a test tube and centrifuged at 1500 revolution per minute (rpm) for four (4) minutes. Then about three millilitres (3mls) of formal saline was added and one mil (1ml) of ether was added afterward and thoroughly mixed/shaken. The mixture was centrifuged at 1500rpm for three (3) minutes again, using a stick bulb layers of debris from the side of the tube, the test tube was inverted to discard the supernatant and immediately returned to its upright position to allow the sediment to settle at the bottom of the test tube. A pipette was used to drop about 0.5ml of the sediment on a grease free microscope slide, then covered with a cover slip and examines under the microscope using 10x and 40x objective of the microscope, [14].

Identification of Parasites of *Achatina achatina*

The parasites were identified by the characteristics of their eggs, shape, cysts and other morphological features, using Standard Diagnostic Laboratory Manuals (Bayou,2005) and Parasitological Atlas [14].

Heavy Metal Analysis

Wet Acid Digestion method was used to digest the samples before transferring them to an Atomic Absorption Spectrophotometer (AAS) machine [15].

Wet Acid Digestion

1 gram of the sample was weighed, 10mls of nitric acid and 1ml of hydrochloric acid was added respectively. The samples were digested till it became colourless. Distilled water was then used to dilute the solution of the digested sample to 50ml. The solution was filtered with a filter paper in other to avoid blockage of the injector nozzle by digested particles. Atomic absorption spectrophotometer machine was then used to analyze the solution for metal ion.

Statistical Analysis

Prevalence of parasites recovered was subjected to statistical analysis using SPSS version 20 and data obtained were analyzed using *t*-test. Significant level was set at 0.05.

III. Results

The resultobtained revealeda high parasitic prevalence across the three sampled communities in Rivers State. Nine (9) out of the 10 sampled snails in Luubaara community were infectedindicating 90% prevalence rate in the community compared to the 10% non-infected snails. Result from Eeken Community showed 80% of the sampled snails were infected with just 20% uninfected snails while result from Kaani Community showed that 70% of the snails were infected(Table 1). The overall parasites infection in the sampled snails showed 80% prevalence and cestodes were the most prevalent parasites recovered across the three communities.

In Luubaara Community, 16 parasites were identified from the 10 snails sampled. The parasites identified includes *Diphyllobothrium latum*6(60.0%), *Hymenolepis sp.* 6(60.0%), *Trichostrongylus sp.*3(30.0%), *Oesophagostomum sp.*1(10.0%),75% of the parasites found in Luubaara were cestodes, while 25% were nematodes. *Diphyllobothrium latum* and *Hymenolepis sp.,* were the most prevalent parasites in Luubaara Community. Heavy metal analysis showed that Zn had the highest concentration with a mean concentration of 22.70mg/kg. Cd recorded the lowest with a mean concentration of -0.03mg/kg, while Pb was absent (Table 2).

Eleven(11) parasites were identified from the 10 snails sampledin Eeken Community. Parasites identified were*Diphyllobothriumlatum*6(60.0%), *Hymenolepis sp.*1(10.0%), *Trichostrongylus sp.1*(10.0%), *Oesophagostomum sp.* 1(10.0%), and *S. stercoralis larva*2(20.0%), 64% of the parasites found in Eeken were cestodes while 36% were nematodes. *Diphyllobothrium latum* had the highest prevalence followed by *S. stercoralis larva.* Heavy metal analysis as shown in Table 2, Zn had the highest concentration in Eeken community with a mean concentration of 28.06mg/kg, Cd recorded the lowest with a mean concentration of -0.27mg/kg, Pb was not found at all.

In Kaani Community nine (9) parasites were identified from the 10 snails sampled. The parasites identified include *Diphyllobothrium latum*4(40.0%), *Hymenolepis sp.* 1(10.0%),*S. stercoralis larva*2(20.0%), *Dictyocaulus sp* 1(10.0%), *Mite egg* 1(10.0%).Heavy metal analysis on the sampled snails indicated that Zn had the highest concentration with a mean concentration of 24.89mg/kg, while Cd had the lowest with a mean concentration of -0.03mg/kg, Pb was not found (Table 2).

