Abstract

Nutritional analysis of the albumen gland of giant African land snail (*Archachatina marginata*) from six Southwest states, Nigeria

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The albumen gland is a vital part of visceral mass of giant African land snail (GALS) and its very rich in nutrients. As with other parts of snails, its composition is influenced by diet, location, age and species. The chemical compositions of albumen gland of GALS across the south western states of Nigeria have not been evaluated despite their diverse climatic conditions. Three hundred and sixty (360) Archachatina marginata were obtained from six south west states (60 snails/ state) and the albumen gland samples were analyzed for their proximate composition (crude protein, fat, ash, fibre and carbohydrate), minerals content $(K^{+}, Ca^{2+}, P, Na+, Mg^{2+}, Cl, Fe^{2+})$, anti-nutrients and vitamins composition. The crude protein of the gland ranged between 12.93% and 24.40% with Ekiti state recording the highest value and Osun the least. The fat content was low (1.14%-2.29%) and no fibre was detected in the albumen gland. Snails from Ekiti and Ondo states had significantly higher Ca^{2+} , P and Mg^{2+} than other states. No Vitamin C was detected in the gland across the states while Vitamin A values ranged from 38.68 (Lagos) to 45.51 (Ondo). Least anti-nutrient concentrations were recorded by snails from Ondo and Ekiti states, while Lagos state recorded the highest (except flavonoid and oxalate). Albumen glands of snails from Ekiti and Ondo states are thus more nutritious than that from other states and can be safely consumed by both man and farm animals

Keywords: albumen gland, Archachatina marginata, nutrients, southwest states,

Une Analyse nutritionnelle de la glande albumine de l'escargot terrestre africain géant (*archachatinamarginata*) de six États du sud-ouest au Nigéria

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Résumé

La glande albumen est une partie vitale de la masse viscérale de l'escargot terrestre géant africain (le 'GALS') et elle est très riche en nutriments. Comme pour d'autres parties d'escargots, sa composition est influencée par le régime alimentaire, l'emplacement, l'âge et l'espèce. Les compositions chimiques de la glande albumine de 'GALS' dans les États du sudouest du Nigéria n'ont pas été évaluées malgré leurs conditions climatiques diverses. Trois cent soixante (360) Archachatinamarginata ont été obtenus de six états du sud-ouest (60 escargots / état) et les échantillons de glande albumen ont été analysés pour leur composition immédiate (protéines brutes, graisses, cendres, fibres et glucides), teneur en minéraux (K +, Ca2 +, P, Na +, Mg2 +, Cl-, Fe2 +), composition anti-nutriments et

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vitamines. La protéine brute de la glande variait entre 12,93% et 24,40%, l'état d'Ekiti enregistrant la valeur la plus élevée et Osun le moins. La teneur en matières grasses était faible (1,14%-2,29%) et aucune fibre n'a été détectée dans l'albumen. Les escargots des états d'Ekiti et d'Ondo avaient des Ca2 +, P et Mg2 + significativement plus élevés que les autres états. Aucune vitamine C n'a été détectée dans la glande à travers les États alors que les valeurs de vitamine A variaient de 38,68 (Lagos) à 45,51 (Ondo). Les plus faibles concentrations d'anti-nutriments ont été enregistrées par les escargots des états d'Ondo et d'Ekiti, tandis que l'état de Lagos a enregistré les plus élevées (sauf les flavonoïdes et l'oxalate). Les glandes d'albumen des escargots des états d'Ekiti et d'Ondo sont donc plus nutritives que celles des autres états et peuvent être consommées en toute sécurité par l'homme et les animaux de ferme.

Mots-clés: glande albumine, Archachatinamarginata, nutriments, états du sud-ouest,

Introduction

Giant African Land Snails (GALS) belong to Phylum Mollusca and Class Gastropoda. The body is divided into three major parts: foot, head and visceral mass (Yoloye, 1994). Land snails are found in moist, cool and wet habitats where they carry out their physiological process at night. The visceral mass contained the reproductive and digestive organs all covered by the haemolymph. Albumen gland is a vital part of the visceral mass as it performs great functions during reproduction. Gametes cells are coated with albumen by the albumen gland (Morishita et al., 1998). It is also the chamber where ova are fertilized (Odaibo, 1997). Ademolu et al. (2013) observed that albumen gland of Archachatina marginata were endowed with hydrolyzing enzymes and organic metabolites. In a recent study, the visceral mass was reported to be highly nutritious and can be used as food and feed for farm animals (Ademolu et al., 2017).

