**Nutritional value of the visceral mass of three giant African land snail species
(*Archachatina marginata*, *Achatina achatina*, and *Achatina fulica*)**

Ademolu, K. O.*¹, Onadeko, D. E.¹, Akinnusi, F. A. O.², Mselbwala, F. M.³, Oropo, A.¹

¹Department of Pure and Applied Zoology, Federal University of Agriculture, Abeokuta,

Ogun State, ²Department of Agricultural Education,

Federal College of Education, Abeokuta, Ogun State,

³College of Veterinary Medicine, Federal University of Agriculture,
Abeokuta, Ogun State

*Corresponding author: kennyademolu@yahoo.com

Abstract

Edible snails are very important as food and adequate information is available on their nutritional, medicinal, and economic benefits. Though the more commonly consumed portion is the flesh, some people however consume the visceral mass, hence the need to determine its nutritional benefits. Two structures of the visceral mass (albumen gland and common hermaphrodite duct) of *Archachatina marginata*, *Achatina achatina* and *Achatina fulica* were analyzed to determine their proximate, mineral, and anti-nutrient compositions. The albumen glands in the three snail species had higher protein ($36.81 \pm 0.02\%$ - $42.69 \pm 0.02\%$) and carbohydrate contents ($0.62 \pm 0.01\%$ - $0.72 \pm 0.02\%$) than hermaphroditic duct, while the hermaphroditic ducts had the higher moisture content ($78.46 \pm 0.02 \pm 0.01\%$ - $80.55 \pm 0.01\%$). *A. marginata* had the highest total nutrients value and the highest total anti-nutrients value; *A. achatina* had the lowest total nutrients value and *A. fulica* had the lowest total anti-nutrients value. This study showed that the edible parts of the visceral mass are nutritious and suitable to be used as food and feed.

Keywords: Visceral mass, GALS, *A. marginata*, *A. achatina*, *A. fulica*, Nutritive value

Introduction

Giant African land snails are pulmonate gastropods belonging to the Phylum Mollusca, the second largest invertebrate Phylum after Arthropoda (Yoloye, 1994). The three species commonly found in tropical Africa are *Archachatina marginata*, *Achatina achatina*, and *Achatina fulica* (Cobbinah, 1993). The body of a snail is divided into the head, foot and visceral mass. The visceral mass is protected by the calcareous shell and consists mainly of the snail's digestive and reproductive organs (Yoloye, 1994). Snail meat is high in protein, low in fat, and is a very rich source of iron (Ademolu *et al.*, 2007; Akinnusi, 2014); they are classified as the major and cheapest protein sources in Nigeria, and their protein compares favorably with conventional sources of

animal protein (Imevbore and Ademosun, 1988; Yoloye, 1994; Ademolu *et al.*, 2007). Snail meat is low in fat, and this makes it useful as an antidote for fat-related diseases. Also, the snail shell which makes up about 30% of its body weight is a good source of calcium (Bright, 1996). The flesh and haemolymph are rich in Ca^{2+} , Mg^{2+} , Na^{+} , Zn^{+} , Fe^{2+} , and Cl^{-} . In traditional medicine, snail flesh and haemolymph are used to prepare concoctions for pregnant women, and in some healing procedures (Akinnusi, 2014), such as reduction of labor pain and blood loss (Amusan and Omidiji, 1999; Akinnusi, 2014). In consumption, the snail foot is the more commonly acceptable portion; however, in some parts of South Western Nigeria, the visceral mass parts are also consumed especially by young children. Information on the nutritional benefits of the

Nutritional value of the visceral mass of three giant African land snail species

visceral mass of GALS is missing in literature, hence this study was carried out to determine and compare the nutritive values of the two edible parts (albumen gland and common hermaphroditic duct) of the visceral mass of the giant African land snail species.

Materials and methods

Snail sample

Forty-five (45) adult GALS snails (15 for each species) were purchased from the snail pen of the Department of Forestry and Wildlife Management, College of Environmental and Rural Management, Federal University of Agriculture Abeokuta (7° 15'N and 3° 25'N), Nigeria.

Dissection and processing

The experimental snails were killed and dissected using the methods described by Segun (1974). Two edible parts of the visceral mass (albumen gland and common hermaphrodite duct) were clearly cut out into separate petri dishes.

