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Comparative study of the carcass characteristics and nutrient composition of three species of giant African land snail

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Abstract

A comparative study was carried out on three breeds of snails in southeastern Nigeria to assess their carcass characteristic and carcass nutrient compositions. The three breeds used were Achatina fulica, Achatina achatina and Archachatina marginata. Four experimental diets were formulated to contain concentrate + pawpaw (Diet I), concentrate + Moringa oleifera (Diet II), concentrate + Moringa oleifera+ African spinach + Amaranthus hybridus (Diet III) and concentrate + Moringa oleifera+Amaranthus spinosus (Diet IV). Fifteen 6-month old growing snails of each breed was assigned per dietary treatment and each dietary treatment was replicated three times to contain five snails per replicate, given a total of one hundred and eighty snails. The experiment involved a 3 x 4 factorial experiment in a completely randomized design (CRD). Feed and water were given ad libitum throughout the duration of the experiment which lasted (56 days). At the end of the experiment, a total of seventy-two (72) snails were starved and slaughtered for carcass evaluation. Carcass nutrient compositions were measured including dry matter, moisture content, ash, crude fibre, crude protein, fat and nitrogen free extract. The results showed that the highest foot weight (57.50%) was observed in snails fed diet I, associated with relatively high live weight and highly reduced offal weight, which makes it comparatively better in improving carcass. The A. fulica, A achatina and A. marginata obtained best carcass composition respectively on diets I, III and II due to interaction effect of breed x diet. The A. achatina and A. marginata had higher dry matter (91.64 and 92.07 respectively) than the A fulica (90.09). The A. marginata carcass had the higher (p<0.05) crude protein (32.78%), highest ash (9.17%) and a moderate fat content (1.59%). Based on overall interaction effects, diet I is recommended for A. fulica, while diet III for A. marginata and diet II for A. marginata. The A. marginata performed better than the A. achatina and A. fulica in highest crude protein, highest ash and a moderate fat content and is thus recommended.

Keywords: *Achatina fulica, Achatina achatina, Archachatina marginata,* carcass nutrient,

Introduction

One of the most serious nutritional problem in the developing countries is the shortage of high protein from animal source, and the continuous increase in Nigeria's population growth rate, which has increased the demand and price of animal protein (Onunkwo, 2019). Hence professional responsibility calls on animal scientist and other stake holders in human progress to articulate an alternative paradigm for the production of cheap, affordable, acceptable and sustainable portentous food. According to Akinnusi (2002), exploring non-conventional feed stuff is a viable option. Snails which can be found in and around our surrounding are known to thrive on non-conventional feed stuff which are always available in large quantities and can be processed cheaply into animal feed. Also, as the consumption of poultry meat has fallen in many countries because of high pathogenic avian influenza (HAPI), Snail and other micro livestock deserve adequate attention of the episteme community. These wonder creatures are not only of nutritional importance but also have economic and medicinal benefit compared with other animals. (Okafor, 2001). Snail is highly recommended for its rich nutritional value of protein, calcium, potassium, ion, and mineral content, which correspond with its usage especially the slime from Ancient Greece to the middle Age against hypertension, gastrointestinal ulcers, reduction of contraption, labour pain reliever, etc. and also have low fat and cholesterol. Bright (1996). Godfriend (1984) stated that snail farming involves the rearing and management of snail in a closely monitored system. In Nigeria it is a very lucrative business. It is easy to manage with little structure and does not require much technicalities or capital (Onunkwo, 2018). Though, there are limitations of snail farming which involves: pest, diseases and other general problem but there are strategies and control measure which are used to control those limitation. Banerji*, et al.* (1998). There are over 40,000 species of snail found throughout the world, but only few species have been found to be cultured. The species of interest are *Archachatina margina, Achatina Achatina, Achatina fulica.*

Materials and methods

Experimental site

This study was carried out at the Poultry Unit of Teaching and Research Farm, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, located at about 10 kilometers from Umuahia, the Abia state capital. Umudike bears the coordinate of 5°281 North and $7^0$321 East, and lies at an altitude of 122 meters above sea level. The environment of study was situated within the tropical rainforest zone and is characterized by an annual rainfall of about 2177 mm. The relative humidity during the rainy season is well over 72 %. Temperature ranged from 22^0C – 36^0C with March being the warmest month, while July to October represents the coolest period with a temperature range of 22^0C – 30^0C (NRCRI, 2017).

