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Physicochemical and organoleptic evaluation of African giant land snails (*Achatina* spp.) meat

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Abstract
120 giant snails of 3 breeds weighing between 86.97-113.58g were used, for this study. Each of the breed constituted an experimental treatment namely, T1 = *Achachatina marginata*, T2 = *Achatina achatina* and T3 = *Achatina fulica* with 40 snails per treatment. They were housed in 6 cages, each cage contained 20 snails each and were fed paw-paw leaves and water ad-libitum. The carcass, physical, chemical and sensory properties of the snails' meat were determined. The results showed that live, whole carcass, foot and visceral weights were significantly ($P<0.05$) higher in *Achachatina marginata* breed followed by *Achatina achatina* breed, while *Achatina fulica* had significantly ($P<0.05$) higher whole carcass, foot, visceral and dressing percentages. Cooking yield and water holding capacity were significantly ($P<0.05$) higher in *Achachatina marginata* meat followed by those of *Achatina achatina* meat while *Achatina fulica* meat had higher protein content, nitrogen free extract, shear force value, colour, texture, flavour and overall acceptability. It was advocated that production of *Achachatina marginata* and *Achatina achatina* breeds be encouraged for their high carcass and meat properties.

1. Introduction

Increase in human population influenced increased demand for Protein especially from animal source. This is because the protein consumption in most developing countries is inadequate compared with the developed countries of the world (Omole *et al*., 2007). In order to cope with protein intake in those countries, efforts are being geared towards domesticating other species of animals apart from the conventional ones such as snails and grass cutters, because, most livestock farmers are unable to operate on a large scale due to high cost of production (Odunaiya and Akinyemi, 2008). Snails are micro animals that have not been fully exploited for meat production and source of income in the tropics. There are different breeds of snails which include *Achachatina marginata, Achatina achatina, Achatina fulica* and *Limocolaria spp*. among others, but the commonest breed in Nigeria is *Achachatina marginata* (Odunaiya and Akinyemi, 2008). Snails are monogastric herbivores with a digestive system made up of the buccal cavity,

radula, pharyx, gullet, crop or stomach, intestine and anus (with the body divided theoretically into three regions viz; Head, ventral muscular foot and dorsal visceral mass covered by a mantle (Brendon, 2001). Snail meat is rich in protein ranging between 89 – 90%, low in fat 0.9 – 3.0%, high in energy 80.5kcal/kg as well as vitamins and minerals (Imovbore and Ademosun, 1998). Snail farming is environmentally friendly and requires small capital outlay to establish and serve as source of income as well as foreign exchange earner (Akinnusi, 1998). There are reports on biological, feeding and nutritional requirements as well as the economic and techniques of snail rearing, however there is inadequate information on carcass and meat characteristics of snails (Odunaiya, 2007). This study was carried out therefore, to evaluate carcass and meat attributes of African giant land snails as a means of improving food security in developing countries like Nigeria.

2. Materials and Methods

One hundred and twenty (120) adult snails of 3 breeds, 40 per breed namely; *Achachatina marginata, Achatina achatina* and *Achatina fulica* of weight between 86.97 – 113.58g were used for this study. They were purchased from Odeda market and transported to snailery unit of the Research and Training Farm of Olabisi Onabanjo University, Yewa Campus Ayetoro in Ogun State where this study was carried out. The snails were housed in 6 cages, each cage contained 20 snails according to their breed and were rested for 2 weeks during which period they were fed paw-paw leaves and water ad-libitum. Each breed of snail constituted an experimental treatment as follows:

T1 = *Achachatina marginata*,
T2 = *Achatina achati*na, and
T3 = *Achatina fulica.*

The snails were slaughtered at the end of 2 weeks and the carcasses separated into foot and offals and weighed separately. Cooking yield and loss, water holding capacity as well as shear force values were determined following the procedures of Aduku and Olukosi, (2000); Suzuki *et al*. (1991) and Qiaofen and Da-wen (2005). Chemical composition of snails meat was determined using (AOAC, 2000) method, while the sensory evaluation of the meat was carried out using (AMSA, 1995) procedures.

Completely randomized design was used for this study. Data collected were analyzed with (SAS, 2002) and the significant means were separated using Duncan Multiple Range Test of the same system.