Intestine, reproductive and head region of the snails were isolated and the parasites found in them were identified. In Luubaara community nine (9) parasites were found in the intestine of the sampled snails, three (3) in the reproductive organs and six (6) in the head region. *Hymenolepis spp.* was more prevalent in the intestine and reproductive organs while *Diphyllobothrium latum* was the most prevalent in the head region. 50% of the parasites identified were found in the intestine, making it the most infected part of the sampled snails (Table 3). In Eeken Community, six (6) parasites were found in the intestine, four (4) in the reproductive organs and three (3) in the head region. *Diphyllobothrium latum* was the most prevalent parasite reported in the intestine and head region. 46% of the parasites identified were found in the intestine While in Kaani Community, five (5) parasites were found in the intestine, two (2) in the reproductive organs and two (2) in the head region. *Diphyllobothrium latum* and *S. Stercoralis larva* were the most prevalent parasite identified. 56% of the parasites identified were found in the intestine. Luubaara Community was the most infected among the three (3) sampled communities and *Diphyllobothrium latum* was the most prevalent parasite identified across the three (3) communities Table 3.

In Luubaara Community,Sample L7 (35.66mg/kg) had the highest level of Zinc (Zn) concentration while sample L2 (15.22mg/kg) had the least. For Chromium (Cr) sample L3 (2.17mg/kg) had the highest concentration, while sample L1(-0.002mg/kg) had the least. Cadmium (Cd) concentration was insignificant, while Lead (Pb) was not detected at all. Mean and standard error of zinc concentration for Luubaara was 22.70 ± 1.88, Chromium 0.43 ± 0.25 and Cadmium -0.03 ± 0.01Table 4. In Eeken community, Zinc (Zn) recorded the highest in metal concentration in the snails analysed. Sample E9 had the highest level of Zinc (Zn) concentration (55.85mg/kg), while sample E1(18.51mg/kg) had the least. For Chromium (Cr) some sample had insignificant concentration, while some were not detected at all. The Cadmium (Cd) concentration was insignificant, while Lead (Pb) was not detected at all. Eeken community recorded the highest level of Zinc (Zn) across the communities. Mean and standard error of zinc concentration for Eeken is 28.06 ± 3.51, Chromium -0.003 ± 0.002 and Cadmium is -0.03 ± 0.01Table 5.

In Kaani Community, Zinc (Zn) recorded the highest in metal concentration in the snails analysed. Sample K2 (42.71mg/kg) had the highest level of Zinc (Zn) concentration, while sample K3 (15.76mg/kg) had the least. For Chromium (Cr) two (2) sample had Chromium (Cr) detected in them while other samples where either insignificant or not detected at all. The Cadmium (Cd) concentration was insignificant, while Lead (Pb) was not detected at all. Sample K2 in Kaani community recorded the highest level of Chromium across the various communities. Mean and standard deviation of zinc concentration for Kaani was 24.89 ± 2.84, Chromium 1.22 ± 1.17 and Cadmium -0.03 ± 0.01.

Table 1. Prevalence of snail infection with parasites by location and class

Community	Number Examined	Number Infected (%)	Number Uninfected (%)	Class of Parasites			
				Cestode (%)	Nematode (%)	Arachnida (%)	Total
Luubaara	10	9 (90.0)	1 (10.0)	12 (75.0)	4 (25.0)	0	16 (44.0)
Eeken	10	8 (80.0)	2 (20.0)	7 (64.0)	4 (36.0)	0	11 (31.0)
Kaani	10	7 (70.0)	3 (30.0)	5 (56.0)	3 (33.0)	1 (11.0)	9 (25.0)
Total	30	24 (80.0)	6 (20.0)	24 (67.0)	11 (30.0)	1 (3.0)	36 (100.0)

Table 2. Distribution of Parasite prevalence and Heavy Metals by location

Community	No. Exam.	*D. latum*	*Hymen.*	*Trichos*	*Oesoph*	*S.sterco*	*Dictyo*	*Mite*	Cr	Zn	Cd	Pb
Luubaara	10	6 (60.0)	6 (60.0)	3 (30.0)	1 (10.0)	-	-	-	0.43 ± 0.25	22.70 ± 1.88	-0.03 ± 0.01	-
Eeken	10	6 (60.0)	1 (10.0)	1 (10.0)	1 (10.0)	2 (20.0)	-	-	-0.003 ± 0.002	28.06 ± 3.51	-0.27± 0.01	-
Kaani	10	4 (40.0)	1 (10.0)	-	-	2 (20.0)	1 (10.0)	1 (10.0)	0.05 ± 0.01	24.89 ± 2.84	-0.03 ± 0.01	-
Total	30	16 (53.0)	8 (27.0)	4 (13.0)	2 (7.0)	4 (13.0)	1 (3.0)	1 (3.0)				