Experimental animal and management

A total number of 180 grower snails of 3 different species *Archachatin amarginata* (Swarmson 1821). *Achatina achatina lime,* and *Achatina fulica (*Bowdieth) were used for the experiment. The snails were purchased from Institute of Agricultural Research and Training (I.A.R and T), Moore Plantation Apata, Ibadan, Oyo state Nigeria. The 180 snails comprising three breeds of 60 snails per breed were separated according to their breeds. The 60 snails in each breed were further divided into four dietary treatments, comprising 15 snails per treatment. Each dietary treatment was replicated thrice to contain 4 snails per replicate. The snails were allowed to acclimatized for 2 weeks before housed in twelve (12) plastic baskets filled with humus soil that was thoroughly heatednd moistened to a depth of 10cm, the snails were provided with feed and drinking water both *at libitum.* They were fed with formulated concentrate and difference forage such as dried pawpaw leave, dried spinach, *Moringa and Amaranthus*. The left-over were recorded and the feed and water trough were washed daily; while the soil in each basket was changed bi-weekly.

Experimental diet

Four dietary treatments I, II, III and IV were used in this study and composed as follows:

Diet I - Concentrate + Pawpaw

Diet II - Concentrate - *Moringaoleifera*

Diet III - Concentrate + *Moringaoleifera* + African spinach + *Amaranthus*

Diet IV - Concentrate + Moringa + *Amaranthus*

Table 1: Gross composition of concentrates fed three species of African Giant snails

Ingredients	Grower
Maize	22.00
BDG	10.00
Wheat offal	12.70
Ground cake	10.00
Palm kernel cake	5.00
Soya bean meal	24.10
Fish meal	4.00
Bone meal	9.70
Nacl	0.10
Premix	0.25
Total	100.00
Calculated analysis	
CP	24.10
Energy (kcal/ml/kg)	2204.20
Calcium (%)	4.50
Phosphorus (%)	0.64

Experimental model

This experiment involved a 3 x 4 factorial experiment in completely randomized design involving three breeds and four dietary treatments. The model of the experiment was as follows:

$$Y_{ijkl} = \mu + B_1 + D_1 + (B \times D)_k + E_{ijk}$$

Where:

Y_{ijkl} = General observation

μ = Overall mean

B_1 = Effect of breed

D_1 = Effect of diets

$(B \times D)_k$ = Effect of interaction between breed and diet

E_{ijk} = Random error assumed to be identically, independently and normally distributed with zero mean and constant variance

Data collection and analysis

Data was collected from the carcass, offal and shell of the snail. The snail was removed from shell with the aid of a broad pin together with the offal. The carcass was properly washed with line to remove the slime also the shell was washed with a detergent and raised with water to ensure that they are free from dirty and slime. The carcass offal shell was weighed separately on an electronic sensitive scale to determine the shell weight, carcass weight and offal weight. Data were also collected on live weight, shell weight expressed as percentage live weight, foot weight expressed as percentage live weight and offal weight expressed as percentage live weight. The carcass nutrient composition were collected (dry matter, moisture content, ash, crude protein, fat crude fibre and nitrogen free extract). Data collected were subjected to analysis of variance (ANOVA) (Steel and Torrie, 1980) and where differences were significant; means were separated with the Duncan's Multiple Range Test (Duncan, 1955).

Results and discussion

The effect of breeds, diet, interaction of breed and diet on carcass performance of African Giant Snails is presented in Table 2, 3 and 4 respectively. Table 2 shows the effect of breeds on carcass performance of African Giant snails, significant differences ($p<0.05$) were observed in live weight, % shell weight, % foot weight and % offal weight of the three breeds. The *A. achatina* recorded the highest ($p<0.05$) live weight (130.30) and % shell weight (36.18); whereas, the *A. fulica*r recorded the least ($p<0.05$) values: (39.19) and (17.17) respectively. The *A. marginata* and *A fulica* were highest in foot weight expressed as percentage of their live weight. The *A.*

marginata recorded higher offal weight, whereas, the *A. fulica* recorded the least offal weight. The lower offal weight of the *A. fulica*is in relation to its lower live weight. The *A. achatina* which recorded the highest live weight, did not correspondingly record the highest % foot weight as a result of its higher composition of shell weight (36.18%). The *A. marginata* and *A. fulica* on the other hand, revealed higher foot weight in relation to their live weight, which was associated with lower % shell weight.

