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Intraspecies variation in nutritive potentials of eggs from two ectotypes of giant African land snail (*Archachatina marginata* var. *saturalis*) in Calabar, Nigeria

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This pilot study provides information on the nutritive potentials of eggs laid by two ectotypes of *Archachatina marginata* var. *saturalis* (P) snails. One hundred (100) adult *A. marginata* snails, 50 each of the black-skinned ectotype and white-skinned ectotype used for the study were selected from the snail sanctuary of the Department of Animal Science, University of Calabar, Nigeria. The snails were raised 5 per hutch and fed fresh paw-paw (*Carica papaya*) leaves and concentrate. Freshly laid eggs from snails' matings were collected from the two ectotypes for chemical analyses (proximate and mineral compositions). Results of the proximate composition of the snail eggs revealed that there were no significant differences (P > 0.05) between the white-skinned and black-skinned *A. marginata* snails for all the fractions (moisture, crude protein, crude fibre, lipid/fat, carbohydrate and ash) analyzed. Results of the mineral composition of the snail eggs also revealed non-significant differences (P > 0.05) between the white-skinned and black-skinned *A. marginata* snails. The results of mineral composition further showed that snail eggs constitute good sources of calcium, iron, sodium, potassium and magnesium, and compared favourably in these minerals with snail meat, as well as meat of lean domestic livestock. These eggs are therefore recommended for both young and old as they will constitute alternative sources of essential nutritional elements (protein and basic minerals) at a lower cost for Nigerians.

Key words: Nutritive potentials, eggs, snail, ectotypes, Nigeria.

INTRODUCTION

Archachatina marginata is the largest known snail kept and reared in Nigeria (Okon et al., 2012). It is an herbivorous non-selective scavenger which dwells naturally in the forest litters of the tropical rainforest of the south and the fringing riparian derived guinea savannah zones of Nigeria (Adedire et al., 1999; Ibom et al., 2012).

There are two known ectotypes of the snail based on the foot (skin) colour, namely; the black-skinned and the white-skinned (Figures 1 and 2). The white-skinned (Albino) ectotype is highly discriminated against by many ethnic consumers in Nigeria (Ebenso, 2003; Ibom et al., 2008; Okon et al., 2009). The reason for this discrimination

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Figure 1. Black-skinned *A. marginata*.

Figure 2. White-skinned *A. marginata.*

according to the authors is that the consumers belief that the white-skinned *A. marginata* are used by "witch doctors" in their activities. Thus, Okon et al. (2009) noted that this has led to the species being found in abundance in any environment it thrives.

Omole and Kehinde (2005) and Ibom et al. (2008) opined that snails lay 4 to 18 eggs in 1 to 2 min unlike chickens that lay one egg per day. Akinnusi (1979) noted that *A. marginata* lays 5 to 11 eggs within the same period (1 to 2 min). Ogogo (2004) described the egg as being spherical and cream yellow in colour; whereas Raut and Barker (2002) stated that the colour of eggs from *A. marginata* is chalky white, Okon and Ibom (2012) opined that the eggs of *A. marginata* are spherical, translucent and yellowish in colour.

The size of giant African land snail (GALS) varies from species to species. It is therefore interesting to know that a small egg size is characteristic of snail. However, the consumption of snail egg is not very common or popular in Nigeria, partly because of its small size and partly because of lack of information on the nutritional qualities of the eggs. Thus, the study was carried out to assess the nutritive values of eggs from both the black-skinned and white-skinned ectotypes of *A. marginata* snail; thereby recommending it as another source of animal protein for the teeming population of the Calabarians in Nigeria.

MATERIALS AND METHODS

The research was carried out in the Department of Animal Science Snailery and the Analytical Laboratory of the Department, University of Calabar, Calabar, Nigeria. The location and climate of Calabar is as prescribed in Okon and Ibom (2011). One hundred (100) adult *A. marginata* var. *saturalis* (P) snails, 50 each of the black-skinned ectotype and white-skinned ectotype were selected from the snail sanctuary of the Departmental Snailery. The snails were raised 5 per hutch and fed fresh paw-paw (*Carica papaya*) leaves and concentrate as recommended by Okon and Ibom (2012). The snails were mated and freshly laid eggs (Figures 3 and 4) were collected from the two ectotypes for chemical analyses.