Nigeria has six states in the western part and they have different climatic conditions ranging from tropical rainforest to derived savannah (Bamidele *et al.*, 2018). Similarly, the industrial development and urbanization of these states differ. Snails growth and survival are affected by changes in microclimatic factors like relative humidity, temperature and rainfall (Ejidike et al., 2004). Earlier studies (Akinnusi, 2018a; Bamidele et al., 2018) revealed that climatic factors affected the chemical composition of the haemolymph, flesh and shell of land snails species. Since previous studies on GALS had shown that there are variations in flesh composition (Bamidele et al., 2018), shell properties (Akinnusi et al., 2018b) and haemolymph parameters (Akinnusi et al., 2018a) across the six (6) south west states, we hypothesized that the albumen gland properties might likely vary across the six (6) states. Hence, the objective of the study is to determine the nutritional value of the albumen gland of A. marginata across the 6 south west states of Nigeria.

Materials and methods *Experimental snails*

Snails (*A. marginata*) used for this study were collected from the wild (uncultivated farmland) located in 3 local government areas of each state of southwest, Nigeria, namely: Lagos, Ogun, Oyo, Osun, Ondo and Ekiti.

Dissection and processing

The experimental snails (*A. marginata*) were dissected at each location following methods of Ademolu *et al* (2013). Dissected albumen gland samples were preserved in ice packs and transported to the laboratory of Department of Pure and Applied Zoology, Federal University of Agriculture,

Abeokuta (FUNAAB) Nigeria for further chemical analysis.

Chemical analysis

Proximate (moisture content, crude protein, fibre, ash, fat and carbohydrate) composition of albumen gland samples from the six states was determined following A.O.A.C (1990) methods. A.O.A.C. (1990) methods were adopted to determine the anti-nutrients (tannin, saponins, alkaloids, flavonoids and oxalate) composition of the albumen gland. Also, minerals content (Ca²⁺, Mg²⁺, Fe²⁺, Na⁺, K⁺, Po_4^2 , Cl⁻) of the albumen gland were analyzed using Flame photometer and Atomic Absorption Spectrophotometer (AAS). Vitamins A, B, and C assays of the gland were carried by A.O.A.C (1990) methods.

All the chemical analyses were done in triplicates.

Statistical analysis

Data collected from the experiments were analyzed by One-way analysis of variance (ANOVA) and mean separation of significant means was done by Student Newman Kuel (SNK).

Results

The proximate composition of the albumen gland of GALS from six western states of Nigeria is shown in Table 1. The albumen gland of GALS from Ekiti state recorded the highest protein content while Osun state had the least protein content. Similarly, GALS from Ekiti state recorded significantly higher fat, ash and carbohydrate than other states. It is noteworthy that all the experimental snails had no crude fibre. The fat contents of the snails were very low varying from 1.14 - 2.29%.

 Table 1: Proximate composition (%) of the albumen gland of Archachatina marginata from six southwest State, Nigeria

States	Moisture content	Crude fat	Ash	Crude fibre	Crude protein	Carbohydrates
Ոցսո	74 23 ^b	1.82	1 69	0.00	20 50 ^b	1 76 ^b
Oyo	72.42 ^b	1.93	1.75	0.00	21.72 ^b	2.18 ^a
Lagos	76.24 ^b	1.67	1.52	0.00	18.69°	1.88 ^b
Ondo	77.07 ^b	1.69	1.44	0.00	18.19 ^c	1.62 ^b
Ekiti	68.87°	2.29	2.05	0.00	24.40 ^a	2.39 ^a
Osun	83.22ª	1.14	1.06	0.00	12.93 ^d	1.45 ^b
S.E.M.	0.11	0.01	0.01	0.20	0.30	0.03

^{abc} Means in the same column having different superscripts are significantly different (p<0.05)

There were present of macro elements in the albumen gland of GALS from the six states. Ekiti and Ondo states had highest concentration of Ca^{2+} , Mg^{2+} , Na^+ and P which are not significantly different from each other (Table 2). The concentration of minerals in the gland followed this pattern or trend: $P > K^+ > Mg^{2+} > Ca^{2+} > Cl$ has the least concentration of all the minerals.

Table 3 shows that vitamins content of the

albumen gland of GALS from the 6 southwestern states. Vitamin C was not detected in the gland while Ondo state followed by Ekiti state recorded significantly higher vitamin A than other states. The least concentration of antinutrients (secondary metabolites) was recorded by albumen gland from Ondo state (Table 4) while Lagos state had the highest (except flavonoid and oxalate). Nutritional analysis of the albumen gland of giant African land snail (Archachatina marginata)

southwest state, high a								
States	Ca ²⁺	Mg ²⁺	Fe ²⁺	Na ⁺	\mathbf{K}^{+}	Р	CL-	
Ogun	11.23ª	13.31ª	4.39	18.45°	41.20	95.05°	1.85	
Oyo	11.40 ^a	13.59 ^a	4.17	19.84 ^b	42.46	97.91°	2.12	
Lagos	9.36 ^b	11.95 ^b	4.37	20.20 ^a	44.04	100.19 ^c	1.97	
Ondo	12.39 ^a	14.50 ^a	4.52	20.38ª	42.76	110.40 ^a	2.18	
Ekiti	12.72 ^a	14.40 ^a	4.32	19.35 ^b	42.83	96.97°	2.06	
Osun	11.57 ^a	12.56 ^b	3.81	19.48 ^b	43.44	107.88 ^b	2.28	
S.E.M.	0.22	0.13	0.11	0.24	0.02	0.01	0.11	