Table 2: Effect of breeds on carcass performance of three species of African giant snails

Parameter	Breeds			SEM
	A. fulica	*A. achatina*	*A. marginata*	
Live weight (g)	39.19[c]	153.28[a]	145.26[b]	0.29
% Shell weight	17.17[c]	36.18[a]	22.33[b]	0.29
% Foot weight (dressing percent)	58.81[a]	44.78[b]	57.59[a]	0.93
% Offal weight	19.03[c]	20.08[b]	26.94[a]	0.29

[a-b] Means in the same rows with different superscripts are significantly different at p<0.05; SEM = standard effort of the mean

Significant difference (p<0.05) were demonstrated in live weight, % shell weight, % foot weight and % offal weight of the snails subjected to the four treatment diets as shown in Table 3. Diet III recorded the strongest influence (p<0.05) in live weight and % offal weight. Diet IV recorded the least influence in live weight. Highest shell weight (27.07%) was observed in snails fed diet II, whereas, diet III produced the lowest shell weight (21.92%). The highest foot weight (57.50%) was observed in snails fed diet I. Offal weight was highly reduced in diets I and II but highest in diet III. Higher offal weight observed in snails fed diet III is not a desirable characteristic. However, this higher offal weight was associated with the highest live weight showing that the higher live weight recorded for this diet may be due to the higher offal weight Diet I produced a low offal weight with a relatively high live weight and the highest foot weight, which makes it comparatively better in carcass performance. Omole*, et al.* (2009) noted that the dressing percent can be affected by dietary treatments. They reported that high dressing percentage is obtained with lower levels of fibre. They also observed that live weight decreased with increase in fibre. The lower live weight obtained in diet IV may be associated with higher fibre content of this diet. Omole, *et al.* (2009) observed no significant effect of fibre on offal/live weight (%) and shell/live weight (%) which contradicts the result of this study. Eze*, et al.* (2010) reported that feeding *A. marginata* snails with different diets exhibited no significant effect on the carcass characteristics of snails which equally contradicts the findings of this study.

Table 3: Effect of diet on carcass performance of three species of African giant snails

Parameter	Diets				SEM
	I	**I**	**III**	**IV**	
Live weight (g)	123.80[b]	100.13[c]	130.30[a]	96.08[d]	1.21
%Shell weight	26.38[ab]	22.07[a]	21.92[c]	25.54[b]	0.33
% Foot weight (Dressing percent)	57.50[a]	52.95[b]	52.77[b]	51.70[b]	1.07
%Offal Weight	20.77[c]	19.98[c]	25.31[a]	21.99[b]	0.33

[a-b] Means in the same rows with different superscripts are significantly different at p<0.05; SEM = Standard effort of the mean

Significant differences (p<0.05) were observed due to interaction on live weight, % shell weight, % foot weight and % offal weight as shown in Table 4. *A. fulica* obtained its highest live weight and foot weight in diet I, whereas it obtained the least live weight in those fed diet IV. This low live weight was associated with the lowest offal weight. Highest % shell weight and % offal weight were obtained in *A. fulica* diet II; whereas, the least values were recorded for those fed diet IV. *A achatina* recorded the highest live weight and % shell weight in snails fed diet IV; whereas, diets II and III had the lowest influence in these parameters. Diet III however, revealed the strongest influence in % foot weight and % offal weight in *A. achatina.* Diet I, however had a relatively high live weight, foot weight and shell weight associated with a reduced offal weight in *A. achatina.* In *A. marginata,* highest live weight and offal weight was obtained in snails fed diet III. This however, was associated with a relatively high shell weight and foot weight. Shell weight was highest in *A. marginata* snails fed diet I and was least in those fed diet III. The highest foot weight was observed in *A. marginata* fed diet I and those fed diet II. The differences observed in the three breeds show strong interaction effects. Okon*, et al.* (2012a) has earlier on from his researches confirmed genotype x environment interaction effects on performance and body characteristics of different genotypes of snails. They also noted that prevailing temperature and soil conditions of the study area, age and size of the snails and season of breeding among other climatic factors may also affect the result. The observed variations in the live weights of the breed of snails used in this study may be related to the hydration stage, stoutness and shell heaviness (i.e thickness of calcium deposit during the process of shell calcification) as *A marginata* has a thicker shell than *A. achatina* (Stievenant, 1996; Ebenebe*, et al.*, 2011). It is possible that the lower shell weight observed in diet III may be connected with the low in calcium and Phosphorus content of African spinach, both of which are very essential for shell growth and development (Odo and Orji, 2010). The higher shell weight in diet II may be connected with the fact that *Moringa oleifera* leaf is rich source of vitamins, amino acids and minerals (Mckkar and Bekkar, 1999; Francis*, et al.,* 2005).