Chemical analysis

The proximate composition of the two parts was evaluated using the standard methods of Association of Official Analytical Chemists (A.O.A.C) (1990). Nitrogen (N₂) content was determined by micro-kjedhal method and the % N₂ was converted to crude protein by multiplying by 6.25. Carbohydrate was determined by difference between 100% and sum of protein, moisture content, fibre, fat and ash. A known mass of the dry sample was ashed at 600°C in muffle furnace for 4 hours. The ash was dissolved in 6M HCl

solution and the resulting solution was used for determination of anti nutrients and minerals. Na⁺ and K⁺ were determined by Flame Photometer (Cornin UK model, 405), while other minerals were determined using Atomic Absorption Spectrophotometry (AAS) (Pye Unicam, Uk model SP 9). Chloride was assessed by spectrophotometric method (SP 118 photometer). Also, total oxalate, hydrocyanide, tanic acid and phytic acid content of the experimental snails were determined using methods of A.O.A.C (1990). The experiments were done in triplicate.

Statistical analysis

Data collected were analysed by one way analysis of variance (ANOVA) and significant means were separated by Student – Newman Kuel Test.

Results

Table 1 shows the results of the proximate composition of the albumen gland of *A. achatina*, *A. marginata*, and *A. fulica*. *A. marginata* (GALS) had the highest moisture content (60.32±0.02%), while *A. fulica* had the least (53.85±0.02%). The fat content was relatively low in all species, however, *A. fulica* had the highest fat content (1.32±0.02%), and *A. marginata* had the least (1.00±0.01%). The ash content was also low, with *A. fulica* having the highest value (1.42±0.02%), and *A. marginata* having the least (1.26±0.01%). The protein content was high in all species; *A. fulica* had the highest crude protein content (42.69±0.02%), while *A. marginata* had the least (36.74±0.01%).

Table 1: Proximate composition (%) of the albumen gland of the three GALS species

Snail Species	Moisture Content	Fat Content	Ash Content	Crude Fibre	Crude Protein	Carbohydrate Content
<i>A. achatina</i>	60.00±0.01 ^a	1.26±0.02	1.31±0.01	ND	36.81±0.02 ^b	0.62±0.01
<i>A. marginata</i>	60.32±0.02 ^a	1.00±0.01	1.26±0.01	ND	36.74±0.01 ^b	0.68±0.01
<i>A. fulica</i>	53.85±0.02 ^b	1.32±0.02	1.42±0.02	ND	42.69±0.02 ^a	0.72±0.02

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

Table 2 shows the results of the proximate composition of the common hermaphroditic duct of the GALS. *Achatina achatina* had the highest moisture content (80.55 ± 0.01), while *A. marginata* had the least (78.46 ± 0.02). The fat content here was also minimal, and *A. achatina* had the highest fat content

(1.19 ± 0.02), while *A. fulica* had the least (0.96 ± 0.01). *A. marginata* had the highest value for ash content (1.06 ± 0.02), while *A. achatina* had the least (0.92 ± 0.01). The protein content in the hermaphroditic duct was relatively low, with *A. marginata* having the highest value (18.89 ± 0.02), and *A. achatina* having the least (17.11 ± 0.01).

Table 2: Proximate composition (%) of the common hermaphroditic duct of the three GALS species

Snail Species	Moisture Content	Fat Content	Ash Content	Crude Fibre	Crude Protein	Carbohydrate Content
<i>A. achatina</i>	80.55 ± 0.01^a	1.19 ± 0.02^a	0.92 ± 0.01^b	ND	17.11 ± 0.01^b	0.22 ± 0.01
<i>A. marginata</i>	78.46 ± 0.02^c	1.08 ± 0.01^a	1.06 ± 0.02^a	ND	18.89 ± 0.02^a	0.51 ± 0.02
<i>A. fulica</i>	80.00 ± 0.01^b	0.96 ± 0.01^b	1.04 ± 0.02^a	ND	17.62 ± 0.01^b	0.38 ± 0.01

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

Table 3 shows the anti-nutrient composition of the albumen gland of the GALS. The anti-nutrients were found to be in low amounts. *A. marginata* had the highest tannin (2.04 ± 0.02 mg/100g), oxalate (2.01 ± 0.02 mg/100g), and hydro cyanide (0.55 ± 0.02 mg/100g) values, *A.*

achatina had the least phytate (0.45 ± 0.01 mg/100g) and hydro cyanide (0.41 ± 0.01 mg/100g) values, while *A. fulica* had the lowest tannin (1.56 ± 0.01 mg/100g), and oxalate (1.62 ± 0.01 mg/100g) values, but the highest phytate (0.72 ± 0.02 mg/100g) value.