No. Exam. - Number Examined, D.latum-Diphyllobothrium latum, Hymen- Hymenolepis sp., Trichos-Trichostrongylus sp., Oesoph- Oeso *phagostomum sp., S. strerco-S. stercoralis larva, Dictyo- Dictyocaulus sp., Mite- Mite egg. Cr- Chromium, Zn-Zinc, Cd- Cadmium, Pb-Lead. FAO/WHO- Food and Agriculture Organisation/ World Health Organisation. FAO/WHO limit for Zn – 2.3g/kg, for Cr – 1.0mg/kg, for Cd – 0.03mg/kg, and for Pb 1.5mg/kg.*

Table 3. Distribution of the parasites according to the organs of the snails

Community	Parasites	**Organ Infestation**			
		Intestine (%)	Reproductive(%)	Head (%)	Total
Luubaara n = 10	*Diphyllobothrium latum,*	4 (40.0)	0 (0.0)	3 (30.0)	
	Hymenolepis sp.,	5 (50.0)	2 (20.0)	0 (0.0)	
	Trichostrongylus.	0 (0.0)	1 (10.0)	2 (20.0)	
	Oesophagostomum	0 (0.0)	0 (0.0)	1 (10.0)	
	Total	9(50.0)	3(17.0)	6(33.0)	18
Eeken n = 10	*S. stercoralis larva*	1 (10.0)	1 (10.0)	0 (0.0)	
	Diphyllobothrium latum,	4 (40.0)	1 (10.0)	3 (30.0)	
	Oesophagostomum	1 (10.0)	0 (0.0)	0 (0.0)	
	Hymenolepis sp.,	0 (0.0)	1 (10.0)	0 (0.0)	
	Trichostrogylus.	0 (0.0)	1 (10.0)	0 (0.0)	
	Total	6 (46.0)	4 (31.0)	3 (23.0)	13
Kaani n = 10	*Diphyllobothrium latum,*	2 (20.0)	1 (10.0)	1 (10.0)	
	Hymenolepis sp.,	1 (10.0)	0 (0.0)	0 (0.0)	
	S. stercoralis larva	2 (20.0)	0 (0.0)	0 (0.0)	
	Mite egg	0 (0.0)	1 (10.0)	0 (0.0)	
	Dictyocaulus	0 (0.0)	0 (0.0)	1 (10.0)	
	Total	5 (56.0)	2 (22.0)	2 (22.0)	9
	Overall Total	20 (50)	9 (22.0)	11 (28.0)	40

Table 4. Parasites identified and concentration of Cr, Zn, Cd and Pb in snails picked from Luubaara Community

S/N	Sample Identity	Parasites Identified	Cr (mg/kg)	Zn (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
1	L1	*Hymenolepsis spp., Trichostrongylus spp.*	-0.002	19.83	-0.03	ND
2	L2	*D. latum*	1.58	15.22	-0.04	ND
3	L3	*D. latum, Hymenolepsis spp.*	2.17	23.27	-0.01	ND
4	L4	*D. latum, Hymenolepsis spp.*	0.73	27.47	-0.03	ND
5	L5	*Hymenolepsis spp., D. latum*	-0.08	15.28	-0.01	ND
6	L6	*Hymenolepsis spp., D. latum*	-0.09	23.83	-0.05	ND
7	L7	*Trichostrongylus spp.*	ND	35.66	-0.02	ND
8	L8	*Hymenolepsis spp.*	ND	21.71	-0.07	ND
9	L9	-	ND	20.64	-0.06	ND
10	L10	*D. latum, Trichostrongylus spp. Oesophagostomum spp.*	-0.03	24.06	-0.01	ND
	Mean/standard error		0.43 ± 0.25	22.70 ± 1.88	-0.03 ± 0.01	-
	Standard deviation		0.925	5.950	0.0211	-

Cr- Chromium, Zn- Zinc, Cd- Cadmium, Pb-Lead, ND- Not detected.