Ani*, et al.* (2014) stated that there was significant (p<0.05) reduction in live weight, weight of edible portion and dressing percentage as the level of *Moringa oleifera* leaf meal in the diets increased beyond 20%. This shows that the three breeds used in this study may have different tolerable limits for each diet.

The effect of breeds, diet and interaction of breed x diet on nutrient composition of African giant snails' meat is shown in Table 5, 6 and 7. Significant variations (p<0.05) were observed in dry matter (DM), moisture content (fresh matter basis), moisture content (dry matter basis), ash, crude protein, fat, crude fibre (CF) and nitrogen free extract (NFE) as shown in Table 5. *A. fulica* recorded the lowest (p<0.05) DM associated with the highest moisture content, whereas, the *A. achatina* and *A. marginata* recorded the highest DM associated with the lowest moisture contents. Ash and crude protein contents were highest (p<0.05) in *A. marginata;* whereas, the *A. achatina* possessed the highest fat and crude fibre content. Crude protein was least in *A. achatina* while fat content was least in *A. fulica.* The *A. marginata* had the highest (p<0.05) crude protein content and a moderate fat content. There are indications of breed variations in the findings of this study. Breed types has a market effect on performance and productivity of snails than all other factors considered (Ibom*, et al.,* 2012). This is attributed to physical adaptability to the environment and genetic variation among and within breeds.

Table 4: Effect of Breeds and diet interaction on carcass performance of three species of African giant snails

Breeds	Parameter	Diets				SEM
		I	I	III	IV	
A. Fulica	Live weight (g)	49.51^{a}	37.80^{c}	39.74^{b}	30.71^{d}	0.58
	% Shell weight	16.90^{b}	23.65^{a}	15.10^{b}	13.03^{c}	
	% Foot weight (dressing percent)	69.83^{a}	55.34^{b}	54.71^{b}	55.36^{b}	1.86
	% Offal weight	18.06^{b}	22.46^{a}	19.44^{b}	16.13^{c}	0.58
A. achatina	Live weight (g)	154.43^{b}	151.89^{c}	149.00^{d}	157.69^{a}	0.58
	% Shell weight	36.82^{b}	33.85^{c}	33.22^{c}	40.84^{a}	0.58
	% Foot weight (dressing percent)	45.06^{b}	43.68^{bc}	47.33^{a}	43.03^{c}	1.87
	% Offal weight	17.00^{c}	16.47^{a}	26.30^{a}	20.54^{b}	0.58
A. marginata	Live weight (g)	168.45^{b}	110.69^{c}	202.07^{a}	99.84^{d}	0.58
	% Shell weight	25.42^{a}	23.71^{ab}	17.44^{c}	22.75^{b}	0.58
	% Foot weight (dressing percent)	57.58^{b}	59.82^{a}	56.26^{b}	56.71^{b}	1.87
	% Offal weight	27.23^{b}	21.01^{c}	30.20^{a}	29.31^{a}	0.58

$^{a-b}$ Means in the same rows with different superscripts are significantly different at p<0.05; SEM = Standard effort of the mean

Table 5: Effect of breeds on nutrient composition of three species of African giant snails' meat

