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A Preliminary Chemical and Structural Analysis on the Albumen Gland of Three Snail Species Found in Abeokuta, Ogun State, Nigeria

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ABSTRACT

The function of the albumen gland is to produce albumen or perivitelline fluid for the egg. A preliminary chemical and structural analysis of the albumen gland of three common land snail species (*Archachatina marginata, Achatina achatina and Achatina fulica*) found in Abeokuta (Nigeria) was carried out. The presence of Na^+, K^+, Ca^{2+} Cl^- and PO_4^{2-} was detected in the gland with the *A.marginata* having the highest chemical concentrations, followed by *A. fulica* and *A. achatina*. Ca^{2+} with the highest concentration in the gland and the protein content was similarly high. The gland contains secretory granules, epithelial lining and tissues which are similar in the three species, indicating that they are structurally similar. Meanwhile, the relevance of these results to the egg production in snails is discussed.

Keywords: Albumen gland, giant land snails, egg, histology

INTRODUCTION

According to Yoloye (1994), they are the largest group of Mollusc constituting the largest animal group after the Arthropods. They are gastropods and differ from others in that their respiration is highly modified for terrestrial life.

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Imevbore and Ademosun (1988) reported that snails commonly live in the high forest and in the derived savanna regions of West Africa. The species of African land snail such as *Archachatina marginata, Achatina achatina, Achatina fulica, Helix pomatia* and *Limicolaria aurora* are consumed in many countries of the world (Amusan & Omidiji, 1998). They are highly favoured in Nigeria and Africa, where they constitute the most conspicuous terrestrial mollusc (Odaibo, 1997). Snail meat is high in protein, low in fat and a

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very rich source of iron (Akinnusi, 2002; Ademolu *et al*., 2007). Nevertheless, the nutritive value of these three species varies. Idowu *et al.* (2008) reported 16.08, 13.16 and 10.24 g/100g crude protein contents for the flesh of *A. marginata, A.achatina* and *A.fulica,* respectively.

Reproduction in snail is sexual, although they are hermaphrodite. The ovotesis which is the reproductive organ of the snail is a complex organ that produces both the sperm and egg. The albumen gland is a compound tubular exocrine gland found in the female reproductive tract. It contains a fertilization chamber where eggs are fertilized and secretes perivitelline fluid that is composed of protein and polysaccharide complex which coat each fertilized egg.

Idokogi and Osinowo (1998) reported that the reproductive system of *Archachatina marginata* has a high correlation with the live weight of the snail, that is, as the snail matures, the reproductive organ also increases in size. Ademolu *et al.* (2008) reported that *A. marginata* has the biggest reproductive structures, and this is followed by *A. fulica,* while *A. achatina* has the smallest size.

Not much has been done on the comparative physiology of some common African land snails, especially those found in Abeokuta. The only comparative work on the African land snails was that of Idowu and Akinnusi (2006) on the morphology and histology of the ovotestis of African land snails found in Abeokuta. The size and total number of eggs laid differ from species to species, and this is related to the size of hatchlings (Odaibo, 1997), while *A. fulica* laid 5.4 eggs/week, 3.75 and 1.4 eggs/week were laid by *A.achatina* and *A. marginata,* respectively (Ebenebe *et al*., 2011; Okon *et al*., 2011). However, little information is available on how the eggs are produced in African land snails and the likely causes of the variations in the size and number of eggs.

The focus of this study was to analyze the chemical composition and the structures of the albumen gland of three common land snails found in Abeokuta.

MATERIALS AND METHODS

Experimental Site

The study was carried out in the Laboratory of the Department of Biological Sciences, University of Agriculture Abeokuta, Ogun state, in Nigeria.

Experimental Snails

Forty-five mature snails of three different species *(A. marginata, A. achatina,* and *A. fulica)* were used (fifteen snails per species). The snails were identified based on the descriptions of Akinnusi (2002) and Amusan and Omidiji (1998).

Data Collection

The live weight of the snails was taken using the sensitive electronic weighing scale (Mettler DM 11-k) and the morphometric data such as the length and width of the body were measured using a vernier caliper.

