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Evaluation of Physiological Indices of Giant African Land Snail (*Achatina achatina*) from Niger Delta Regions of Nigeria

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ABSTRACT

Background and Objective: Prevailing climatic conditions of a given region affect the physiological and biochemical adjustment in snails. Numerous researches have been published on physiological parameters of commonly eaten *Achatina achatina* from different ecological zones in Northcentral and Western Nigeria. There is a paucity of updated information on the physiological indices of giant African land snails in Niger Delta regions of Nigeria. This research was aimed at evaluating the physiological indices of a commonly eaten giant African land snail (*Achatina achatina*) from 5 different ecological zones in Niger Delta regions of Nigeria. **Materials and Methods:** The 25 matured snails were purchased from farmers returning from the forests in Akwa Ibom, Abia, Bayelsa, Rivers and Cross River States, respectively for this study. The snails were transferred to the biochemistry laboratory for physiological analyses. Data obtained were subjected to analysis of variance using SPSS version 16.0 and least significant difference test was used to separate the means. Significance level was set at 5%. **Results:** Snails from Rivers State had higher significant ($p<0.05$) concentrations of protein (52.13±0.03), glucose (33.01±0.20) and lipid (20.80±0.04), respectively in their hemolymph than those recorded for other locations. The concentration of protein was higher than other metabolites in both hemolymph and the flesh of *Achatina achatina* across the 5 States. *Achatina achatina* snails obtained from Akwa Ibom state recorded higher and significant ($p<0.05$) values of dry matter (24.05±0.03), ash (1.84±0.02), crude fibre (1.02±0.01), fat (2.02±0.01), carbohydrate (1.09±0.02) and crude protein (22.20±0.04), respectively than those from other States of Niger Delta Region in Nigeria. No significant ($p>0.05$) difference was observed in Mg^{2+}, PO_4^{2+} and Cl^{-} across the 5 states. **Conclusion:** Locations that have effects on chemical composition of the hemolymph have been observed, but no substantial differences were recorded in the nutritional composition of *Achatina achatina* snails across the 5 Niger Delta States in Nigeria.

KEYWORDS

Achatina achatina, terrestrial snails, physiological parameters, haemolymph, biochemical analysis, chemical composition, South-South Nigeria

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INTRODUCTION

Snails are noiseless invertebrates with soft bodies which are protected with hard calcareous shells[1,2]. They are bilaterally symmetrical with over 100,000 species found around the world. They belong to the phylum Mollusca and class Gastropoda[2]. Giant African land snails are nocturnal in nature and are only active at night and in dark places during the day. They are the largest groups of mollusca with the largest animal group after arthropods[3]. The habitat of giant African land snails ranges from the dense tropical high forest in Southern Nigeria to the fringing riparian forest of the derived Guinea Savanna[4].

Snail meat is becoming a highly preferred delicacy in Nigeria and this constitutes an essential source of animal protein for many Nigeria citizens[5]. Snail meals are rich in protein, calcium, magnesium, zinc and iron, with very low fat content[6,7]. Ademolu *et al*.[8] documented that snail's protein contains all the essential amino acids such as lysine, leucine, isoleucine and phenylalanine, which are needed by the body for metabolic activities. Medicinally, snail meat can be used to treat ailments including whooping cough, anaemia, asthma and high blood pressure due to their relatively low cholesterol level but high mineral content[9-11].

Ejidike *et al*.[12] reported that micro-climate variables like relative humidity, rainfall, photo-period and temperature are important determinants of extent to which snail species can perform and their survival depends on these variables. Numerous researches have been published on physiological parameters of commonly eaten giant African land snails (*Achatina achatina*) from different ecological zones in western Nigeria[6,9,12-14]. There is a paucity of updated information on the physiological indices of giant African land snails in Niger Delta regions of Nigeria.

Therefore, this research aimed at evaluating the physiological indices of commonly eaten giant African land snails (*Achatina achatina*) from 5 different ecological zones in Niger Delta regions of Nigeria.

MATERIALS AND METHODS

Study duration: This research was conducted from May, 2022 to July, 2023.

