

**LIFECYCLE EVALUATION OF THE NUTRITIONAL BENEFITS AND BIOSAFETY OF
SNAIL *Archachatina marginata* (Swainson, 1821) (Gastropoda: Pulmonata: Achatinidae)**

Abstract

Ninety snails *Archachatina marginata* (Swainson, 1821), which comprised 30 each of adults (325.43 ± 2.03g), growers (119.05 ± 1.05g) and snaillets (33.05 ± 1.00g) were used to determine the lifecycle nutritional and bio-safety benefits of consumption of snail meat. Each age group was regarded as a treatment, for the holistic determination of the proximate, macronutrient, heavy metals, lipid profile and carcass yield of the snail meat. Snail were carefully cleaned and dressed for meat samples collection in triplicates for subsequent laboratory determination of the nutritional and bio-safety parameters. The collected samples were processed, using standard procedures. Data were collected for proximate components (Crude protein, crude fiber, Ether Extract, NFE and Ash), macronutrients (Na, K, Ca, P, Mg and Fe) heavy metals (Cu, Pb, Ni, Cd, Cr and MN), total cholesterol and lipid profile (HDL, LDL and FFA) and carcass yield. Data collected were subjected to (ANOVA), in a complete randomized design, while significant means were separated using Duncan's Multiple Range Test. Proximate components such as Crude protein 15.88±1.39% and ether extract 1.24 ± 0.22%, increased (P<0.05) with the age of snail, while NFE reduced with age. Highest (P<0.05) carcass yield (44.23%) was obtained for snaillets, with corresponding least (P<0.05) values for total cholesterol, LDL, HDL and FFA, cholesterol levels were significantly varied, in all groups and the contents of macronutrients and heavy metals in snail meat were tolerable in human nutrition and therefore not deleterious.

Keywords: "Snail meat", "Carcass yield", "Nutrients heavy metals", "Macronutrients".

Introduction

Food items are produced throughout the year, due to the need to feed on a daily basis, this encompasses crops and animals. Animal being protein source is a very vital component of the human food chain (Mogbo *et al*,2014) and has been discriminated to be grossly inadequate in the diet, in most developing countries, (Musa *et al.*, 2018).

In order to salvage the gross inadequacy of conventional animal protein sources like cattle, sheep, Goat, Poultry, and others, non-conventional protein sources, such as the micro-livestock like Quail, Snail and Guinea fowl are cheaper alternatives within the reach of the rural dwellers, who are regarded as poor (Ejidike and Oyekunle, 2019).

Snail farming is becoming a very popular vocation, due to its embracement as an empowerment and job creation avenue by the Federal Government of Nigeria (Oropo *et al*, 2019). It has been adjudged as a self-sustaining business, requiring small capital, land and other logistics, with resultant job creation potentials, along its value chain; for collectors, farmers, marketers, and research scientists (Akinnusi *et al*, 2018and Adeniyi *et al*, 2013).

An analysis of snail market, revealed that snails of different breeds, such as *Archachatina marginata*, *Archatina achatina*, *Achachatina fulica* and *Limicolaria* species are restricted to the southern parts of Nigeria, with the predominance of *Archachatina marginata* (Kehinde, 2009). Snail gathering is very popular in West Africa, especially during the raining season, in the forest ecological zones (Edem, 2019), this is not sustainable, due to the decline in snail population and an ever increasing human populations combined with other factors, such as climate change

46 human activities, like deforestation, construction, use of agrochemicals and unregulated land use
47 system(Edem,2019).

48 It is very important to protect snail from extinction through advocacy on its nutritional
49 importance and its adoption in the treatment of many diseases, such as hypertension (Sodipe *et*
50 *al.*, 2019), reduction of blood sugar, skin diseases and general well-being (Omole, 2002). In the
51 views of the marketers, traditional healer and consumers, snail does not only to bridge the wide
52 animal protein intake gap in human, it is also regarded as antidote for the treatment of ailments.

53 Musa *et al.*, 2018 inferred that environment and soil have a significant influence on the
54 chemical and proximate composition of snail meat, shell and haemolymph, since they hibernate
55 in the soil, feed on decaying plants and crops. In order to ensure that humans are fed with safe
56 animal protein from Snails, effort is made to evaluate the meat of *Archachatina marginata* for its
57 nutritional properties and bio-safety to humans.