Table 5. Parasites identified and concentration of Cr, Zn, Cd and Pb in snails picked from Eeken Community

S/N	Sample Identity	Parasites identified	Cr (mg/kg)	Zn (mg/Kg)	Cd (mg/kg)	Pb (mg/Kg)
1	E1	*D. latum*	- 0.06	18.51	-0.001	ND
2	E2	*S. stercoralis larva, D. latum*	- 0.03	25.05	-0.01	ND
3	E3	-	ND	21.74	-0.02	ND
4	E4	*Oesophagostomum spp., D. latum*	ND	25.16	-0.053	ND
5	E5	*Hymenolepsis spp.*	ND	30.11	-0.03	ND
6	E6	*S. stercoralis larva*	-0.01	36.11	-0.03	ND
7	E7	-	ND	26.98	-0.07	ND
8	E8	*D. latum*	ND	19.64	-0.03	ND
9	E9	*D. latum, Trichostrongylus*	ND	55.85	-0.01	ND

10	E10	*D. latum*	-0.02	21.40	-0.013	ND
	Mean/standard error		-0.003 ± 0.002	28.06 ± 3.51	-0.03 ± 0.01	-
	Standard deviation		0.0211	11.087	0.021	-

Cr- Chromium, Zn- Zinc, Cd- Cadmium, Pb-Lead, ND- Not detected.

Table 6. Parasites identified and concentration of Cr, Zn, Cd and Pb in snails picked from Kaani community

S/N	Sample Identity	Parasite identified	Cr (mg/kg)	Zn (mg/Kg)	Cd (mg/kg)
1	K1	*D. latum*	ND	16.17	-0.001
2	K2	*D. latum*	1.71	42.71	-0.02
3	K3	-	-0.01	15.76	-0.05
4	K4	*D. latum*	ND	19.65	-0.01
5	K5		-0.09	33.56	-0.001
6	K6	*Hymenolepsis spp.*	ND	19.75	-0.02
7	K7	*S. stercoralis larva, D. latum*	ND	20.36	-0.09
8	K8	-	ND	25.44	-0.08
9	K9	*Dictyocaulus sp.*	ND	21.42	-0.03
10	K10	*S. stercoralis larva, Mite egg.*	0.62	34.09	-0.01
	Mean/standard error		0.05 ± 1.17	24.89 ± 2.84	-0.03 ± 0.0
	Standard deviation		5.777	8.966	0.032

IV. Discussion

The present investigation on assessment of heavy metals and parasites of *Achatina achatina*from three (3) communities in Ogoni, Rivers State revealed that majority of the snails examined were infested with parasites. The findings from this work is not far from the results of a studymade by Igbinosa*et al*. [16], on parasites of edible snails in four (4) communities in Edo State, the total result for *Achatina achatina* infected with parasites were 58.33%. Karamoko*et al.*[17] reported52% prevalence in their study on Giant Snails for Parasites in a South-East Region of Côte d'Ivoire. This study revealed that 67% of the parasites recovered were cestodes, 30% nematodes and 3% arachnida, this differs with the findings of [17] who reported helminths (95.8%) and trematodes (4.1%)in their study.

Diphyllobothrium latum known as the broad tapeworm was the most prevalent parasite identified across the three (3) communities, they were found in the intestine and head region of snails found in Luubaara, and also in intestine, reproductive and head region of snails picked from Eeken and Kaani. This finding differs with the results of [17] who recorded *Balantidium spp*, larva of *Protostrongylus spp*, larva of *Dicrocoelium* spp as well as *Trichomonas spp* as the dominant parasites in their study conducted in South Eastern region of Cote D'Ivoire. The variations recorded in these works can be attributed to difference in study locations as both study were conducted in different countries though in the West Africa region, as parasites prevalence and species differs across different geographical settings. *Strongyloides stercoralis* larvae which are parasitic nematodes were seen in intestine and reproductive organs of snails found in Eeken and intestine of snails picked in Kaani communities. This is in line with other previous study of Igbinosa *et al.*[16]who investigated on parasites of edible land snails in Edo and it was the most prevalent parasite found in the study.