Study location and area: The Niger Delta basin lies in the South-Western part of a larger tectonic structure, the Benue Trough. The other side of the basin is bounded by the Cameroon Volcanic line and the transform passive continental margin. The Niger Delta Basin is located in the Gulf of Guinea on the west coast of Africa. Matured giant African land snails from the forests in Akwa Ibom, Abia, Bayelsa, Rivers and Cross River States (Niger Delta regions), Nigeria were used for this study. The major economic activities in the region include agriculture (vegetables and fruit production), livestock farming and business.

Laboratory analysis: The 25 matured snails were purchased from farmers returning from the forests in Akwa Ibom, Abia, Bayelsa, Rivers and Cross River States, respectively for this study. The snails were transferred to the biochemistry laboratory, University of Calabar, for physiological analyses. The shell was broken at the apex and the haemolymph emanating out was collected in a measuring cylinder, using the method previously documented[8]. The flesh of the snails was obtained and washed for proximate and mineral analyses after dissecting the snails according to the protocols of Ademolu *et al*.[15]. The protein contents of the flesh were estimated by biuret method as documented by researchers Ademolu *et al*.[15], while glucose content was determined using calorimetric method as reported by Adeyeye[4] and Nkansah *et al*.[9]. The protocol used for the determination of lipids was described by Akinnusi *et al*.[13]. A flame photometer (Corning UK Model 403) was used to determine sodium and potassium concentration in the columella muscles according to a previously documented procedure[13]. Calcium was determined using an atomic absorption spectrophotometer (Model AA 405), while PO_4^{2-} and Cl^- content of the tissues were assessed as previously published[13].

Statistical analysis: Data obtained were subjected to Analysis of Variance (ANOVA) using SPSS (Statistical Package for Social Sciences) version 16.0 and least significant difference test was used to separate the means. The significance level was set at 5%.

RESULTS

Biochemical analysis of the hemolymph: There were significant differences ($p<0.05$) in the levels of protein, glucose and lipid in the hemolymph of the *A. achatina* snails across the 5 different States in Niger Delta regions of Nigeria as shown in Table 1. *Achatina* snails from River State had higher significant ($p<0.05$) concentrations of protein (52.13±0.03), glucose (33.01±0.20) and lipid (20.80±0.04), respectively in their hemolymph than those recorded in other locations. There was also a higher significant ($p<0.05$) concentration of Cl^- (97.60±0.30) and Ca^{2+} (8.20±0.20) in the hemolymph of *A. achatina* snails from River State, while Bayelsa State had the least Cl^- (92.00±0.20) and Ca^{2+} (7.50±0.02) in the hemolymph of *A. achatina* snails (Table 1).

Mineral analysis of the snail's flesh: There were significant differences ($p<0.05$) in the levels of minerals (Na^+, Ca^{2+} and K^+), while other minerals (Mg^{2+}, PO_4^{2+} and Cl^-) showed no significant difference ($p>0.05$) across the 5 states in the Niger Delta regions of Nigeria (Table 2). However, Na^+ recorded the highest mineral values for all 5 states, while Cl^- had the least mineral values across all the states (Table 2).

Proximate analysis of the snail's flesh: The values of dry matter (24.05±0.03), ash (1.84±0.02), crude fibre (1.02±0.01), crude protein (22.20±0.04) and carbohydrate (1.09±0.02) were significantly ($p<0.05$) higher from the snails obtained from Akwa Ibom State than those from other Niger Delta states of Nigeria (Table 3). Fat and carbohydrate contents recorded for snails from Abia, Bayelsa, Rivers and Cross River States showed no significant differences ($p>0.05$) (Table 3).

Table 1: Biochemical analysis of the hemolymph of *Achatina achatina* obtained from 5 Niger Delta regions of Nigeria