Preparation of the Samples for Analysis

The snails were dissected as described by Segun (1975) and modified by Idowu and Akinnusi (2006). The digestive system was dissected and the albumen gland was carefully removed from the hermaphroditic duct with a pair of scissors onto a sterile Petri dish. The length and width of the albumen gland was measured using a vernier caliper. The albumen gland was subsequently weighed using the sensitive electronic weighing scale (Mettler DM 11-k).

Proximate Analysis of the Sample

The crude fibre, ash, crude protein and carbohydrate content of the samples were determined using the methods of Association of Official Analytical Chemsit (A.O.A.C.) (1990). Similarly, the minerals (Mg^{2+}, Na^{+}, Ca^{2+}, K^{+}, Cl and PO_4^{2-}) were determined using Flame Photometer and Atomic Absoption Spectrphotomer (AAS).

Histology

The albumen gland from the three snails species were fixed in 10 % formalin. The fixed glands were dehydrated and embedded in paraffin wax (melting point 58-60%). Sections were cut at 10µm and stained with haematoxylin and eosin. Slides were viewed under a microscope at x400.

Data Analysis

All the collected data were analyzed using a simple one-way analysis of variance (ANOVA) and means separation was done by using the Student Newman Kuel's test.

RESULTS

The mean weight, length and width of the albumen gland of different land snails are presented in Table 1. The results presented in the following table show that the mean weight, length and width of the albumen followed the trend- *A. marginata*> *A. achatina* > *A. fulica.*

Mineral Analysis

The mineral analysis of the albumen gland of different land snails is shown in Table 2. The results depicted in the following table show that Ca^{2+} has the highest concentration of all the minerals analysed, and *A. marginata* has the highest concentration, followed by *A. fulica* while *A. achatina* has the lowest.

TABLE 1
Measurement of the Albumen Gland of the Different Land Snails.

	SNAIL SPECIES		
Albumen gland parameter	*Archachatina marginata*	*Achatina achatina*	*Achatina fulica*
Mean weight (g)	7.96± 0.52^{a}	2.60± 0.16^{b}	2.10± 0.16^{c}
Mean length (cm)	2.03± 0.15^{a}	1.85± 0.05^{b}	1.45± 0.05^{c}
Mean width (cm)	0.51± 0.09^{a}	0.43± 0.07^{a}	0.27±0.07^{b}

Values (mean±SD) within row followed by different superscript were significantly different (P<0.05)

TABLE 2
The mineral analysis of the albumen gland of three land snails species

	SNAIL SPECIES		
Mineral composition (mg/100g)	*Archachatina marginata*	*Achatina achatina*	*Achatina fulica*
Magnesium	0.07±0.017[b]	0.06±0.017[b]	0.09±0.017[a]
Sodium	0.58±0.25[a]	1.00±0.25[a]	0.85±0.25[a]
Potassium	1.75±0.58[c]	3.00±0.58[a]	2.50±0.58[b]
Calcium	82.50±6.76[a]	67.50±6.76[c]	77.50±6.76[b]
Chlorine	0.88±0.075[b]	1.03±0.075[a]	0.95±0.075[b]
Phosphorus	0.120±0.007[b]	0.126±0.007[a]	0.109±0.007[c]

Values (mean±SD) within row followed by different superscript were significantly different (P<0.05).

TABLE 3
Proximate analysis of the albumen gland of different land snails

	SNAIL SPECIES		
PARAMETER(g/100g)	*Archachatina marginata*	*Achatina achatina*	*Achatina fulica*
Moisture content	58.16±1.64[c]	61.54±1.64[a]	60.32±1.64[b]
Fat content	0.88±0.034[a]	0.82±0.034[a]	0.86±0.034[a]
Ash content	1.36±0.043[a]	1.31±0.043[b]	1.27±0.043[c]
Crude fibre content	0.72±0.20[a]	0.70±0.69[b]	0.71±0.20[b]
Crude protein content	38.26±2.20[a]	33.22±2.20[c]	36.26±2.20[b]
Carbohydrate content	0.62±0.094[a]	0.41±0.094[c]	0.51±0.094[b]

Values (mean±SD) within row followed by different superscript were significantly different (P<0.05).