According toIgbinosa*et al*. [16]morphologically,*Strongyloides stercoralis* could readily penetrate snail foot or any exposed area and infect the visceral organs.

Hymenolepis spp. known as dwarf tapeworm are found mainly in areas with poor hygiene and sanitation. In this study, they were identified in intestine and reproductive organ of snails picked from Luubaara, reproductive organ of snails picked from Eeken and intestine of snail picked from Kaani.*S. stercoralis* and *F. gigantica*where also identified in the intestine of *Achatina achatina*[16]. *Hymenolepis spp.* is the most common cestode of humans found mainly in young children [19]. Heavy infections with *Hymenolepis nana* can cause diarrhoea, abdominal pain, headaches, anorexia and weakness [20].*Trichostrongylus spp.* was found in the reproductive and head region of snails picked from Luubaara and in the reproductive organs of snails picked from Eeken. This is in disparity with the report of Igbinosa *et al*., Karamoko *et al*. [16, 17] who reported no parasite in the reproductive organ of *Achatina achatina*. Human infections are mostly without symptoms, however in severe cases the larvae and adult form can cause tissue damage and inflammation of the bowel mucosa. Symptoms are abdominal pains, flatulence, nausea and diarrhea. Heavy load of worms can lead to anaemia and eosinophilia [21, 22]. *Oesophagostomum spp.* known as nodule worm because of the nodules that form on the intestine of the host infected was found in the head region of a snail picked from Luubaara and in the intestine of snail picked from Eeken community. However, *Prostostronggylus spp.*was recoveredin the intestine of *Achatina achatina*[17].*Dictyocaulus spp.*, parasitic nematode known as lungworm of cattle, sheep, goats and other livestock was found in the head region of snail picked from Kaani. Typical symptoms are heavy coughing, nasal discharge and difficulty in breathing. Severe infections can also cause pneumonia and pulmonary edema, [24].

Zinc had the highest concentration among the heavy metals examined across the three (3) communities, it had its mean values as 22.70mg/kg, 28.06mg/kg and 24.89mg/kg for Luubaara, Eeken and Kaani respectively. This similar results were observed in astudy on human health risk assessment of heavy metals in snails (*Archachatina marginata)* from four contaminated regions in Rivers State, Nigeria [25], their concentration of Zn ranged from 11.6 – 27.6mg/kg. According to Beatrice [26] who reported 7.58 to 13.10mg/kg mean concentration of Zn in a study on heavy metal determination and investigation of nutritional composition in three species of snail collected from Edo, Zaria and Kaduna states in Nigeria, her results were much lower than the amount detected in this study.Shotuyo *et al*, [27] in a study on the assessment of heavy metals concentration in tissues of African Giant snail in selected major markets in Abeokuta Nigeria, the Zn mean concentration was recorded at 129.5mg/kg which is more than the result recorded in this study. The mean concentration of Zn recorded in this study were within the WHO acceptable safe limit, which set its permissible limit at 2.3g for Adult of 70kg, [28]. Zn across the different communities had no significant difference between their means. The concentration of Zn in the soil could be as a result of human/anthropogenic activities, and subsequently the level of Zn detected in snail depend on what the snail feeds on as well as its environment. Zn in small quantities is essential in human diet and growth, but when in excess can cause damage to nervous system, kidney and liver tissues, can also lead to hair and finger loss [26].

The mean concentration for Cr across the locations were 0.43mg/kg, -0.003mg/kg, and 0.05mg/kg for Luubaara, Eeken and Kaani respectively. Eeken had its Cr mean value below detection limit. A similar results was observed by Iwegbue *et al*. [29] in a studyon heavy metal content in the African giant snail *(Archachatina Marginata)* in nine localities in southern Nigeria, they reported Cr to be below detection limit across the localities. Cr was reported in [25] to be 0.001 intheir investigation.A mean concentration of 379mg/kg for Cr was recorded byIshaq *et al*. [30] on trace metal levels in African giant snails *(Achatina achatina)* from selected local Government Areas in Akwa Ibom, Nigeria. This was far greater than the values recorded in this work. The differences recorded may be due to polluted environment due to untreated industrial waste and anthropogenic activities. Analysis of Chromium(Cr) across the different communities showed that there was no significant difference, this indicates that the concentration found in the different locations are similar to each other. Chromium(Cr) was below the maximum permissible safe limit of 1.0mg/kg set by FAO/WHO [31] and USEPA [32].Cr has been suggestedto help improve blood pressure [33].Also, it has demonstrated the ability to lower total and low densitycholesterol levels in blood, particularly for people with high cholesterol levels [33]. However, excess intake of Cr is said to have adverse effect on man's health, as it has been reported to be carcinogenic in its +6 oxidation state [30].