Location	Protein (g/L)	Glucose (mg/dL)	Lipid (mg/dL)	Cl^- (mm/L)	Na^+ (mm/L)	PO_4^{2-} (mg/L)	Ca^{2+} (mg/L)
Akwa Ibom	25.45±0.01^d	13.80±0.21^d	13.50±0.20^d	92.40±0.20^c	132.00±0.30^{bc}	1.50±0.20^c	7.85±0.02^a
Abia	30.30±0.31^b	18.01±0.30^b	13.50±0.10^d	95.30±0.30^b	132.00±0.31^{bc}	2.20±0.10^b	7.76±0.01^a
Bayelsa	26.35±0.01^c	14.30±0.02^c	14.71±0.02^c	92.00±0.20^c	134.60±0.21^b	2.61±0.01^a	7.50±0.02^b
Rivers	52.13±0.03^a	33.01±0.20^a	20.80±0.04^a	97.60±0.30^a	131.50±0.20^c	2.40±0.02^{ab}	8.20±0.20^a
Cross River	19.14±0.02^e	13.76±0.02^d	16.30±0.20^b	96.00±0.20^b	132.40±0.10^b	2.60±0.01^a	7.85±0.01^a

Mean±Standard error in the same column having the same superscripts are not significantly different ($p>0.05$)

Table 2: Mineral analysis of the flesh of *Achatina achatina* obtained from 5 Niger Delta regions of Nigeria

Location	Na^+(mm/L)	Ca^{2+}(mg/dL)	Cl^- (mm/L)	K^+(mm/L)	Mg^{2+}(mg/dL)	$PO4^{2-}$ (mg/dL)
Akwa Ibom	1.02±0.02^b	0.31±0.03^{ab}	0.02±0.01^a	2.51±0.02^c	0.25±0.03^c	0.51±0.01^c
Abia	1.26±0.01^a	0.33±0.01^a	0.01±0.01^b	3.58±0.01^a	0.25±0.02^c	0.52±0.02^b
Bayelsa	1.24±0.02^a	0.30±0.02^{ab}	0.01±0.02^b	2.84±0.04^c	0.27±0.01^a	0.54±0.01^a
Rivers	1.06±0.01^b	0.24±0.02^c	0.02±0.00^a	3.12±0.02^b	0.26±0.01^b	0.50±0.02^c
Cross River	1.20±0.02^a	0.26±0.01^c	0.02±0.01^a	3.10±0.03^b	0.25±0.02^c	0.53±0.02^a

Mean±Standard error in the same column having the same superscripts are not significantly different ($p>0.05$)

Table 3: Proximate analysis of the flesh of *Achatina achatina* obtained from 5 Niger Delta regions of Nigeria

Location	M.C (%)	D.M (%)	A.C (%)	C.F (%)	F.C (%)	CHO (%)	C.P (%)
Akwa Ibom	71.91±0.03^d	24.05±0.03^a	1.84±0.02^a	1.02±0.01^a	2.05±0.01^a	1.09±0.02^a	22.20±0.04^a
Abia	75.01±0.10^c	21.05±0.05^b	1.65±0.01^b	0.85±0.02^b	1.69±0.02^b	0.93±0.01^b	19.86±0.01^b
Bayelsa	76.81±0.02^b	19.21±0.02^c	1.46±0.03^c	0.81±0.02^c	1.58±0.01^{bc}	0.91±0.02^{bc}	18.41±0.02^c
Rivers	77.56±0.02^a	18.32±0.01^c	1.39±0.01^c	0.75±0.02^c	1.47±0.02^c	0.88±0.01^c	17.76±0.02^d
Cross River	75.38±0.01^c	20.69±0.02^b	1.61±0.01^b	0.86±0.01^b	1.74±0.02^b	0.96±0.03^b	14.64±0.01^e

Mean±Standard error in the same column having the same superscripts are not significantly different ($p>0.05$), M.C: Moisture content, D.M: Dry matter content, A.C: Ash content, C.F: Crude fibre content, F.C: Fat content, CHO: Carbohydrate content and C.P: Crude protein

DISCUSSION

The findings of this study show that locations affect the chemical composition of the hemolymph of giant African land snails (*A. achatina*) obtained across the 5 states in the Niger Delta region of Nigeria. The physiological processes of snails are affected by environmental factors like temperature because snails are ectothermic animals[8]. This observation was in tandem with the report of Ejidike *et al.*[12] where climate and dietary variables have influences on the physiology of giant African land snails.