Table 3: Anti-nutrient composition (mg/100g) of the albumen gland of the three GALS species

Snail Species	Tannin	Phytate	Oxalate	Hydro Cyanide
<i>A. achatina</i>	1.82 ± 0.02^b	0.45 ± 0.01	1.86 ± 0.01^b	0.41 ± 0.01
<i>A. marginata</i>	2.04 ± 0.02^a	0.63 ± 0.01	2.01 ± 0.02^a	0.55 ± 0.02
<i>A. fulica</i>	1.56 ± 0.01^b	0.72 ± 0.02	1.62 ± 0.01^b	0.42 ± 0.01

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

Table 4 shows the anti-nutrient composition of the common hermaphroditic duct of the GALS. The anti-nutrients in the hermaphroditic duct were also in low amounts. *A. marginata* had the highest tannin (1.72 ± 0.01 mg/100g) value, but the lowest phytate (0.87 ± 0.01 mg/100g), and oxalate

(1.87 ± 0.01 mg/100g) values. *A. achatina* had the highest phytate (0.92 ± 0.02 mg/100g), and oxalate (2.45 ± 0.02 mg/100g) values, but the least hydro cyanide (0.46 ± 0.02 mg/100g) value. *A. fulica* recorded the highest hydro cyanide (0.61 ± 0.02 mg/100g) value, and the least tannin (1.16 ± 0.02 mg/100g) value.

Table 4: Anti-nutrient composition (mg/100g) of the common hermaphroditic duct of the three GALS species

Snail Species	Tannin	Phytate	Oxalate	Hydro Cyanide
<i>A. achatina</i>	1.67 ± 0.01	0.92 ± 0.02	2.45 ± 0.02^a	0.46 ± 0.02
<i>A. marginata</i>	1.72 ± 0.01	0.87 ± 0.01	1.87 ± 0.01^b	0.51 ± 0.01
<i>A. fulica</i>	1.16 ± 0.02	0.89 ± 0.01	2.37 ± 0.01^a	0.61 ± 0.02

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

Nutritional value of the visceral mass of three giant African land snail species

Table 5 shows the mineral composition of the albumen gland of the GALS. Sodium, calcium, iron, and chloride (Na^+ , Ca^{2+} , Fe^{2+} , and Cl^-) were detected in the albumen gland of the three snail species. However they were found in small amounts. Of all the

minerals, Ca^{2+} was recorded to have the highest values in all three GALS species (*A. achatina*- $1.87 \pm 0.01 \text{ mg/100g}$, *A. marginata*- $1.91 \pm 0.01 \text{ mg/100g}$, and *A. fulica*- $1.92 \pm 0.01 \text{ mg/100g}$). No significant difference ($p > 0.05$) was observed in the values across all three GALS species.

Table 5: Mineral composition (mg/100g) of the albumen gland of the three GALS species

Snail Species	Ca^{2+}	Na^+	Fe^{2+}	Cl^-
<i>A. achatina</i>	1.87 ± 0.01	0.54 ± 0.01	0.1 ± 0.01	0.09 ± 0.01
<i>A. marginata</i>	1.91 ± 0.01	0.62 ± 0.02	0.1 ± 0.01	0.09 ± 0.01
<i>A. fulica</i>	1.92 ± 0.01	0.52 ± 0.01	0.08 ± 0.02	0.08 ± 0.01

Table 6 shows the mineral composition of the common hermaphroditic duct of the GALS. Sodium, calcium, iron, and chloride (Na^+ , Ca^{2+} , Fe^{2+} , and Cl^-) were detected in small amounts. As was observed in the mineral analysis of the albumen gland, Ca^{2+}

had the highest overall values (*A. achatina*- $2.06 \pm 0.01 \text{ mg/100g}$, *A. marginata*- $2.12 \pm 0.01 \text{ mg/100g}$, and *A. fulica*- $2.16 \pm 0.01 \text{ mg/100g}$). There was no significant difference ($p > 0.05$) in the values across the three species.