Proximate composition analyses of the freshly laid eggs were determined by the methods of the Association of Official Analytical Chemists (AOAC, 1990). Nitrogen was determined by the Micro-Kjeldahl method as described by Pearson (1976) and the percentage nitrogen was converted into crude protein by multiplying by 6.25. Lipid content was extracted and determined by methods outlined by Bligh and Dyer (1959) and Holman and Hayes (1958), respectively. Carbohydrate was estimated by the difference between the sum of the values of the previous nutritional components (protein, moisture, fibre, fat and ash) and 100% (accepted overall value of nutritional components).

The mineral components of the snail eggs were analyzed from solutions obtained by first dry-ashing the egg samples at 550°C and dissolving the ash in standard flasks with distilled, de-ionized water containing a few drops of concentrated hydrochloric acid.

Phosphorous was determined calorimetrically from sample using Spectronic-20 (Gallenkamp, U.K.) described by Pearson (1976) with KH_2PO_4, as a standard. Sodium and potassium were analyzed by means of flame photometer (Model 405, Corn, U.K.), using NaCl and KCl to prepare the standards. Calcium, magnesium, iron and zinc were analyzed by means of atomic absorption spectrophotometry (Modak SP 9, Pye Unicam, Uk).

The data obtained were analyzed using T-test of GENSTAT (2004) software package for comparison between the two ectotypes.

RESULTS AND DISCUSSION

The chemical composition of the snail eggs (Table 1) revealed that the crude protein content of the white-skinned and black-skinned *A. marginata* snail eggs were 64.01 ± 2.40% and 63.89 ± 2.35%, respectively. There was no significant difference (P > 0.05) in crude protein between the eggs of these two ectotypes. These values compared favourably with the value of 63.46 ± 2.56% for flesh (foot) obtained by Uboh et al. (2010), but lower than

Figure 3. Eggs from white-skinned *A. marginata.*

Figure 4. Eggs from black-skinned *A. marginata*.

the 80.95 ± 0.01% for flesh (foot) reported by Eneji et al. (2008). The protein values of the snail eggs were also higher than the values of 9.7 to 10.6% and 15.7 to 16.6% reported by Li-Chan et al. (1995) as protein values for chicken egg albumen and yolk, respectively. The high value for protein content of the snail eggs implies that the snail eggs, though small in size is a good source of protein. Hence, due to high cost of poultry products (meat and eggs) and beef, snail eggs that can be obtained at minimal cost may be used as a suitable source of protein.

The percentage moisture contents of the snail eggs obtained were 60.00 ± 2.18% and 59.94 ± 2.00% for white-skinned and black-skinned *A. marginata* snails, respectively. There was no significant difference (P > 0.05) in moisture content between the eggs of these two ectotypes. These values were quite lower than the 80.30 ± 0.03% and 73.69% obtained by Eneji et al. (2008) and Babaloa and Akinsoyinu (2009) for snail meat, respectively. Similarly, the moisture content values of these snail eggs were also lower than the value of 84.3 to 88.8% reported by Li-Chan et al. (1995) for chicken egg albumen. However, the snail egg values obtained in this study were almost similar to the 63.1% moisture content of snail meat reported by Malik et al. (2011). The variation in moisture content obtained may be due to either the method of analysis, strain of snail or snail flesh (meat) used. This analysis was for snail eggs.

The percentage crude fibre contents of *A. marginata* snail eggs were negligible, 0.01 ± 0.01 and 0.00 ± 0.00 for the white-skinned and black-skinned snail eggs, respectively (Table 1). These agreed with the reports of Fagbuaro et al. (2006) and Malik et al. (2011) for snail meat. Uboh et al. (2010) reported a higher crude fibre value of 3.01 ± 0.01% for the snail meat of the same species, making the snail eggs with lower crude fibre level more suitable for consumption than the meat. There was no significant difference (P > 0.05) in crude fibre between the eggs of these two ectotypes studied.