Parameter	Breeds			SEM
	A. fulica	*A. achatina*	*A. marginata*	
DM	90.09^{b}	91.64^{a}	92.07^{a}	0.29
MC on fresh basis	82.85^{a}	71.41^{b}	70.87^{b}	0.29
MC dry matter basis	9.91^{a}	8.36^{b}	7.93^{b}	0.29
Ash	7.79^{b}	8.35^{ab}	9.17^{a}	0.29
Crude protein	30.88^{b}	28.85^{c}	32.78^{a}	0.29
Fat	1.04^{c}	1.85^{a}	1.59^{b}	0.00
Crude fibre	0.81^{b}	1.46^{a}	0.59^{c}	0.01
Nitrogen free extract	49.58	51.04	47.95	0.29

$^{a-b}$ means in the same rows with different superscripts are significantly different at p<0.05; SEM = standard effort of the mean

Significant differences (p<0.05) were observed in moisture content (fresh matter basis), fat and crude fibre content of the carcass of snails fed the four dietary treatments as presented in Table 6. Diet I recorded the least moisture content in the carcass but produced the highest fat content in the carcass. Diets II and IV recorded the highest carcass moisture content. The high moisture content of diet IV was associated with high crude fibre content and moderate fat content; whereas, the high moisture content of diet II was associated with low crude fibre but equally moderate fat content. Diet III recorded the least carcass fat. No significant influence (p<0.05) of diet was observed in crude protein, ash and nitrogen free extract of the carcass. Diet III recorded the least carcass far which was associated with low fibre content and moderate moisture content. Sang-Min and Tim-Jun (2005) has shown the strong influence of diet in performance.

Significant interaction effect (p<0.05) was observed in the moisture content (fresh matter basis) of the three breeds as shown in Table 7. No interaction effect was found in the other parameters. This shows that the carcass nutrient composition of the African Giant snail is largely not affected by the genetic and environmental interactions but largely due to individual effects of diet or genetic make-up of each breed. According to Ani, *et al.* (2009), one of the problems facing the rearing of snails is formulating a balanced/standard diet that will meet their nutrient requirements. Protein level of the snails' diet is very necessary because of its

Table 6: Effect of diet on nutrient composition of three species of African giant snails' meat

Parameter	Diets				SEM
	I	I	III	IV	
DM	91.78	90.97	91.26	91.06	0.13
MC on fresh matter basis	72.93[c]	76.49[a]	74.65[b]	76.12[a]	0.33
MC on dry matter basis	8.22	9.03	8.74	8.94	
Ash	8.43	8.52	8.41	8.39	0.33
CP	31.21	30.78	30.66	30.82	0.33
Fat	1.51[a]	1.49[b]	1.47[c]	1.49[b]	0.00
CF	0.95[ab]	0.94[b]	0.93[b]	0.99[a]	0.01
NFE	49.68	49.24	49.79	49.37	0.33

[a-b] Means in the same rows with different superscripts are significantly different at $p<0.05$; SEM = Standard effort of the mean

Table 7: Effect of breeds x diet interaction on nutrient composition of three species of African giant snails' meat

Breeds	Parameter	Diets				SEM
		I	I	III	IV	
A. Fulica	DM	90.38	89.85	89.98	90.14	0.58
	MC on fresh matter basis	81.04[b]	84.92[a]	82.65[b]	82.80[b]	0.58
	MC on dry matter basis	9.62	10.15	10.02	9.86	0.58
	Ash	7.89	7.81	7.91	7.56	0.58
	CP	30.98	30.86	30.72	30.96	0.0
	Fat	1.07	1.00	1.02	1.05	0.01
	CF	0.79	0.76	0.82	0.85	0.02
	NFE	49.65	49.42	49.51	49.72	0.58
A. achatina	DM	92.40	91.05	91.80	91.32	0.58
	MC on fresh matter basis	68.76[b]	72.40[a]	71.75[a]	72.74[a]	0.58
	MC on dry matter basis	7.60	8.95	8.20	8.68	0.58
	Ash	8.20	8.61	8.24	8.35	0.58
	CP	29.40	28.86	29.07	28.46	0.58
	Fat	1.84	1.90	1.79	1.87	0.01
	CF	1.51	1.45	1.38	1.50	
	NFE	51.45	50.23	51.32	51.14	0.58
A. marginata	DM	92.55	92.00	92.00	91.72	0.58
	MC on fresh matter basis	68.99[b]	72.14[a]	69.54[b]	72.84[a]	0.58
	MC on dry matter basis	7.45	8.00	8.00	8.28	0.58
	Ash	9.20	9.14	9.09	9.26	0.58
	CP	33.25	32.61	32.20	33.04	0.58
	Fat	1.62	1.58	1.60	1.55	0.01
	CF	0.55	0.60	0.58	0.61	0.02
	NFE	47.93	48.07	48.53	47.26	