58 Africa Giant Land Snail or Black Snail (*Archachatina marginata*) is very common in
59 Nigeria and most research resources is concentrated on its breeding, multiplication and
60 utilization, humans must however feed on rich and safe food, hence the need for this study to
61 further investigate, the nutrients, heavy metals and bio-safety of snail consumed by Nigerians,
62 due to increasing industrialization, use of agro-chemical mineral exploration, fumes from
63 vehicles and improper disposal of refuse and sewage.

64 **Materials and method**

65 **Experimental animals**

66 Ninety Snails (*Archachatina marginata*), which comprised of thirty each of snaillets,
67 growers and adults were sourced from collectors from rural settlement in Oluyole local
68 Government Area of Oyo state, Nigeria, to ascertain the nutritional and bio-safety properties of
69 snail meat. The three categories had a corresponding weight of $328.43 \pm 2.0g$, 119.05 ± 1.5 and
70 $33.05 \pm 1g$ for adult, growers and snaillets respectively.

71 **Experimental procedure**

72 **Snail processing for carcass analysis**

73 Individual snail was cleaned with distilled water, after which the shell was carefully
74 broken for the separation of the shell, visceral mass, foot, for carcass yield analysis. This was
75 done for each adult, grower and snaillet. 5g of muscle was collected from each sample, further
76 washed with distilled water and stored at $-18^{\circ}c$ prior to analysis (Chukwujindu *et al.*, 2008).

77 **Chemical analysis of snail meat for heavy metals**

78 Collected samples were pre-digested in 10ml concentrated HNO_3 at $135^{\circ}c$ until the liquid
79 was clear. Then followed by the addition of 10ml HNO_3 and 2ml $HClO_4$, until the liquid becomes
80 clear and colorless. The digest was slowly evaporated till near dryness. Then, dissolved in 1M
81 HNO_3 , filtered through Whitman N01 filter paper and diluted to 25ml with 1m HNO_3 , the
82 resulting solution was analyzed for with Cd, Pb, Zn, Mn, Fe, Cu, Cr and Co, with graphite
83 furnace atomic absorption spectrophotometer (GBC scientific equipment seas AA). Control
84 procedure was carried out for result reliability.

85 **Proximate and macronutrient analysis of snail**

86 The proximate composition of snail meat was determined by the official method of
87 analysis as described by the Association of official Analytical Chemists (A.O.AC, 18th edition,

2005). This elicited the component crude protein, crude fiber, ether extract, Nitrogen free Extract, Ash and Moisture. All analyses were carried out in triplicate.

The level of calcium, potassium and sodium was determined by the method of A.G.Arc. (975.11), by the use of Jenway digital flame Photometer (PFP7, model). Phosphorus content of meat samples was determined by the use of spectrophotometric method (A.O.A.C 975.16) and magnesium by A.O.A.C (975.23)

Determination of cholesterol content and profile of snail meat

The cholesterol content of snail meat samples was determined to elicit total cholesterol and component High Density Lipid (HDL), Low Density Lipid (LDL) and Free Fatty Acid (FFA), using the procedure highlighted by Idowu *et al.* (2008)

Statistical analysis

Data collected were subjected to Analysis of variance (ANOVA), using complete Randomized Design, while significant means were separated ($P < 0.05$), using Duncan's Multiple Range Test (1995) as explained by Sam *et al* (2008).

Result

Proximate composition of the meat of different age categories

Table 1 shows the proximate parameters in the different age groups of *Archachatina marginata*, which varied significantly ($p < 0.05$) in all the treatment. All proximate constituents, such as dry matter $19.61 \pm 1.14\%$ crude protein, $15.83 \pm 1.39\%$, ether extract, $1.24 \pm 0.22\%$ and Ash, $1.18 \pm 0.16\%$, were highest ($P < 0.05$) in adult Snails; except its carbohydrate component (Nitrogen Free Extract), which reduced ($P < 0.05$) from snaillets to adults.