The mean concentration of Cd across the localities were -0.03, -0.02 and -0.03 for Luubaara, Eeken and Kaani respectively, the concentrations were all below detection level and insignificant. Cd concentration was reported by [25] to range from 0.50 – 0.63mg/kg in their study and these values were far greater than the values obtained in the study. Cd was recorded byIshaq *et al*. [30] to be below detection levels in their investigation of trace metal levels in African giant snails *(Achatina achatina)* in five (5) local government area (L.G.A.) in Akwa Ibom, Nigeria except for Abak L.G.A. which recorded 20.04 – 2.80mg/kg of Cd. Another studyreported a concentration of 0.01mg/kg of Cd in snails from Alaro River within Oluyole industrial area Ibadan, Nigeria [34].Mean concentration of 0.09 – 0.50mg/kg Cd was recorded in investigation done by [26].Mean concentration of 0.99 – 3.28mg/kg of Cd was reported in [29] onAfrican giant snail *(Archachatina Marginata)* in nine localities in southern Nigeria. While concentration of Cd was recorded to range from 0 – 0.032mg/kgin [35] in their study on Bioconcentration of heavy metals in the snails *Archachatina Marginata* and *Limicolaria Spp*. of the Ouémé Valley in Benin. Cadmium when penetrates the placenta during pregnancy could damage the membrane and DNA [26]. High levels of Cd could lead to kidney dysfunction, reproductive deficiency and skeletal damage [30]. Permissible limit for Cd is 0.03mg/kg [31].Pb across the three communities was not detected at all. This shows that the environment is safe from Pb and its health effect both on man and organisms in the communities. Pb concentration as reported by [30] were below detection limit in their work on trace metal levels in African giant snails *(Achatina achatina)* from selected local government areas in Akwa Ibom State, Nigeria. Pbconcentration of 0.012 to 0.878 mg/kg was reported by [35] in their syudy on bioconcentration of heavy metals in the snails *Archachatina Marginata* and *Limicolaria Spp.* of the Ouémé Valley in Benin. Also,2.60 -5.00mg/kg of Pb concentration was recorded by [25] in their investigation on human health risk assessment of heavy metals in snails (*Archachatina marginata)* from four contaminated regions in Rivers State. Lead is unsafe and toxic to human beings, with very harmful effects on the urinary tract, nervous, reproductive organs [30]. Food and Agricultural Organisation/ World health Organisation set maximum permissible limit for Lead (Pb) to be 1.5mg/kg [31].

V. Conclusion

Achatina achatina across the three (3) communities were found to be colonized by *Diphyllobothrium latum, Hymenolepis spp., Trichostrongylus spp, Oesophagostomum spp. S. stercoralis larvae,Mite egg andDictyocaulus spp.* Heavy metal analysis carried out on the snails all had the concentration values within the permissible limits of FAO/WHO and USEPA. This indicates that snails found in Ogoni have safe contents of heavy metals, however the parasite contamination poses a serious problem to lovers of snails in these communities.

Reference

[1]. Awharitoma, A. O., Ewere, E. E., Alari, P. O., Idowu, D. O. & Osowe, K. A. (2016). Assessment of Heavy Metals in African Giant Snail (Archachatina marginata) and its Parasites Collected from Three Communities in Edo State, Nigeria. International Journal of Scientific & Engineering Research, **7**(10): 793-79.

[2]. Agbogidi, O. M., Okonta, B. C. & Ezeani, E. L. (2008). Effects of Two Edible Fruits on the Growth Performance of African Giant Land Snail (Archachatina marginata). Journal of Agriculture and Biological Science, **3** (3): 26 – 29.

[3]. Fagbuaro, O., Oso, J.A., Edward, J.B. & Ogunleye, R.F. (2006). Nutritional status of four species of giant land snails in Nigeria. Journal of Zhejiang University Science, **7**(9): 686 – 689.