The percentage lipid contents of white-skinned and black-skinned *A. marginata* snail eggs obtained were 1.03 ± 0.02% and 1.01 ± 0.01%. These values were higher than the value of 0.03% reported by Li-Chan et al. (1995) as lipid content value of chicken albumen. However, the snail egg values were quite related to the 1.3 to 1.5% and 1.23 ± 0.01% reported by Asibey and Eyeson (1995) and Fagbuaro et al. (2006) for snail meat. The lipid content values obtained in this study were lower than the value of 31.8 to 35.5% reported by Li-Chan et al. (1995) for chicken egg yolk. Lipid provides energy for the body. Thus, the low fat content makes the snail egg a good antidote for hypertensive patients and those that have fat related diseases. The percentage carbohydrate contents of the two ectotypes of snail eggs were 3.97 ± 0.05% and 3.85 ± 0.04% which was quite higher than the 1.70% obtained by Adeola et al. (2010) for black-skinned *A. marginata* snail meat. Similarly, Li-Chan et al. (1995) also reported lower values of 0.4 to 0.9% and 0.2 to 1.0% for chicken egg albumen and yolk, respectively. There was no significance (P > 0.05) in percent carbohydrate between the eggs of white-skinned and black-skinned *A. marginata*. The results were however lower than the 22.53 ± 1.08% reported by Uboh et al. (2010) for black-skinned *A. marginata* snail meat. The disparity in carbohydrate contents here might be due to the strain or species of snail used as well as the method of analysis either on wet basis or dry basis. Besides, this analysis was done on snail eggs and not the flesh or meat.

This pilot study provides information on mineral elements of snail eggs. The study revealed that snail eggs compared favourably in mineral contents with snail meat, as well as those of lean domestic livestock. Eggs from the two ectotypes of *A. marginata* snail studied constitute good sources of calcium, iron and sodium (Table 2),

Table 2. Mineral composition of GALS (*A. marginata* var. *saturalis*) eggs and meat (DW basis).

Mineral (mg/100 g)	White-skinned eggs	Black-skinned eggs	Meat**
Potassium (K^+)	4.65 ± 0.05	4.62 ± 0.05*	98.47 ± 2.87
Sodium (Na^+)	17.16 ± 1.00	17.28 ± 1.15*	30.89 ± 3.25
Calcium (Ca^{++})	184.20 ± 9.38	185.10 ± 10.15*	199.26 ± 15.32
Iron (Fe^{++})	5.10 ± 0.07	5.00 ± 0.06*	0.64 ± 0.01
Magnesium (Mg^{++})	4.70 ± 0.05	4.72 ± 0.06*	31.00 ± 3.02
Zinc (Zn^{++})	0.08 ± 0.01	0.09 ± 0.01*	2.01 ± 1.01

Values are presented as means ± SD of five determinations. *Not significantly different from each other. **Uboh et al. (2010).

Table 1. Proximate composition of GALS (*A. marginata* var. *saturalis*) eggs and meat (DW basis).

Proximate composition (%)	White-skinned eggs	Black-skinned eggs	Meat**
Moisture content	60.00 ± 2.18	59.94 ± 2.00*	
Crude protein	64.01 ± 2.40	63.89 ± 2.35*	63.46 ± 2.56
Ash	30.98 ± 0.03	31.25 ± 1.80*	2.08 ± 0.01
Crude fibre	0.01 ± 0.01	0.00 ± 0.00*	3.01 ± 0.01
Lipid/Fat	1.03 ± 0.02	1.01 ± 0.01*	2.40 ± 0.02
Carbohydrate	3.97 ± 0.05	3.85 ± 0.04*	22.53 ± 1.08

Values are presented as means ± SD of five determinations. *Not significantly different from each other. **Uboh et al. (2010).

indicating that the consumption of these eggs could increase the levels of these minerals in the human body. Minerals play a vital role in the maintenance of various biochemical activities. For instance, calcium present in high concentrations, 184.20 ± 9.38 mg/100 g and 185.10 ± 10.15 mg/100 g for white-skinned and black-skinned *A. marginata* snails, respectively is known to play a crucial role in blood clotting and bone development in human. No wonder snail meat is used to stop bleeding during child birth (Akinnusi, 2002; Okon and Ibom, 2012). The calcium values of this study were higher than the values of 0.008 to 0.02% and 0.121 to 0.262% reported by Li-Chan et al. (1995) for chicken egg albumen and yolk, respectively. According to Pearson and Gillel (1999), calcium is the most abundant mineral element in the animal body and considered as an important constituent of the skeleton and teeth, in which about 99% of total calcium in the body is found. Besides, calcium is also important for the activity of a number of enzyme systems, including those necessary for the transmission of nerve impulses.