Table 1: Proximate composition of the meat of different age categories of Snail(*Achachatina marginata*).

Parameters (%)	T ₁ (Adult)	T ₂ (Grower)	T ₃ (Snaillet)	± SEM
Dry matter	20.75	20.07 ^b	19.61 ^b	0.50
Crude protein	17.22 ^a	16.30 ^b	15.83 ^b	0.50
Ether Extract	1.46 ^a	1.35 ^{ab}	1.24 ^b	0.15
Ash	1.34 ^a	1.24 ^b	1.18 ^b	0.06
Nitrogen Free Extract	59.23 ^b	60.04 ^b	62.14 ^a	1.10

abc: Means along the same row with different superscripts are significantly different ($P < 0.05$)

Mineral composition

Table 2 shows the level of Sodium, Potassium, Calcium, Phosphorus, Magnesium and Iron in the meat of snail due to their importance in body metabolism and human nutrition and health. The values obtained were 31.20 – 44.75 (Na), 69.24 – 92.34 (K), 26.46 – 42.19(ca), 274.50 – 295.64 (P), 238.80 – 266.70 (Mg) and 5.25 – 9.53 (Fe)mg/100h, all values were highest (< 0.05) for adult snails.

Table 2: Mineral composition of the meat of three age categories of snails.(*Archachatina marginata*)

Parameters (mg/100g)	T ₁ (Adult)	T ₂ (Grower)	T ₃ (Snaillet)	± SEM
----------------------	------------------------	-------------------------	---------------------------	-------

Sodium	44.75 ^a	39.57 ^b	31.26 ^b	1.20
Pottasium	92.34 ^a	77.55 ^b	69.24 ^b	2.34
Calcuim	42.19 ^a	31.64 ^b	26.46 ^b	2.11
Phosphorus	295.64 ^a	286.65 ^b	274.50 ^b	1.71
Magnesium	59.23 ^b	60.04 ^b	238.80 ^a	1.23
Iron	9.53 ^a	7.37 ^b	5.25 ^c	1.48

122 abc: Means along the same row with different superscripts are significantly different (P<0.05).

123

124 **Carcass Analysis of 3 days Categories of Snail (*Archachatina marginata*)**

125 The carcass yield of *Archachatina marginata* was elicited in table 3 This showed the
 126 dressing percentage, which was estimated from the weight of foot divided by total live weight,
 127 expressed as a percentage. All values for carcass analysis parameters were significantly (P<0.05)
 128 varied. Highest shell weight (17.17%) and least offal weight (36.27%) and dressing percentage
 129 (34.25%), were obtained for adult snails. Highest dressing percentage (44.23%) was obtained in
 130 snaillets. Shell accounted for 29.45% in adult snails.

131

132 Table 3: Carcass Analysis of Different age categories of snail (*Archachatina marginata*)

Parameters (mg/100g)	Ti (Adult)	T2(Grower)	T3(Snaillet)	± SEM
Live weight (g)	328.43	119.05	33.05	
Shell Weight (%)	29.45 ^a	21.95 ^b	17.17 ^c	1.53
Offal Weight(%)	36.27 ^c	42.35 ^a	38.59 ^b	0.94
Dressing (%)	34.25 ^c	35.66 ^b	38.59 ^b	1.02

133 abc: Means along the same row with different superscripts are significantly different (P<0.05).

134 **Cholesterol Analysis of Snails (*Archachatina marginata*)**

135 Table 4 shows the cholesterol profile of snail meat, which showed the total cholesterol,
 136 low Density Lipid (LDL) High Density Lipid (HDL) and Free Fatty acid (FFA). The content of
 137 total cholesterol, HDL, LDL and FFA increased with the age of snail. Highest 18.33mg/100g
 138 cholesterol was obtained for adult snail, followed by 13.50mg/100g for growers and least for
 139 snaillet. Adults had highest HDL(2.06mg/100g),LDL(3.30mg/100g) and FFA(12.97mg/100g).

