



## Chemical composition of snail offal waste from Giant African Land Snail as animal protein source in aquaculture nutrition

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### Abstract

Snail meat is a relished delicacy for its nutritional and health benefits all over the world while its production and consumption has increased tremendously with the attendant waste generated from snail processing. Information is scanty on Snail Offal Waste (SOW) composition and nutritional value. SOW was analysed for its nutritional contents according to standard methods. The offal waste of African giant land snails (*Archachatina marginata*; *Achatina achatina*) proximate composition revealed a crude protein of  $43.78 \pm 0.07$ , fat  $24.61 \pm 0.01$ , ash  $8.48 \pm 0.00$ , moisture content  $6.73 \pm 0.06$ , fibre content  $1.79 \pm 0.02$  and NFE  $16.49 \pm 0.03$ . The mineral content analysed were for macro mineral P 10.73g/kg, Ca 9.95g/kg, Mg 7.76g/kg, K 5.40g/kg, Na 1.71g/kg while micro mineral were low Mn 0.80g/kg, Fe 0.39g/kg, Zn 0.38g/kg and Cu 0.07g/kg. Amino acid profile analysis revealed samples to contain methionine, 2.19g/100g; Lysine, 4.56g/100g and tryptophan, 1.05g/100g. Glutamic acid was the highest (12.57g/100g) and cysteine the lowest (0.90g/100g). Snail offal waste can be utilised as feedstuff ingredient that furnishes essential nutrients in livestock ration to replace other expensive animal protein sources.

**Key words:** Heliculture, feedstuff, Inedible, Snail offal, Waste.

### Introduction

Heliculture, the culture of snail for table meat has been on the increase while collection from the wild has also helped in nutrition and income generation for the rural dwellers. Consumers prefer the consumption of Giant African Land Snails (Olaleye, 2013) due to its dressing yield over other species. The economic value of waste from terrestrial livestock has been of importance in recent times (Falaye, 1992; Kale *et al.*, 2011). Snail farming and snail meat consumption is on the increase worldwide, hence the need to harness the by-product from snail meat processing. Cobbinah *et al.*, (2008) reported the annual consumption of 7.9 million kg of snail in Cote

d' Ivoire while worldwide consumption of 400,000 tons of which only 55,000 tons were produced from heliculture with turnover of 10 billion Euro in 2010 and 2011 (Toader, 2012). Snail exportation is under reported (Yildirim *et al.*, 2004) worldwide. The consumption of this lean nutritious meat generates non-edible waste that constitute nuisance with malodorous odour (Imevbore, 1987 in Odunaiya, 1995). The offal contains visceral mass of heart, kidney, loop of intestines reproductive, respiratory, circulation, digestion organs and eggs (Murphy, 2001; Sule and Sotolu, 2010). Hodasi, 1984 (in Odunaiya 1995) reported the weight of Giant African land snails of West Africa's advantage over commercially farmed

European species with largest European species (*Helix pomata*) market weight between 16g-25g and African species between 80g-200g. Awesu, (1980) (in Odunaiya, 1995) and Serra (1997) reported 21% extraction rate for golden snail meat. Cobbinah *et al.*, (2008) reported the visceral mass of 32-34g/snail by weight of 200g live weight snail. Morrissey (2018) reported the global snail market to worth millions of dollars with the sale of forty-three thousand tons of snail in 2016. Proximate analysis, mineral content and amino acid of snail meat along with its use as food and feed has been widely researched Gohl (1981); Imevbore and Ademosu (1988); Shafiei and Costa (1989); Imevbore (1990); Ayodele (1992); Firmin (1995); Yusuf (1998); Adebowale (1998); Sogbesan *et al.*, (2006); Oyelese (2007). While Adeyeye (1996) reported collection of snail intestine for use as organic fertilizer. Sule *et al.*, (2019) analysed the essential amino acid profile of the waste. The inedible part removed and discarded after processing for *A. marginata* (Awah *et al.*, 2009). The waste generated from snail processing and evisceration of meat from shell at market currently constitutes environmental hazards and extra cost is involved in proper disposal. Information on the offal generation capacity abounds in literature but lacking on the analysis of Snail Offal Waste (SOW) utilisation in livestock nutrition which necessitated this study.