The high significant concentrations of protein, glucose and lipid in the snails obtained from River State may be due to the vegetation and topography, climate of the area. Lipids and glucose are good sources of energy that can be stored as glycogen and glycerol in the body of the snails for later use. The results obtained in this current research were in tandem with the report of Akinnusi *et al.*[13] in Nigeria. Similar results were also obtained by other researchers in Western Nigeria using normal and albino snails of *A. marginata*[14,15]. In present study, the highest concentration of glucose was 33.01±0.20 mg/dL in *Achatina achatina* from Rivers state but a lower concentration of 21.27±0.71 mg/dL was reported among *Archachatina marginata* from some States in South-South Nigeria and South-West Nigeria[16]. These differences in glucose level may be due to type of species.

The hemolymph of snails was high across the 5 states for both cations and anions and high hemolymph where previously reported by researchers, agreeing with current findings[15,17]. Hemolymph is the fluid that bathes the flesh of snails and any physiological process occurring in the body must be reflected by the haemolymph[14,17]. Biochemical properties of hemolymph have often determined the growth performance of land snails (*A. marginata*) as the animal possesses an open circulatory system[15]. The higher concentration of Na^+ followed by Cl^- recorded in this study was also observed in South West Nigeria[14], in harmony with present study results in South-South Nigeria. The concentration of protein was higher than other metabolites in both the hemolymph and the flesh of *A. achatina* across the 5 states, indicating that protein is the most abundant solute in the snail's hemolymph. Snails have been reported to be a good source of protein[1,11,13]. The higher hemolymph level for both cation and anion obtained in this study was in conformity with other reports by Ademolu *et al.*[14] and Adelakun *et al.*[17].

The proximate composition (moisture content, dry matter content, fat content, ash content, crude fibre content, crude protein content and carbohydrate content) of *A. achatina* obtained in this study was high across all the 5 Niger Delta states used for the study. These results correlated with the findings of other scientists using *A. achatina*, *Limicolaria* species and *A. marginata* snails[5,6,13]. In contrast, lower proximate composition was documented among freshwater snails (*Pila ampullacea*) from River Benue, Nigeria[17], in *Limicolaria* species and *A. fulica*[6].

This differences may be due to variations in ecological niches, locations and species of the snail used in the study. In this study, the snails used for the study were *A. achatina*, collected from 5 Niger Delta states in Nigeria while *A. marginata, A. fulica, Limicolaria* species and *Pila ampullacea* were documented in Southwest and North Central Nigeria[5,6,13,16,17].

The updated biochemical analysis of the hemolymph, minerals and proximate analysis of giant African land snails (*A. marginata*) from Niger Delta regions, Nigeria have been established based on the findings of this research. The study recommended for the evaluation of physiological and morphometric parameters of aquatic snails from Niger Delta Regions of Nigeria should be investigated. Research should be conducted on the morphometric and physiological parameters of other species of land snails in South-South and South-East regions of Nigeria.

The limitation of the study includes the evaluation of physiological parameters of giant African land snails (*A. marginata*) was limited to only Akwa Ibom, Abia, Bayelsa, Rivers and Cross River States, excluding other

states (like Imo State, Delta State, Edo State and Ondo State) in the Niger Delta Regions of Nigeria. The use of molecular markers in studying variations in giant African land snails (*A. marginata*) was not investigated.

CONCLUSION

This study provided updated information on biochemical analysis of the hemolymph, minerals and proximate analysis of giant African land snails (*Archachatina marginata*) from South-South region, Nigeria. Also, this current research has highlighted the locations from which giant African land snails (*Archachatina marginata*) can be selected for farming, breeding programs, domestication, medicinal or consumption purposes based on their biochemical, minerals and proximate analysis. Therefore, the use of bio-molecular markers in studying variation in giant African land snails (*Archachatina marginata*) in South-South Nigeria should be highlighted in further study.

SIGNIFICANCE STATEMENT

This current research evaluated and presented updated information on the physiological indices of giant African land snails in Niger Delta. The 25 matured snails from forests in the region were used for this study. The study revealed that snails from Rivers State had higher significant concentrations of protein, glucose and lipid, respectively in their haemolymph than those recorded for other locations. The concentration of protein was higher than other metabolites in both haemolymph and the flesh of snails across the 5 states. Snails obtained from Akwa Ibom state recorded higher and more significant values of dry matter, ash, crude fibre, fat, carbohydrate and crude protein, respectively than those from other states. This finding will be relevant for further study.

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