140

141 Table 4: Cholesterol Analysis of Different Age Categories of Snail(*Archachatina marginata*)

Parameters (mg/100g)	Ti (Adult)	T2(Grower)	T3(Snaillet)	± SEM
Total cholesterol	18.33 ^a	13.50 ^b	11.59 ^c	2.07
HDL	2.06 ^a	1.96 ^b	1.97 ^b	0.12
LDL	3.30 ^c	3.08 ^a	2.72 ^b	0.25
Free Fatty Acid	12.97 ^c	8.50 ^b	7.10 ^b	0.46

142 abc: Means along the same row with different superscripts are significantly different (P<0.05).

143

144

145

146 Heavy Metal Content

147 Table 5 revealed the levels of Cu, Pb, Co, Ni, Cd, Cr and Mn in snail meat. The probe
148 into heavy metals is due to their lethal nature when present in high quantity, it is dangerous,
149 because the human body does not have good mechanism for eliminating them, their bio-
150 accumulation is dangerous and must be avoided. The outcome of the analysis showed that snail
151 meat had 8.76 ± 1.8 (Cu) 0.04 ± 0.002 (Pb), 0.021 ± 0.027 (Co), 2.0 ± 1.27 (Ni), 0.02 ± 0.002 (Cd),
152 1.32 ± 1.41 (Cr) and 3.68 ± 2.56 (Mn) in Mg/kg. the levels vary ($p < 0.05$) and increased age of
153 snails.

154 **Table 5:** Heavy Metal Content of the Meat of (*Archachatina marginata*)

Parameters (mg/kg)	T1 (Adult)	T2 (Grower)	T3 (Snaillet)	± SEM
Cu	10.56 ^a	9.58 ^a	8.76^a	1.0
Pb	0.008 ^a	0.006 ^a	0.004^a	0.002
Ni	3.27 ^c	3.02 ^a	2.0 ^a	1.1
Cd	0.004	0.003 ^a	0.002 ^a	0.002
Cr	2.63 ^a	1.42 ^a	1.32 ^a	0.5
Mn	6.24	5.79 ^a	3.68 ^a	

155 abc: Means along the same row with different superscripts are significantly different ($P < 0.05$).

156

157 Discussion

158 Proximate composition

159 Highest dry matter, crude protein, ether extract and ash is not unexpected, since they are
160 required for growth development and formation of reproductive parts (Akinnusi *et al.*, 2018),
161 there is however an inverse relationship between the level of crude protein and NFE, with the
162 highest value of 62.14% in Snaillets. The increased requirement for sugar for body process could
163 be responsible for the observed variation. Adult snails are more active and have more
164 requirements for energy substrate (Akinnusi *et al.*, 2018). All age categories were good sources of
165 protein and low in ether extract, which is consistent with the findings of Ogunsanmi, *et al.*, 2019
166 and Ejidike and Oyekunle, (2019), that snail meat compared with sources of animal protein like
167 beef, mutton, chicken and goat meat and its level of fat and cholesterol.

168 Carcass analysis of 3 Age categories of snail (*Archachatina marginata*) .

169 Highest dressing percentage (44.23%) was obtained in snaillets. Shell accounted for
170 29.45% in adult snails due to its size, thickness and shell calcification (Akinnusi *et al.*, 2018).
171 Offal weight (42.35%) was highest in growers, because of its active rate of formation of internal
172 organs, such as reproductive, digestive excretory and others. The foot, which is the edible part of
173 snail was least in adult snail, the low values of less than 40% is characteristic of snails from the
174 wild, without any organized feeding programme and an indication that balanced diet is required
175 for good carcass yield in snails (Omole, 2002). The lower the offal and shell weight, the higher
176 the dressing percentage. However, for the purpose of conservation and prevention of extinction,
177 the consumption of snaillets is discouraged, through advocacy (Edem, 2019), because many
178 generations of snails are aborted, by preventing, maturity, egg laying and reproduction. The
179 determination of carcass yield gives an indication of feed utilization, feed quality and meat
180 yielded by snail. An average farmer planning his foundation stock of snail is guided by the
181 fullness of the foot in the shell, low carcass yield is an indication of starvation, aestivation and

182 unfavorable environment condition. The result revealed that snail carcass yield is lower than that
183 of grass cutter (60%) and 55% each for rabbit and goat (Ukah *et al.*, 2006). Omole, (2002)
184 commented that snails fed balanced diets had improved carcass yield of above 45%.