### Materials and Methods

The morphometric (weight of shells, meat, SOW, eggs were related to total weight of snail) of Fifty adult *Archachatina marginata* and *Achatina achatina* species were collected and snails eviscerated of its meat from its shell and SOW processed by boiling in water for 10 minutes and oven dried at 60°C for 8 hours according to Sule (2001). Proximate analysis of replicate samples of SOW was carried out at the Department of Human Nutrition

Laboratory, University of Ibadan according to AOAC (2000). Amino acid profile analysis was according to Dedeke *et al.*, (2010). This was conducted using HPLC/TSM (High Performance Liquid Chromatograph/Technichon Technosequential Multisample analyser). Ten (10) gram of oven dried snail offal was weighed and 7ml of 6N HCl added into ampoule sample. The ampoule sample was subjected to heat on a Bunsen burner flame in an oven at 105°C for 22 hours. The cooled ampoule was filtered off its humins and filtrate evaporated to dryness in a rotary evaporator under vacuum at 40°C. Filtrate was dissolved with 5ml acetate buffer and stored in freezer. Hydrolysed filtrate of 5-10 microliter was loaded into the cartridge system of the TSM and analysed after 76 minutes by reading off the height of each peak on the TSM chart recorder. The amount of each amino acid in the sample was calculated in g/100g crude protein. Mineral analysis was conducted at the Department of Agronomy, University of Ibadan, using Atomic Absorption Spectrophotometer according to Babalola and Akinsoyinu (2009). Descriptive statistics IBM SPSS 20 was used to analyse morphometric of specimen and reported as means  $\pm$  SE.

### Results and Discussion

Ascertaining the quantitative inedible portion for feed and livestock protein requirement is essential due to the volume generated from snail processing at the markets. Snails are sold in open and specialised snail markets, while species identification and difference is not of utmost concern to consumers. Snail offal collections have been reported at local markets in two states in South Western Nigeria (Sule and Sotolu, 2010) which are waste product of snail meat processing.

The morphometric of sample indicated (Table 1) the weight, length, flesh weight and offal yield respectively. Quantity of snail used

for this study doubled that of Shafiei and Costa (1989) of twenty-three; similar to Aluko *et al.*, (2014) of fifty and forty samples for species been studied and lower to Ademolu *et al.*, (2016) of ninety samples for species combination. Per-cent waste yield from samples were lower to Adeyeye (1996) who reported waste generated from three species of land snails ranged 39.93%-50.79%, which is enormous when processed snail consumption is taken into consideration and the offal weight in line with Cobbinah *et al.*, (2008) 17%; Oluokun *et al.*, (2005) 37.9-45.18g; Okonkwo and Anyaene (2009) 33.6g; Ugwuowo and Ani (2011) 29.8-32.0g and Omole *et al.*, (2013) 28.69- 43.85g. The whorls in this study were lower than six whorls reported by Ademolu *et al.*, (2016) suggesting that the samples are yet to attain their maximum age and size. The weight of snail (live weight) in this study falls within the range reported by Oluokun *et al.*, (2005) (197.2-232.4g) and Badmus *et al.*,

(2011) (145.07- 184.43g). The edible weight falls within the range reported but a little higher than Adeyeye (1996). The shell weight and per cent shell in line with Oluokun *et al.*, (2005) 44.17-55.59g; Cobbinah *et al.*, (2008) 30% while value is than Okonkwo and Anyaene (2009) 18.6g. The fluid for Cobbinah *et al.*, (2008) 13% and Awah *et al.*, (2009) 32.5g are within values reported for this study. Length of specimen also within the range of Adeyeye (1996) 5.00- 14.20cm; Siyanbola (2008) 11.23-13.98cm and lower to Awah *et al.*, (2009) 15.8cm. The eggs collected in the offal were low and within the reported value of Mogbo *et al.*, (2013) 4-18 eggs, this may be as a result of the season of collection as the snails were collected in dry season, with the egg size higher than Gorka *et al.*, (2017) of 0.03g which is as result of species. The African giant land snails possess a higher capacity to generate waste than other species of snails in the world due to the size of the species.

**Table 1: Morphometric characteristics and waste yield from Snail offal waste**

Parameters	Minimum	Maximum	Mean±Std. Error
Weight (g)	115.88	214.19	172.01±12.06
Length (cm)	10.50	13.00	11.51±0.29
Whorls	3.00	4.00	3.63±0.18
Shell weight (g)	35.23	58.10	48.21±2.84
Edible weight (g)	41.26	91.09	66.59±5.55
Offal weight (g)	22.80	53.36	32.71±3.39
Egg number	0.00	5.00	1.13±0.74
Egg weight (g)	0.00	11.75	2.91±1.90
% offal	14.68	24.91	19.02±1.23
Fluid (g)	7.26	40.20	24.49±4.18
Weight less fluid (g)	102.19	192.31	147.51±9.61
% fluid	4.83	20.00	13.86±1.83
% flesh	35.18	42.53	38.52±0.98
% shell	22.34	38.65	28.60±1.95

In Table 2 the nutritive value showed comparative analysis of different species of snail meat to this study (SOW) with that of other scientists, which indicated the nutritive importance of SOW which makes it a potential choice of protein in feeding livestock and

aquatic organism.