Proximate Analysis

The proximate analysis of the albumen gland of different land snails are shown in Table 3. The results reveal that the moisture content is relatively high in the three species, while the crude protein and ash content values are the highest in *A. marginata.*

Histology

The structures of the albumen gland of the three snail species are shown in Fig.1 to Fig.3. The structures are made up of epithelial lining, secretory granules, and connective tissues. An examination of the structures revealed that the albumen gland of the three species are not different.

DISCUSSION

A. marginata recorded the largest size and weight of albumen gland. Furthermore, the present study revealed that a strong correlation exists between the body parameters and the weight, length and width of the albumen gland of the different land snails. This observation agrees with the findings of Idokogi and Osinowo (1998) and also Ademolu *et al.* (2008) that the reproductive tract of *A. marginata* has a high correlation with the live weight of the snail.

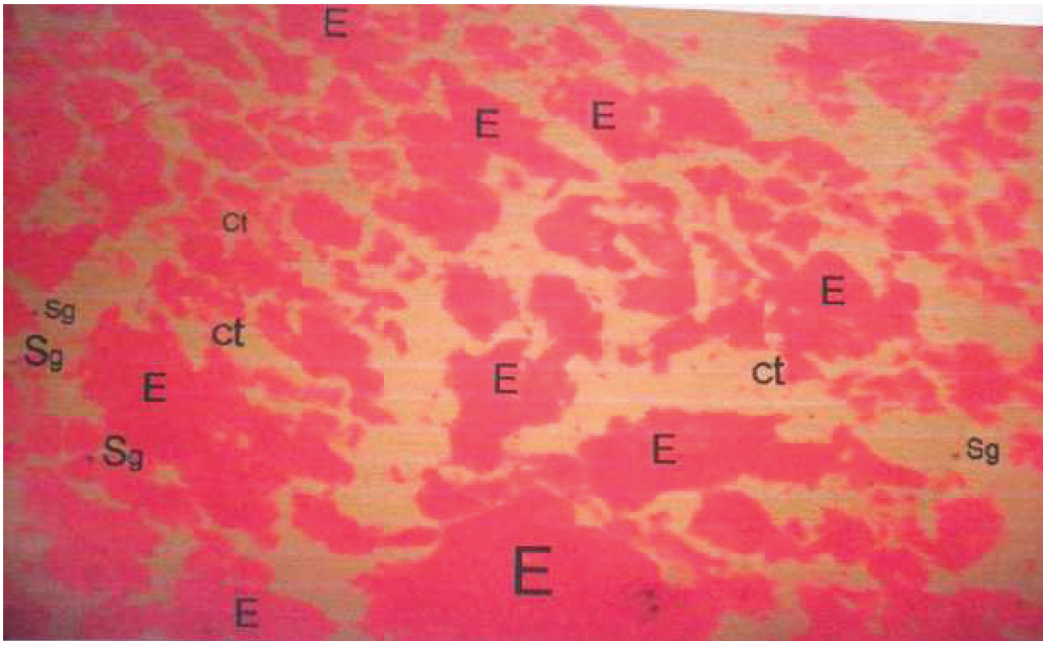

Fig.1: Transverse Section of Albumen gland of *Archachatina marginata* (E-epithelial lining,Sg-secretory granules, ct- connective tissues)