185 All values were highest (<0.05) for adult snails, thus confirming the finding of
186 Ogunsanmi *et al.*, (2003), when it was revealed that mineral availability increase with the age of
187 snail. On a general note, snail meat of all age categories had more iron than goat meat, Tilapia
188 fish, beef and mutton. The optimal use of cholesterol is ensured by the right combination of the
189 component lipids. A good quality cholesterol must be richer in HDL than LDL (Neal, 2002) to
190 prevent arteriosclerosis. The HDL is vital, as a demobilizer of fat from the wall of blood vessels,
191 thus preventing blockage.

192 Snaillets had the least value for total cholesterol, HDL, LDL and FFA, this could be the
193 reason for the increasing consumption of snaillets, and sub adult snails in some communities in
194 Nigeria (Omole, 2002). On a general note, snail meat consumption is beneficial and
195 recommended for people suffering from blood and fat related diseases, irrespective of the age of
196 such snail.

197 **Mineral composition of snail meat of three age categories (*Archachatina marginata*)**

198 All mineral salts, Na, K, Ca, P, Mg and Fe increased with the age of snail, thus
199 corroborating the findings of Ogunsanmi *et al.*, (2003), *When they stated that snail meat is rich in*
200 *mineral nutrients though low in sodium, Omole (2002) emphasized that snail meat is higher in*
201 *iron than goat meat, Tilapia fish, beef and mutton and was regarded as the preferred meat for*
202 *the elderly, hypertensives and people suffering from anemia. The consumption of snail meat is*
203 *good for the heart, due to its richness in K, Ca and Magnesium.*

204 **Heavy metal content**

205 The outcome of the analysis showed that snail meat had 8.76 ± 1.8 (Cu) 0.04 ± 0.002 (Pb),
206 0.021 ± 0.027 (Co), 2.0 ± 1.27 (Ni), 0.02 ± 0.002 (Cd), 1.32 ± 1.41 (Cr) and 3.68 ± 2.56 (Mn) in
207 mg/kg. the levels vary ($p < 0.05$) and increased age of snails, however, values were within
208 permissible limit in human nutrition FAO (1983), Adegoke *et al.*, 2010 and Chukwujindu *et al*
209 (2008), hence the consumption of snails of any age may not be deleterious to human health,
210 however the consumption of snaillets and sub adult is been discouraged through advocacy and
211 promotion of snail farming to avoid extinction of snails.

212 **Conclusion**

213 The trial has revealed that snail meat is rich in mineral elements and low in crude fibre,
214 fat, cholesterol and LDL. It is nutritionally beneficial in Na, K, Ca, P, Mg and Fe and its levels of
215 heavy metals were within levels tolerable in human nutrition.

216 Snail carcass yield of 35 – 45% is lower than that of Grass cutter (63%), Boilers (60%)
217 and 55%, each for Rabbit and Goat. To further enhance the nutritional benefits of snail meat and
218 improve performance, captive breeding, balanced diet and advocacy on snail conservation are
219 important and should be adopted by all the stakeholders in snail production. Snail meat is safe
220 and its consumption is not dangerous to human health.