3. Results

Carcass characteristics of giant land snails is shown in Table 1. *Achachatina marginata* was the most significant (P<0.05) with the highest live (113.58g), whole carcass (39.70g), foot (26.31g) and visceral (10.46g) weights followed by *Achatina achatina* with live, whole carcass, foot and visceral weights of 86.97g, 32.17g, 21.11g and 7.38g respectively. While *Achatina fulica* had the least significant (P<0.05) weights of 23.04g, 12.94g, 7.48g and 5.01g respectively. *Achatina fulica* breed however, had higher significant (P<0.05) percentage of these variables including dressing percentage than the other two breeds.

Table 1. *Carcass Characteristics of giant land snails*

Variable	Treatments			
	1	2	3	SEM
Live weight (g)	113.58^{a}	86.97^{b}	23.04^{c}	13.44
Whole carcass weight (g)	39.70^{a}	32.17^{b}	12.94^{c}	3.99
Whole carcass (%)	34.95^{c}	36.98^{b}	56.16^{a}	6.82
Foot weight (g)	26.31^{a}	21.11^{b}	7.48^{c}	2.81
Foot (%)	23.16^{c}	24.27^{b}	32.46^{a}	5.38
Visceral weight (g)	10.46^{a}	7.38^{b}	5.01^{c}	0.80
Visceral (%)	9.20^{b}	8.48^{b}	21.74^{a}	1.21
Dressing percent (%)	21.43^{c}	28.50^{b}	34.42^{a}	5.20

abc: Means on the same row with different superscripts are statistically significant (P<0.05).

The physical characteristics of the three African giant land snails meat is shown in Table 2. *Achachatina marginata* had higher foot weight (26.31g), cooking yield (81.24%) and water holding capacity (71.11%), while *Achatina fulica* had the lowest (P<0.05), 7.48g, 51.65% and 55.08% respectively.

Table 2. *Physical Properties of African land Snails' Meat*

Variable	Treatments			
	1	2	3	SEM
Foot weight (g)	26.31^{a}	21.11^{b}	7.48^{c}	2.81
Cooking yield (%)	81.24^{a}	69.21^{b}	51.65^{c}	9.64
Cooking Loss (%)	18.76^{c}	30.79^{b}	48.35^{a}	9.64
Water Holding Capacity (%)	71.11^{a}	67.09^{b}	55.08^{c}	6.37
Shear force (kg/cm^{3})	2.02^{c}	2.63^{b}	3.55^{a}	0.23

abc: Means on the same row with different superscripts are statistically significant (P<0.05).

Table 3 shows the proximate composition and pH of African giant land snails' meat. *Achachatina marginata* meat had highest moisture content (76.04%) while *Achatina fulica* meat had the lowest moisture content (74.20%). Crude protein was highest in *Achatina fulica's* meat (19.45%) and was the same in the meats of the other two breeds. There were no significant (P>0.05) differences in the fat, ash and pH of the meats of the three breeds used in this study. *Achachatina marginata* breed meat had lowest nitrogen free extract (2.06%) and was highest in *Achatina fulica's* meat (3.10%) followed by that of *Achatina achatina* (2.99%).

Table 3. *Proximate Composition and pH of African land Snails' meat*

Variable	Treatments			
	1	2	3	SEM
Moisture (%)	76.34[a]	75.26[b]	74.20[c]	0.25
Crude Protein (%)	18.30[b]	18.42[b]	19.45[a]	0.13
Fat (%)	2.16	2.20	2.18	0.11
Ash (%)	1.14	1.13	1.12	0.10
NFE (%)	2.06[b]	2.99[ab]	3.10[a]	0.04
pH	6.02	6.19	6.20	0.02

abc: Means on the same row with different superscripts are statistically significant (P<0.05).
NFE = Nitrogen Free Extract

Table 4 shows the results of sensory properties of African giant snails' meat. Color, flavour, texture and overall acceptability scores were significantly (P<0.05) higher in meat from *Achatina fulica*, while tenderness and juiciness scores were higher in *Achachatina marginata*'s meat and were least in the meat of *Achatina fulica* breed.

Table 4. *Sensory Properties of African Land Snails' Meat*

Variable	Treatments			
	1	2	3	SEM
Colour	5.09[b]	5.26[b]	6.32[a]	0.11
Flavour	4.70[b]	4.86[b]	5.98[a]	0.23
Tenderness	5.32[a]	4.46[b]	3.24[c]	0.22
Juiciness	5.13[a]	4.32[b]	3.20[c]	0.11
Texture	5.18[a]	5.20[b]	6.36[a]	0.17
Overall Acceptability	3.28[c]	4.55[b]	5.76[a]	0.38

abc: Means on the same row with different superscripts are statistically significant (P<0.05).