Table 2: Mineral composition (mg/100g) of the albumen gland of *Archachatina marginata* from six southwest State, Nigeria

^{abc} Means in the same column having different superscripts are significantly different (p<0.05)

Table 3: Vitamin composition (µg/100 g) of the albumen gland of *Archachatina marginata* from six southwest State, Nigeria

States	Vitamin A	Vitamin B	Vitamin C
Ogun	43.81 ^b	0.13	0.00
Оуо	42.24 ^b	0.14	0.00
Lagos	38.68°	0.12	0.00
Ondo	45.51 ^a	0.15	0.00
Ekiti	45.22 ^a	0.14	0.00
Osun	41.51 ^b	0.14	0.00
S.E.M.	0.52	0.25	0.16

^{abc} Means in the same column having different superscripts are significantly different (p < 0.05)

Table 4:	Anti-nutrients ((secondary	metabolites)	composition	(mg/100g)	of the	albumen	gland (of
Archacha	<i>tina marginata</i> f	rom six sou	uthwest State	e, Nigeria					

States	Tannin	Alkaloid	Saponin	Flavonoid	Oxalate	
Ogun	3.33 ^b	7.43 ^a	2.74	3.55 ^b	26.98°	
Оуо	3.08 ^b	6.52 ^a	3.07	3.38 ^b	24.98°	
Lagos	4.06 ^a	8.42 ^a	3.38	4.20 ^b	30.40 ^b	
Ondo	2.91°	5.12 ^b	2.73	2.50 ^c	26.26 ^c	
Ekiti	3.12 ^b	6.59ª	2.96	2.50°	26.92°	
Osun	3.18 ^b	7.11 ^a	2.64	11.74 ^a	42.38 ^a	
S.E.M.	0.06	0.21	0.33	0.29	0.46	

^{abc} Means in the same column having different superscripts are significantly different (p<0.05)

Discussion

The albumen gland of GALS from the southwestern state had high protein content which validates the reason for their consumption by people of western Nigeria. Ademolu *et al.* (2017) earlier reported that albumen gland and hermaphroditic duct of three GALS were very rich in protein and very nutritive. This result is not surprising as the foot (fleshy) part of the snails had been confirmed to be a good source of protein (Imevbore and Ademosun, 1988; Ademolu *et al.*, 2007). Like the flesh part of the snail, the albumen gland has very low

fat content making it safe for consumption by man. Chemical analysis of albumen gland of the three common land snails (*Archachatina marginata, achatina achatina* and *achatina fulica*) found in Abeokuta, Nigeria similarly showed low fat content (Ademolu *et al.*, 2013). Phosphorus, potassium and calcium were present in high concentrations in the albumen gland of GALS from the 6 states. Albumen gland is an exocrine gland containing fertilization chamber where eggs are fertilized. Higher Phosphorus and Calcium than other minerals highlight their

roles in shell formation as earlier reported by Odaibo (1997). Hence, high mineral concentration at this gland means stronger egg shells. Giant Africa land snails from Ekiti and Ondo states recorded significantly higher nutrients and minerals than other south western states. Akinnusi *et al* (2018b) observed that snails from these 2 states had higher shell minerals than other states. This might not be unconnected to the high rainfall, tropical rain forest vegetation and low temperature that characterized the 2 states (Bamidele et al., 2018). Snails from rain forest areas experience high relative humidity, less disturbance due to better cover: better soil qualities derived from fallen leaves and varieties of nourishing food plants. Nutrition and diet have previously been observed to affect chemical properties of albumen gland (Ademolu et al., 2013). Hence, a relative better weather conditions in Ondo and Ekiti states resulting in abundance and varieties of food plants consumed by snails might be responsible for the higher nutrient and minerals recorded by the albumen gland of GALS from the state. Pollutants coming from discharges and exhaust (gases) from vehicles and industries find their way to farmland inhabited by snails, thereby contaminating the soil consumed by snails. This observation might be accountable for high concentration of anti-nutrients in albumen gland of snails from Lagos state. However, it is worth noting that the concentrations of the anti-nutrients in the albumen gland were low and below the FAO recommendations. At low concentrations, anti-nutrients play beneficial pharmacological and therapeutic functions in animal systems (Tiony et al., 2013).

Conclusion

The study has shown that the albumen gland of snails from Ekiti and Ondo states were more nutritious than other southwest states and hence deemed fit for consumption by both man and farm animals.

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Received: 25th August, 2020 Accepted: 16th November, 2020