[4]. Dragos, V. N., Despina-Maria, B., Monica, H., Marian, B. & Iosif, G. (2014). Interactions among heavy metals and metallic macroelements in Roman Snail Helix pomatia. Acta mettalomica, **301**: 65-71.

[5]. Nica, D., Bura, M., Gergen, I., Moigrădean, D., Popescu, R. and Bordean, D.M. (2012). Snail survival as bioindicator of cadmium contaminated soils under semirealistic field conditions. Journal of University of Szeged, Faculty of Agriculture, **1**(1): 192-198.

[6]. Smolders, E. & Mertens, J. (2013). Cadmium in heavy metals in soils: trace metals and metalloids in soils and their bioavailability. pp. 283−311. Springer Science Business Media: Dordrecht, the Netherlands.

[7]. Raut, S.K. & Barker, G.M. (2002). Achatina fulica and Other Achatinidae as Pests in Tropical Agriculture. In:Barker, G.M. (ed.) Molluscs as Crop Pests. pp. 55-114.

[8]. Hassan, A.H., Zanbagi, N.A. & Nabati, E.A. (2016). Impact of nematode helminthes on metal concentrations in the muscles of Koshar fish, Epinephelus summana, in Jeddah, Saudi Arabia. The Egyptian German Society for Zoology. The Journal of Basic and Applied Zoology, **74**: 56–61.

[9]. Jayakumar, P. & Paul, V.1. (2006). Patterns of cadmium accumulation in selected tissues of the catfish Claiias batrachus (Linn.) exposed to sublethal concentration of cadmium chloride. Veterinary Archive, **76**: 167-177.

[10]. Dugo, G., Pera, L.L., Bruzzese, A., Pellicano, T. & Turco, V. (2006). Concentration of Cd (II), Cu (II). Pb (II), Se (IV) and Zn (II) in cultured sea bass (Dicentrarchus labrax) tissues from Tyrrhenian Sea and Sicilian Sea by derivative stripping potentiometry. Journal of Food control, **17**: 146-152.

[11]. Sures, B. (2008). Environmental Parasitology: Interactions between parasites and pollutants in the aquatic environment. Parasite, **15**: 434-438.

[12]. Genc, E., Sangun, M.K., Dural, M., Can, M.F. & Altunhan, C. (2008). Element concentrations in the swim-bladder parasite Anguillicolacrassus (nematoda) and its host the European eel, Anguilla anguilla from Asi River (Hatay-Turkey). Environmntal Monitoring Assessment, **141**: 59–65.

[13]. Khan, A. B. & Kath, S. (2014). Evaluation of heavy metal and total petroleum hydrocarbon contamination of roadside surface soil. International Journal of Environmental Science and Technology,**11**: 2259–2270.

[14]. Cheesbrough, M. (2006): District laboratory practical in tropical countries (2nd edition). pp. 442. Cambridge University Press, London.

[15]. Stewart, E. A., Grimshaw, H. M., John, A. P. & Christopher, Q. (1974). Analysis of Heavy Metals, Chemical analysis of Ecological Materials. Pp 133-145.

[16]. Igbinosa, B., Isaac C., Ojagefu, H. A. & Adeleke, G., (2016). Parasites of edible land snails in Edo State, Nigeria. Helminthologia, **53**(4): 228-32.

[17]. Karamoko, M. A., Touré, K.O., Otchoumou, A. F. & Kouassi, K. P. (2016).Prevalence of African Giant Snails for Parasites in a South-East Region of Côte d'Ivoire. European Scientific Journal, **12** (21): 186-197.

[18]. Global Health. (2014). S, stercoralis larvae. Laboratory identification of Parasites of public health concern. Division for Parasitic Diseases. Center for Disease Control. Retrieved on November 14, 2018 from www.cdc.gov

[19]. Philip, C. & Akira, I. (2007). Intestinal cestodes. Current Opinions in infectious diseases.**20**(5): 524-534.

[20]. Global Health. (2017). Hymenolepsis spp. Laboratory identification of Parasites of public health concern. Division for Parasitic Diseases. Center for Disease Control. Retrieved on November 14, 2018 from www.cdc.gov

[21]. Ralph, A., Suillivan M. V., Sangster N. C. & Walker J. C. (2006). Abdominal pain and Eosinophilia in suburban goat keepers-Trichostrongylosis. Medical Journal Austria. **184**, 467-9.