4. Discussion

These results could be due to the size of the snails, which furnished much meat portion of *Achachatina marginata* breed when compared with the meats of other two breeds. However, the results of live weight and dressing percentages obtained from this study were very close to those reported by Odunaiya and Akinyemi (2008) as well as Hamzat *et al*. (2007). The same authors reported visceral and muscular foot weights similar to values recorded for these variables in this study. Though, *Archachatina marginata* and *Achatina achatina* breeds had higher carcass foot and visceral weight *Achatina fulica* furnished highest percentages of these variables which means that the later breed could have commercial significance when processed. But, shear force value was highest in *Achatina fulica* breed's meat (3.55kg/cm^3) while *Achachatina marginata* breed's meat had the lowest shear force value (2.02kg/cm^3). The results of cooking yield of the three breeds of snails meat evaluated in this study followed the pattern of the sizes of the snails with *Achatina fulica* having the least yield, while *Archachatina marginata* had the highest yield of meat due to its original size which was higher. However, *Achatina fulica* elicited the highest cooking loss of 45.35% against 30.79% and 18.76% for *Achatina achatina* and *Achatina marginata*. The results showed that the smaller the size of the snail breed the higher the cooking loss, but the lower the water holding capacity of the meat thereby showing the inverse relationship between the size between the cooking loss, water holding capacity and the size of the snails. Barbika *et al*. (1990) reported that there were significant differences among the cooking losses of different breeds of food animals while (Okubanjo 1997) noted that many of the physical and organoleptic properties of meat are dependent on water holding capacity as observed in this study. These results showed inverse significant (P<0.05) relationship between water holding capacity and the shear force values of the snails meat, the lower the water holding capacity, the higher the shear force value of the snails meat. The meat moisture content of the breeds of the snails tested in this study followed the trends of water holding capacity and yield which was highest in *Archachatina marginata* followed by that of Achatina achatina while *Achatina fulica* had the least the yield of meat and meat products is influenced by moisture or water holding capacity which is bound water that cannot be removed by application of mechanical or physical force according too Aduku and Olukosi (2000). The protein content of the snails meat was high with *Achatina fulica* having while *Achatina marginata* and *Achatina achatina* breeds meat had similar protein values. The results obtained for protein contents of the three snails meat corresponded with what (Omole 1998) reported. The results of fat and ash contents of the snails meat in this study were very low and similar statistically, but ash content value was numerically lower in *Achatina fulica's* meat probably the cooking loss was higher coupled with low water retention observed in its meat. The results obtained on fat and ash contents of African giant snails were close to the figures of fat and ash reported by Imevbore and Ademusun (1998) who gave the range of snail meat fat they observed between 0.96 and 3.0 percent while in this study, the fat content of snail meat observed was between 2.16 and 2.20 percent respectively. Perhaps, this level of fat content place the snail meat in a favourite position for majority who cannot consume meat especially poultry due to its high cholesterol content (FAO, 1986; Odunaiya, 1995). Higher acceptability score recorded for *Achatina fulica's* meat might be connected with high colour, flavour, texture and shear force which showed that colour is the first quality criterion that attracts consumers followed by flavour to accepting any meat (Cornforth, 1994) and that consumers still preferred fairly tough meat in developing countries (Okubanjo, 1990) as shown in the Table. This was because tenderness and juiciness scores were lower in meat of *Achatina fulica* breed yet it was more accepted than meat from other two breeds.

5. Conclusion

This study revealed that *Achachatina marginata* had higher live, whole carcass, foot and visceral weights, followed by *Achatina achatina*, while *Achatina fulica* had higher whole carcass, foot, visceral and dressing percentages. Cooking yield and water holding capacity were higher in meat from *Achachatina marginata* followed by those of *Achatina achatina*, while *Achatina fulica* had higher protein, nitrogen free extract, shear force value, colour, flavour, texture and overall acceptability scores with lowest cooking yield and water holding capacity and was highly accepted. It is advocated in conclusion, that *Achachatina marginata* and *Achatina achatina* breeds production be encouraged for their high carcass and meat physical properties which are very important to producers, and consumers alike, while, further research should be carried out on *Achatina fulica* with the view to improving its size for commercial production as a result of its high meat colour, texture, flavour and overall acceptability.

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