221
222
223
224

225 **References**

- 226 A.O.A.C. Official methods of Analysis 18th edition Association of Official Analytical Chemists,
227 Washington D.C 1141, 1995
- 228 Adegoke, A.A Adebayo – Tayo, C.B, Inyang, U.C Aiyegoro, A.O and O.A, Komolafe. Snails as
229 meat source. Epidemiological and nutrient perspective **Journal of Microbiology**
230 **Antimicrobial** 2: (1): 1-5, 2010
- 231 Adeniyi, B, Shobonke, I.A and A.B, Omotosho. Economic analysis of snail meat consumption in
232 Ibarapa local Government Area of Oyo state. **Journal of Market Resources**2:16-21,
233 2013
- 234 Akinnusi: F.A.O, Adeoye, A.S, Bello, T.T and Ajuwon, A.O comparative growth and feed intake
235 analyze of Albino and Normal skinned Giant land snail (*Archachatinamarginata*) during
236 dry season. **Journal of Molluscan Research** Vol 4:17-24, 2018
- 237 Akinnusi: P.A.O, Oni, O.O and Ademolu, K.O. Heamolymph biochemical properties of Giant
238 African Land Snail (*Archachatinamarginata*) from south west Nigeria. **Journal of**
239 **Mollusca Research** Vol 4:40-44, 2018
- 240 Chukwujindu, M.AIwegbue, F, O, Arimoro, Godwin, E and NwajeiOsa – Eguavoen. Heavy
241 metals contents in the African Giant Snail (*Archachatinamarginata*, Swainson 1821)
242 GastropodaPulmonata: Achatinidae in Southern, Nigeria. *Folia Malacologica* Vol
243 16(1):31-34, 2008
- 244 Edem, A.E. Land Snail conservation strategies in southern Nigeria paper presented at the plenary
245 session of he international conference on Giant Land Snail, Tagged, Uyo, 2019, edited by
246 Ebenso, I.E, Olajide, O and Akpan, I,P, 8th international conference pp 9-14, 2019
- 247 Ejidike, B.N and Oyekunle S.K (2019). Survival and growth performance of African Land Snail
248 Juvenile Reared on different soil types. **Journal of Mulluscan Research** vol. 5:25-30
- 249 F.A.O; Farming Snails” Batter Farming Series, 3133 Rome Italy, 10:28-33, 1983
- 250 Idowu, O.M.O, Oladele, V.O and Erubetine, O. Response of plain cholesterol of laying hens to
251 varying levels of dietary Organic and Inorganic Copper salt. Proceeding of the 9th
252 Annual conference, Animal Science Association of Nigeria pp 72-72, 2008
- 253 Kehinde, A.S. Utilization of cassava by products by African land snail (*Archachatinamarginata*,
254 Swainson) PhD Thesis Submitted at the department of Animal Science, University of
255 Ibadan pp1-8, 2009
- 256 Mogbo, F.C Nwakwo, O.D and Nwuzor, T.L. Growth performance of snails
257 (*Archachatinafulica*) fed with three different leaf materials. **American Journal of**
258 **Biology and Life Sciences**, 2014
- 259 Musa, I.A, Ebenso I.E and Daja, A. Enzymatic Oxidative stress response of snail
260 (*Archachatinamarginata*) exposure to chrolopyrifosOrganophosphates Pesticides treated
261 cabbage (*Brassica Oleracea*). **Journal of Mollusca Research** Vol 4:53-60, 2018
- 262 Neal, P: Cholesterol health and nutrition articles from meat free zones accessed of
263 <http://heartkumu.org>, 2002
- 264 Ogunsanmi, A.O. Taiwo, V.O andAkintominde, T.O. Haemolymph biochemical parameters of
265 African Giant Land Snail (*Archachatinaachatina*) and *Archachatinamarginata* from
266 South West Nigeria. *Tropical Vet* 21 (2): 43 – 48, 2003
- 267 Omole, A.J. Nutrients requirement from different stages of growth of African Giant Land Snail
268 (*Archachatinamarginata*) PhD thesis, submitted at the department of Animal Science,
269 University of Ibadan.pp2, 2002

- 270 Oropo, A.O Olabode, O.AAkeredolu, E.O and Ademolu K.O. Effect of different light regimes on
271 nutritional and Haemollphbiochemical values of Giant African Land Snail
272 (*Archachatinamarginata*). **Journal of Mollusca Research** Vol, 5: 4-9, 2019
- 273 Sam, I.M., Essien, C.A, Christopher, G.I and Asuquo,. M.A. Potential feed materials for
274 sustainable Snail Farming: A review, proceedings of 8th International Conference (Net
275 gals), Uyo 2nd – 5th June, 2019. Pp 27-37,2019
- 276 Sodipe, O.G, Ajayi, O.A, Abiola, M.O and Osinowo, D.A Effect of Organo Phosphate on the
277 growth performance of *Archchatinamarginata* in South West Nigeria. **Journal Mollusca**
278 **Research** Vol 5:10- 14, 2019

UNDER PEER REVIEW