[22]. Wall, E. C., Bhatnagar, N., Watson, J. & Doherty, T. (2011). An usual case of Hypereosinophilia and abdominal pain: An outbreak of Trichostrongylus imported from New Zealand. Journal of Medicine, **18**: 59-60.

[23]. Bogers, J. J. (2001). Human Oesophagostomiasis:AHistomorphometric study of 13 new cases in northern Ghana. Virchows Archeology, **439**: 21-26.

[24]. Junquera, P. (2017). Dicytocaulus spp, parasitic lungworms of horses, cattle, sheep, goats and other livestock: Biology, prevention and control. Dictyocaulus filarial, Dictyocaulus viviparous, Dictyocaulus arnfiedi. Retrieved on December 5, 2018 from www.parasitipedia.net.

[25]. Onuoha, S. C., Anelo, P. C. & Nkpaa1, K. W. (2016). Human Health Risk Assessment of Heavy Metals in Snail (Archachatina marginata) from Four Contaminated Regions in Rivers State, Nigeria. American Chemical Science Journal, **11**(2): 1-8.

[26]. Beatrice, K. (2015). Determination of some heavy metals and investigation of nutritional composition in three species of snails (Achatina fulica, Archachatina marginata, Limicolaria flammea). M.Sc. Thesis at Open Access Institutional Repository at Ahmadu Bello University (Open air @ABU). pp. 36-47.

[27]. Shotuyo, A. L. A., Bambgose, O. Oduntan,O. O., Akintunde, A. O. & Oyatogun, M.O. (2015). Assessment of heavy metals concentrations in tissues of the African Giant Snail (Archachatina marginata) in selected major markets in Abeokuta, South West Nigeria. African Journal of Agriculture, Technology and Environment, **4**(2): 15-20.

[28]. World Health Organisation. (1993). Evaluation of food additives and contaminates. 27th Report of the Joint FAO/WHO Expert Committee on food additives. WHO Technical Report No. 695, Geneva.

[29]. Iwegbue, C.M.A., Arimoro, F.O, Nwajei, G.E. & Eguaveon, O. (2008). Heavy metal contents in the African gaint snail Archatina Marginatain southern Nigeria. Folia Malacologica, **16**(1): 31-34.

[30]. Ishaq, S. E., Raymond A. W. & Utibe, J. A. (2016). Trace Metals Levels in African Giant Land Snails (Achatina achatina) from Selected Local Government Areas in Akwa Ibom State, Nigeria. Open Access Library Journal.

[31]. FAO/WHO (Food and Agriculture Organization/World Health Organization). (1995). List of Maximum Levels Recommended for Contaminants by the Joint FAO/WHO Codex Alimentarius Commission. Second Series. CAC/FAL, Rome, **3**: 1-8.

[32]. United State Environmental Protection Agency (2011). USEPA Regional Screening Level (RSL) Summary Table. Retrieved on December 6, 2018 from:http://www.epa.gov/regshwmd/risk/human/Index.htm

[33]. Tulasi, G. & Jayantha, R. K. (2014). Essentiality of chromium for human health and dietary nutrion. Journal of Entomology and Zoology studies.**2**(1), 107 – 108.

[34]. Adedeji, O. B., Adeyemo, O. K. & Oyedele, M. O. (2011). Heavy Metals in Snail and Water Samples from Alaro River in Oluyole Industrial Area of Ibadan Southwestern Nigeria. Journal of Applied Sciences in Environmental Sanitation, **6**: 115-12.

[35]. Adamou, R., Yehouenou P. E. & Elegbede, M. B. (2018). Bioconcentration of Heavy Metals in the Snails Archachatina Marginata and Limicolaria Spp of the Ouémé Valley in Benin. International Journal of Biology, Pharmacy and Allied Science (IJBPAS): **7**(8): 1474-1488.

Eze, Chinwe N, et. al. "Heavy Metals and Parasites in African Giant Snail (Achatina achatina) from Three Communities in Ogoni, Rivers State, Nigeria." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(3), 2021, pp. 27-35.