The crude protein for SOW is lower than values reported by reduced against Sule and Sotolu (2010) when used in the diet of *Clarias gariepinus*. However, it is similar to the result of *A. fulica* 42.69% by Ademolu *et al.*, (2017)

for the albumen gland of the snail and also comparable to the report of Shafiei and Costa (1989) for *A. fulica* meal in *O. mossambicus* diet. The ash content was higher to the result of Gohl (1981); Shafiei and Costa (1989); Sogbesan *et al.*, (2006); this could be as a result of season of the year and biodiversity loss with less forage and concentration of high lipid during aestivation. SOW is high in fat for this research. This is not in consonance with Gohl (1981); Shafiei and Costa (1989); Sule and Sotolu (2010) that reported lower fat content for the snail meal. Babalola and Akinsoyinu (2009) analysis of different fresh snail meat *A. marginata* (19.53%); *A. achatina* (17.20%); *A. fulica* (10.08%) and *Limicolaria sp.* (5.86%) were lower which differs entirely from this study. The SOW contain a lower protein content and this was contrary to Ravindran and Blair (1993) 60%; Sogbesan *et al.*, (2006) 66.67%; Cobbinah *et al.*, (2008)

60.8%; as the main protein in fresh snail meat that had been extracted for consumption, which differs from the remnant in current study. This is in line with the findings of Lubell (2004) who stated that this may be as a result of phytophagous feeding nature on different plant species and the analytical method employed in the analysis. It was also noted during the heat treatment that the water was green with emission of irritating odour, which gave the waste a bad taste. Lubell (2004) reported that this is due to the excretory products which accumulated in the snail organs. Ravindran (1987) cited in Ravindran and Blair (1993) reported that SOW contains 70-90mg/kg hydrocyanic acid which might be responsible for the bitter taste. This taste can however be eliminated totally through boiling in water for 15 minutes (Ravindran, 1987) which this study actually experimented.

**Table 2: Comparative proximate composition of SOW and different shell-less snail species.**

Proximate %	A	B	C	D	E	F	G	H
Crude Protein	43.78±0.07	50.85	51.30	49.55	60.00	66.76	60-80	50.50
Fat	24.61±0.01	9.73	2.70	10.70	6.00	7.85	1.3-1.7	4.20
Ash	8.48±0.00	9.74	7.90	7.43	10.00	4.10	1.3-1.4	21.70
Fibre	1.79±0.02	4.27	na	Na	4.00	na	na	8.80
Moisture Content	6.73±0.06	na	11.10	Na	na	na	na	na
Nitrogen Free Extract	16.49±0.03	25.41	na	33.30	na	na	na	na

A: Current study; B; Sule and Sotolu (2010); C: Gohl (1981); D: Shafiei and Costa (1989); E: Ravindran and Blair (1993); F: Sogbesan *et al.*, (2006); G: Cobbinah *et al.*, (2008); H: Heuze and Tran (2015a).

The mineral profile is as presented in Table 3. The macro mineral content (P, Ca, K, Mg and Na) are lower to that reported in different species of snail meat analysed by scientists: Aboua (1990); Adeyeye (1996); Ozogul *et al.*, (2005); Fagbuaro *et al.*, (2006); Eneji *et al.*, (2008); Babalola and Akinsoyinu (2009); Offiong *et al.*, (2013); Engmann *et al.*, (2013); Solomon (2013) and Huez and Tran (2015b). The P and Ca in this study is higher than reported values of Ravindran and Blair (1993) (1.0 mg/100g; 2.0 mg/100g); Ikauniece and

Jemeljanovs (2013) (0.03 mg/100g; 1.99 mg/100g) respectively. The low Ca supports the findings of *Anonymous* that states that Ca is not found accumulating in flesh and visceral but in the shell and P value in this study is same as *Anonymous* for visceral who states that this makes it an important feed source for livestock.

The trace mineral content followed same trend as in the macro mineral content with low Cu, Zn, Mn and Fe. The Mn in this study is however higher than values reported by

Adeyeye (1996); Ozogul *et al.*, (2005) and Fagbuaro *et al.*, (2006). These findings also support the mineral content of SOW and its importance in mineral availability. Ozogul *et*

*al.*, (2005) stated that the mineral composition depends on species, biological cycle, season of harvest/collection etc.