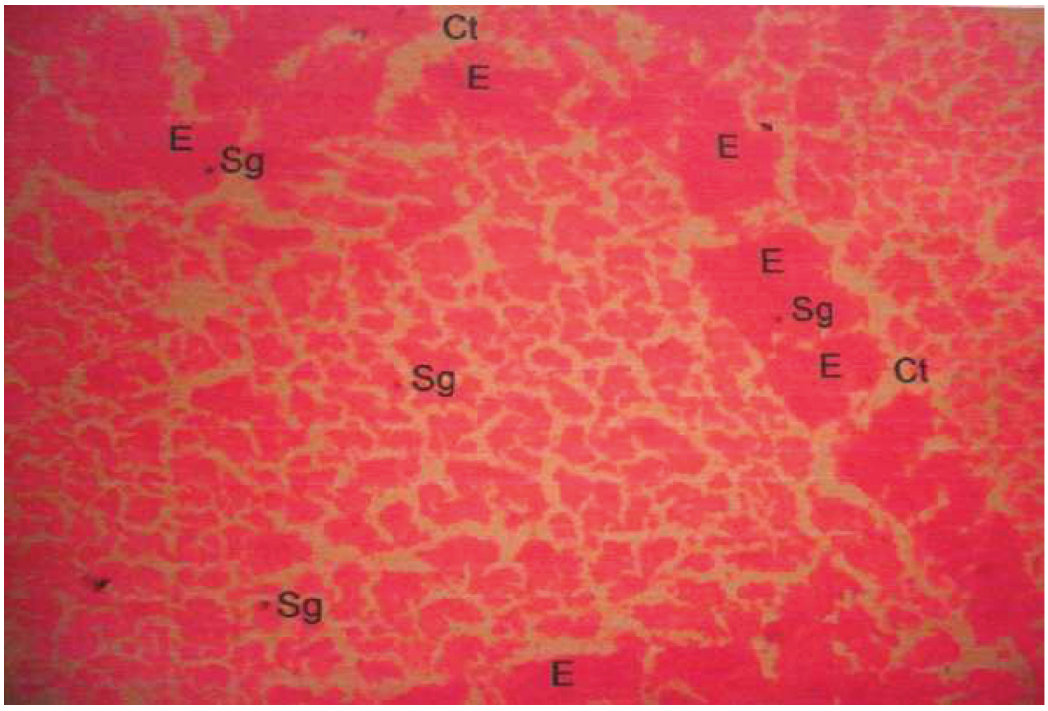

Fig.2: Transverse Section of Albumen gland of *Achatina achatina* (E - epithelial lining, Sg - secretory granules, ct - connective tissues)