The eggs from the two ectotypes of *A. marginata* snails studied also constitute good sources of iron. The iron contents of 5.10 ± 0.07 mg/100 g and 5.00 ± 0.06 mg/100 g obtained for white-skinned and black-skinned *A. marginata* snails, respectively, though not significantly different ($P > 0.05$) from each other were quite higher than the 2.29 mg/100 g and 0.64 ± 0.01 mg/100 g values reported by Babalola and Akinsoyinu (2009), and Uboh et al. (2010), respectively for snail meat of the same species. Li-Chan et al. (1995) reported 0.0009% and 0.00053 to 0.011% as iron content of albumen and yolk, respectively of chicken egg, which is also lower than the iron values obtained in this study for the eggs of the two snail ectotypes evaluated. The disparity in the levels of iron is attributed to variations in iron contents from one locality to another, depending on the mineral content of the soils in which the snails were raised (Wosu, 2003). Iron facilitates the oxidation of carbohydrate, protein and fats. The iron in the eggs will not only enhance the absorption of iron from other sources such as cereals but will also increase considerably the level of iron absorption in the blood and prevent anemia (Andrew, 2011). Iron also helps in bone and teeth formation as well as for haemoglobin of the red blood cells in human.

Magnesium contents of the two ectotypes snail eggs obtained were 4.70 ± 0.05 mg/100 g and 4.72 ± 0.06 mg/100 g for white-skinned and black-skinned *A. marginata* snail eggs, respectively. These values though quite lower than the value of 31.00 ± 3.02 mg/100 g reported by Uboh et al. (2010) for *A. marginata* snail meat, were higher than the values of 0.009% and 0.032 to 0.128% reported by Li-Chan et al. (1995) for chicken egg albumen and yolk, respectively. The low magnesium content of snail eggs obtained here might be due to differences in the level of magnesium in the soil used for the rearing and the inability of the snails used to transfer a reasonable amount of this magnesium to the eggs.

Magnesium is a key element in cellular biochemistry and functions. Magnesium is closely associated with calcium and phosphorous and about 70% of the total magnesium is found in the skeleton. Magnesium is an enzyme activator, for example, in systems with thiamine pyro-phosphate as a co-factor and oxidative phosphorylation is reduced in magnesium deficiency. It is an essential activatior of phosphate transferase, activates pyruvate carboxylase, pyruvate oxidase and the reactions of the tricarboxylic acid cycle (Lehninger, 1984; Uboh et al., 2010).

Potassium values (4.62 ± 0.05 mg/100 g and 4.65 ± 0.05 mg/100 g for black-skinned and white-skinned ectotypes, respectively) obtained for these snail eggs though low will help to play an important role in osmotic regulation of the body fluid and in acid-base balance in the animal. The potassium values obtained for the snail eggs in this study were higher than the values of 0.145 to 0.167% and 0.112 to 0.360% reported by Li-Chan et al. (1995) for chicken egg albumen and yolk, respectively. The potassium content of these eggs will also participate in nerve and muscle excitability as well as carbohydrate metabolism (Aganga et al., 2003; Uboh et al., 2010).

Zinc contents obtained from the study were 0.08 ± 0.01 mg/100 g and 0.09 ± 0.01 mg/100 g for white-skinned and black-skinned *A. marginata* snail eggs, respectively. These values were not significantly different (P > 0.05) from each other but compare with the value of 0.5 mg/100 g reported by Andrew (2011) for chicken egg. The zinc values obtained in this study were lower than the 1.69 mg/100 g and 1.16 ± 0.01 mg/100 g values reported by Fagbuaro et al. (2006) and Eneji et al. (2008), respectively for snail meat. The low zinc content in snail eggs implies that the eggs are non-toxic to health, thus, recommended for human consumption.

Conclusion

The results of this pilot study showed that the eggs of the two ectotypes of *A. marginata* (white-skinned and black-skinned) snail are not significantly different (P > 0.05), thus, they are good sources of protein and basic minerals. These eggs are highly recommended for both young and old. The snail eggs constitute an alternative source of essential nutritional elements at a lower cost for Nigerians.

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