Table 6: Mineral composition of the common hermaphroditic duct of the three GALS species

Sample	Ca^{2+}	Na^+	Fe^{2+}	Cl^-
<i>A. achatina</i>	2.06 ± 0.01	0.67 ± 0.01	0.10 ± 0.0	0.08 ± 0.01
<i>A. marginata</i>	2.12 ± 0.01	0.63 ± 0.01	0.09 ± 0.02	0.07 ± 0.01
<i>A. fulica</i>	2.16 ± 0.01	0.72 ± 0.02	0.11 ± 0.01	0.08 ± 0.01

Discussion

The proximate analyses carried out on the edible visceral parts of the giant African land snails (GALS) have shown that they have high nutritive value, which makes them good for consumption by humans and livestock. The visceral parts in this study are rich in protein and low in fat, which corresponds with earlier reports by Imevbore and Ademosun (1988); Ketiku and Adeleke (1998); Ademolu *et al.* (2007) and Akinnusi (2012). Therefore it can be deduced from the results of this research that the visceral mass of GALS are also good sources of nutrients required by the body. Snail meat has been recommended for patients of heart related diseases (Akinnusi,

2012). Fats are known to increase the cholesterol level in the blood, and complicate cardiac diseases as they block the arteries carrying blood to the body tissues, especially the brain, causing hypertension, and stroke, hence, a low-fat diet is preferred, and the edible visceral parts which are low in fat, can be classified as healthy diet. This study also shows that the visceral parts have similar nutrient and anti-nutrient values with the foot, which is more commonly consumed. This could be because the snail has an open circulatory system, through which the haemolymph bathes all the organs and tissues, thus making the fluid content available to the visceral mass (Ademolu *et al.*, 2007). There were significant

differences in the values of protein and carbohydrate in the two visceral parts; the albumen glands in the GALS species had higher protein and carbohydrate values than the common hermaphrodite duct, which agreed with the report of Ademolu *et al.* (2009). These differences could be due to the fact that they perform different functions (Segun, 1974). The common hermaphrodite duct functions as a passage or channel through which gamete cells are transported into the albumen gland where they are coated with albumen (Morishita *et al.*, 1998). Albumen also contains a fertilization chamber where ova are fertilized (Odaibo, 1997). Albumen gland is a tubular gland that secretes perivitelline fluid composed of protein and polysaccharide complex which coat fertilized eggs (Morishita *et al.*, 1998). The visceral parts have high moisture content and this corresponds with earlier reports by Udoh *et al.* (1995); Fagbua *et al.* (2006); Idowu *et al.* (2008) on the moisture content in meat of *Limicolaria aurora* (71.24%) and GALS (76-78%). The visceral parts had low anti-nutrients concentrations in all species of snails analyzed, which corresponds with an earlier report by Udoh *et al.* (1995) on low concentrations of anti-nutrients in the meat of *L. aurora*. High concentrations of anti-nutrients decrease the body's ability to absorb nutrients essential for growth and development, which makes them injurious to health when accumulated beyond certain amounts in the body (Tiong *et al.*, 2013), for example, the lethal dose of oxalate and hydro cyanide range from 2g to 5g and 0.5mg/kg-3.5mg/kg respectively (Oke, 1969). However, at low concentrations, they are capable of eliciting appreciable pharmacological or therapeutic functions. For instance, alkaloids have been associated with anti-diabetic effects in

animal model studies (Tiong *et al.*, 2013). The mineral composition of the visceral parts in all species were all in low concentrations, and this makes them safe for consumption because an increase in or high concentration of K^+ and Cl^- raises the osmotic potential of cells and if not checked can result in damage of cells due to haemolysis (Odiete, 1999).