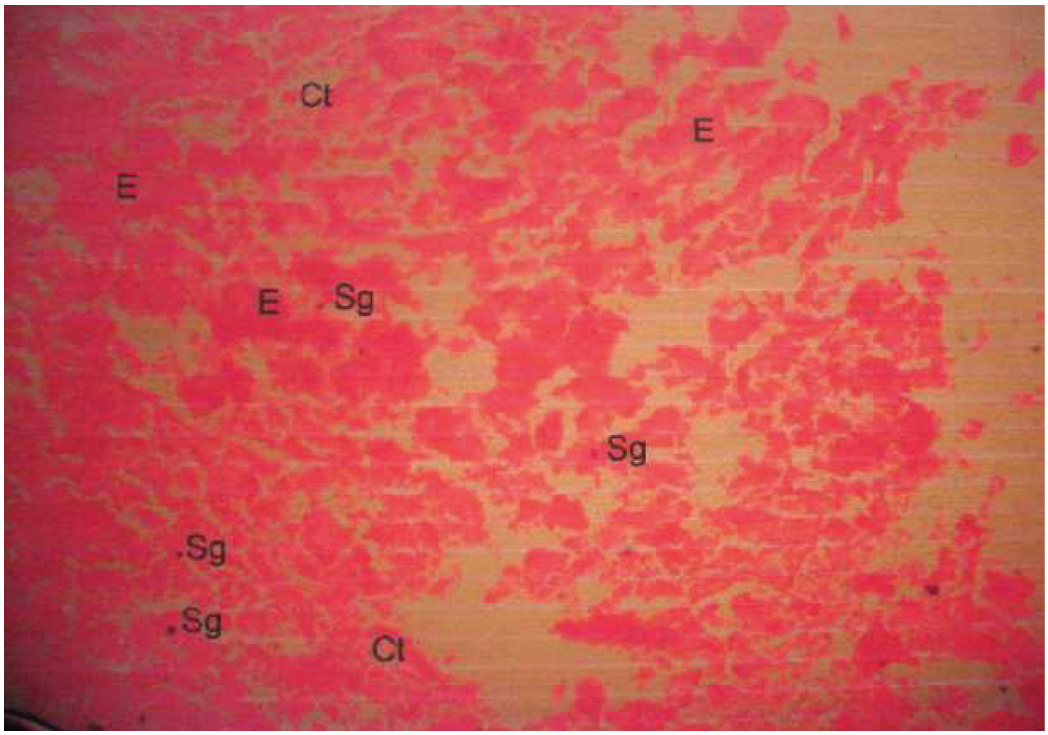

Fig.3: Transverse Section of Albumen gland of *Achatina fulica* (E - epithelial lining, Sg - secretory granules, ct - connective tissues)

Nonetheless, little information is available on the chemical composition of the albumen gland of giant land snails. However, the values recorded in this study can compare the composition of the snail flesh well. Idowu *et al.* (2008) and Ademolu *et al.* (2007) recorded the ash content value of 1.45 -2.78 g/100g and the fat content of 1.18-1.78 g/100g. This seemingly similarity in the values noticed might be due to its open circulatory system, where the haemolymph bathes the tissues and organs, and thereby diffusing the same substances throughout the snail body, as opined by Ademolu *et al* (2008) earlier on.

The presence of the tested minerals in the albumen gland of each species shows how important the organ is in the egg production in snail. Odaibo (1997) earlier highlighted the importance of calcium in the shell formation and that the lack of calcium in snails could lead to the formation of thin and transparent egg shell, as well as stunted growth and infertility in snails. This implies that the highest value of calcium observed in the albumen gland of *A. marginata* might be responsible for its eggs' large sizes as calcium affects the coating of the fertilized eggs, and thus increasing the thickness of the eggs produced. Furthermore, higher concentrations of Ca^{2+} in both *A.marginata* and *A. fulica* might be responsible for the better thickness of their egg shells as compared to that of *A. achatina* which is

thin and fragile, as observed by Chapman and Berker (1972).

Udoh (1994) reported that the ash content is a reflection of the amount of minerals present in such sample. The high ash and protein contents in the albumen gland of *A. marginata* revealed that it has a high nutritive value which could be passed to the egg in the process of egg coating, and thereby increased the nutritive value of the eggs which affects the size and survivability of the hatchings produced by this species. Similarly, high protein values were also recorded in the albumen gland of the fresh water snail *Helisoma duryi* (Morishita *et al.,* 1998). Nubuhiro and Makoto (1999) also discovered a high level of soluble protein in the albumen gland of land snail, *Euhadra peliompha,* which are seasonally influenced. Proteins are regulators of the physiological processes such as growth and reproduction (South, 1992). The eggs and hatchings of *A. marginata* have high hatchability and survival rate, respectively (Akinnusi, 2002) and this may likely be due to the transfer of nutrients from the albumen gland to the eggs during their formation. Albumen provides a major source of nourishment for the fertilized eggs (Yoloye, 1994); the more nutrients it contains, the better the egg produced by the snails.

The transverse section of the albumen gland of the three snail species showed the presence of epithelial lining, secretory granules and connective tissues. Similarly, no marked difference was observed in the structures of the three snails. In a study by Abiona *et al.* (2007), no significant different was recorded in the size of the ova and spermatozoa found in the albumen gland of two giant land snails, namely, *A. marginata* and *A. achacha*. These similarities in the structures may not be unconnected to their being from the same family, i.e. *Achatinidae*. Meanwhile, Idowu and Akinnusi (2006) also observed a resemblance in the structures of the ovotestis of the giant land snails found in Abeokuta, Nigeria. In addition, Egonwon (2007) also reported that the albumen gland of *A. marginata* is made up of tubules with are closely packed columnar secretory cells. The secretory cells produce secretions which are passively stored in their cytoplasm.

CONCLUSION

This study has given a clue or an insight into a better reproductive performance of *A. marginata* as it possesses higher nutrient values and minerals in the albumen gland compared to other land snail species.

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