**Table 3: Comparative mineral content of SOW and different shell-less snail species.**

Macro mineral	A	B	C	D	E	F	G	H	I	J
P (mg/g)	10.73	500.00	108.06	104.52	127.31	55.33	16.42	102.00	269.20	5.00
Ca (mg/g)	9.95	1060.00	200.67	726.25	204.31	179.89	83.55	117.67	585.50	13.30
Mg (mg/g)	7.76	343.00	42.06	54.05	45.75	28.86	16.18	47.70	na	2.80
K (mg/g)	5.40	565.00	47.03	82.17	201.37	65.39	na	na	331.80	22.30
Na (mg/g)	1.71	28.00	189.06	90.50	55.87	Na	na	80.30	na	23.20
Micro mineral										
Mn (mg/g)	0.81	1.72	0.39	0.19	0.39	Na	na	22.78	na	na
Fe (mg/g)	0.39	13.00	7.16	1.71	9.06	7.52	1.55	45.22	9.80	na
Zn (mg/g)	0.38	4.70	1.66	1.35	1.65	1.19	na	0.58	39.00	na
Cu (mg/g)	0.07	1.04	0.62	na	Na	Na	0.67	12.52	3.30	na

A: Current study; B: Aboua (1990); C: Adeyeye (1996); D: Ozogul *et al.*, (2005); E: Fagbuaro *et al.*, (2006); F: Eneji *et al.*, (2008); G: Babalola and Akinsoyinu (2009); H: Offiong *et al.*, (2013); I: Engmann *et al.*, (2013); J: Huez and Tran (2015b).

Of the essential amino acid tryptophan was the least while leucine was the highest; and proline was the least while glutamic was the highest of the non-essential amino acid (Table 4). The high protein content necessitated the study into the amino acid profile which has been reported to be the building blocks of protein by researchers. The quantitative and qualitative essential amino acid profile of SOW was comparable to that of Snail meat (Ghosh *et al.*, 2014), slightly higher than the amino acid reported for snail meat with shell (Gohl, 1981); Huez and Tran (2015a) and lower for snail meal without shell (Huez and Tran, 2015b). The amino acid analysis of the offal revealed that it can adequately meet the requirements of catfish (NRC, 1993) if included in the diet (Sule and Sotolu, 2010) with supplementation of some of the limiting amino acid such as lysine, methionine and phenylalanine which need partial supplementation in the diet. This

is in consonance with Lubell (2004) that amino acid in snail meat may not fulfil the total dietary need of livestock but able to meet human requirement. Sogbesan and Ugwumba (2008) reported higher values for snail meat while Ikauniece *et al.*, (2014) observed wild caught snail had more essential amino acid value than heliculated snail. This arose from the fact that wild snails are able to utilise different plant sources to meet their dietary need through proper selection and avoiding toxic plants while cultured snail nutritional requirement is yet to be fully understood. The inedibility of the waste by human may be due to some of the anti-nutrient reported in some organs Ravindran and Blair (1993); Ademolu *et al.*, (2017) and this may be due to the feeding habit of the species in the wild due to the rich biodiversity of plants in the environment.

**Table 4: Amino acid profile of Snail offal waste**

EAA (g/100g)	A	B	C	D	E	F	G
Leucine	7.30	6.9	8.4	7.5	10.0	6.0	6.79
Lysine	4.56	4.6	11.3	7.2	17.5	5.67	5.10
Isoleucine	4.19	2.9	7.8	4.2	9.2	4.08	6.23
Phenylalanine	4.43	3.5	6.3	4.2	7.6	4.29	5.04
Tryptophan	1.05	1.0	1.2	1.4	1.2	4.17	na
Valine	4.38	3.6	7.3	5.1	8.7	4.41	5.90
Methionine	2.19	1.6	1.7	1.7	2.0	1.31	1.33
Arginine	6.45	6.1	15.4	8.0	18.9	4.65	11.99
Histidine	3.26	1.5	2.3	2.3	2.8	2.12	1.77
Threonine	3.50	4.0	7.4	4.6	8.8	3.99	5.91
NEAA							
Proline	2.65	4.0	na	Na	na	4.26	na
Tyrosine	3.44	3.3	na	3.9	na	3.26	na
Cysteine	0.90	1.1	na	1.0	na	na	na
Alanine	3.64	4.8	na	Na	na	5.59	na
Glutamic acid	12.57	11.9	na	Na	na	11.10	na
Glycine	4.01	5.0	na	6.2	na	5.41	na
Serine	4.10	4.2	na	Na	na	3.65	na
Aspartic acid	10.11	8.5	na	Na	na	7.48	na

A: Current Study; B: Heuze and Tran (2015a); C: Heuze and Tran (2015b); D: Ravindran and Blair (1993); E: Gohl (1981); F: Ikauniece *et al.*, (2014); G: Sogbesan and Ugwumba (2008). EAA: Essential Amino Acid; NEAA: Non- Essential Amino Acid. na: not analysed.

### Conclusion and Recommendation

This study concludes that the utilisation and value addition of Snail offal waste can be considered in the nutrition of fish to replace fishmeal based on its composition; mineral content; amino acid profile and also help in increasing the income of snail meat processors as no cost has been adduced to the waste at the moment. Economical utilization will assist in environmental protection and disease control through indiscriminate disposal of the offal as is been done presently.

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