This study revealed that all GALS species analyzed are nutritious and safe for consumption, however, the proximate analysis showed that *A. marginata* had higher nutrient values than the other species. The diet and habitat of snails have great effect on their nutrition, and the *A. marginata* snails used in this research may have had more favorable diet and environmental conditions than the other species. *A. achatina* had the lowest total nutrients value, while *A. fulica* appeared to have the highest total mineral and the lowest total anti-nutrient values.

Conclusion

This study has shown that the digestive (albumen gland) and reproductive (common hermaphroditic duct) parts of the visceral mass are not only edible, but also nutritious and safe for consumption by humans and livestock.

References

- Ademolu, K. O., Idowu, A. B. and Jayeola O. A. 2009. Changes in Haemolymph Biochemical values during different growth phases in African giant land snail, *Archachatina marginata* (Swainson). *Nigerian Journal Animal Production* 36:161-166.
- Ademolu, K. O., Idowu, A. B., Mafiana, C. F. and Osinowo, O. A. 2007. Performance, proximate and mineral analysis of African giant snail

Nutritional value of the visceral mass of three giant African land snail species

- (*Archachatina marginata*) fed different nitrogen sources. *Tropical veterinarian* 25 (4):124-131.
- Akinnusi, F.A.O. 2014.** Snail Production and Management. Tolukoya Print House, Abeokuta. Pp 7-11.
- Amusan, J. A. and Omidiji, M. O. 1999.** Edible land snails- a technical guide to snail farming in the tropics. Ibadan: Verital Printers, Ibadan. Pp 1-16, 5-50.
- A.O.A.C. 1990.** Association of Official Analytical Chemist. Ed. W. Horwitz 13th edition Washington, D.C 1141pp.
- Bright, S. O. 1996.** Prospects and problems associated with snail farming. Heritage Printer, Nig. Ltd., Lagos. Pp 96.
- Cobbinah, J. R. 1993.** Snail farming in West Africa. A Practical CTA. UK, pp. 1-15.
- Imevhore, E. A. and Ademosun, A. A. 1988.** The nutritive value of the African giant land snail (*Archachatina marginata*). *Animal Production Research*. 8(2): 76-87.
- Ketiku, A. O. and Adeleke, A. O. 1998.** Nutrient composition of Black fleshed and white fleshed African giant land snails (*Archachatina marginata*). *West African Journal of Biological and Applied Chemistry*. 44:21-23.
- Morishita, F., Mukai, S. T. and Saleuddin, A. S. 1998.** Release of proteins and polysaccharides from albumen gland of fresh water snail *Helisoma duryi*: effect of CAMP and brain extracts. *Journal of Comparative Physiology (A)*. 182:817-825.
- Price, K. R., Johnson, I. T. and Fenwick G. R. 1987.** The chemistry and biological significance of saponins in foods and feeding stuffs. *Crit Rev Food Sci Nutri*. <www.ncbi.nlm.nih.gov/pobmed/3308321>.
- Odaibo, A. B. 1997.** Snails and Snail farming. Nigerian Edible Land Snails. Stirling –Hordon Publishers, Ibadan, Nigeria. 29pp.
- Odiete, W. D. 1999.** *Environmental Physiology of Animals and Pollution*. Diversified Resources Ltd. Surulere, Lagos. Pp 95-97.
- Oke, O. L. 1969.** Oxalic acid in plants and in nutrition. *World Rev. Nutrition* 10: 262-302.
- Segun, A. O. 1974.** The Giant Land Snail, *Archachatina (Calachatina) marginata*, Swainson. Ethiopic Publishing House and Midwest Mass Communication Corporation, Benin City. Pp 10-15.
- Tiong, S. H., Looi, C. Y., Hazni, H., Arya, A., Paydar, M., Wong, W. E., Cheah, S. C., Mustapha, M. R. and Awang, K. 2013.** Antidiabetic and antioxidant properties of alkaloids from *Catharantus roseus* (L). *Molecules* 18(8):9770-9784.
- Udoh, A. P., Akpanyung, E. O. and Igiren, I. E. 1995.** Nutrients and antinutrients in small snails (*Limicolaria aurora*). *J. Food Chem*. 53: 239-241.
- Yoloye, V. I. 1994.** Basic Invertebrate Zoology. Code and Quanta, Nigeria LTD pp140-145.

Received: 10th July, 2017

Accepted: 9th December, 2017