[a-b] Means in the same rows with different superscripts are significantly different at $p<0.05$; SEM = Standard effort of the mean

immense role in animals' well-being which includes growth, maintenance, hormonal and enzymatic activities (Adomola*, et al.,* 2004). The non-significant effect of diet in the carcass protein content suggests that sufficient protein was obtained from the four diets fed in this study .According to Adeyeye (1996), Akinnusi (2002) and Ejidike (2002), snail meat is high in protein, iron, calcium and phosphorus, but low in sodium, fat and cholesterol, and contains almost all the amino acids needed by man. Variations in the ash content was only due to differences in genetic make-up of the three breeds. The higher as content of the *A. marginata* over the other two breeds suggests that this breed has richer minerals than the other breeds. Proximate carcass composition of *A. marginata* fed varying levels of protein was reported as moisture (9.5-9.7%), crude protein (56.4-72.1), ash (5.2-5.7) and fat (1.31-1.40%) (Ejidike, 2004). These values were higher than the 7.93 obtained for moisture, 32.73% CP, but lower than the 9.17 and 1.59 obtained for ash and fat respectively in this study. Eneji, *et al.* (2008) obtained mean crude protein which ranged from 70.00 ±0.03 in *Lanistes varicus* to 84.43 ±0.01% in *Archachatin marginata* ovum and moisture content of 73.69 ±0.01 in *Nucellaq lapillus* to 80.78 ±0.06% in *Archachatina marginata ovum* were obtained. Their moisture content compares with the 70.87 to 82.85 obtained in this study; their crude protein content however was far higher than the range 28.95 to 32.78 obtained in this study. The authors obtained values as low as 0.50 ±0.02 crude fibre in *Archachatina marginata ovum* which compares with the 0.59 obtained in *A. marginata* in this study.

Conclusion and recommendations

The result of the carcass performance showed significant breed, diet and interaction effects in live weight shell weight, foot weight and offal weight. The *A. marginata* and *A. fulica* revealed higher foot weight in relation to their live weight, which was associated with lower % shell weight, whereas, the *A. achatina* recorded lower foot weight in relation to its live weight, associated with higher shell weight. The highest foot weight (57.50%) was observed in snails fed diet I, associated with relatively high live weight and highly reduced offal weight, which makes it comparatively better in improving carcass. Whereas, the effect of diet portrayed diet I to have the strongest influence on foot weight, the interaction effect rather showed that different diets are suitable for each breed. The *A. fulica, A. achatina* and *A. marginata* performed best on diets I, III and II respectively. The *A. achatina* and *A. marginata* had higher dry matter than the *A. fulica.* The *A. marginata* carcass had the highest ($p<0.05$) crude protein, highest ash and a moderate fat content. No significant influence ($p>0.05$) of diet was observed in crude protein, ash and nitrogen free extract of the carcass. While breed effect was significant for all carcass nutrient parameters, dietary effect was observed in moisture content (fresh matter basis), fat and crude fibre. Diet III recorded the least carcass fat which was associated with low fibre content and moderate moisture content. The variation in carcass fibre was due to the different fibre contents of the diet. Diet x breed interaction produced sparing effect only on moisture content of the carcass (fresh matter basis). Diet II was implicated in the highest carcass moisture content, whereas, diet I revealed the least moisture content similarly in the three breeds. From the foregoing, diet III and diet I performed more significantly than the other diets in carcass characteristics and carcass nutrient composition. Based on interaction effects, diet I is recommended for *A. fulica,* diet III for *A. marginata* and diet II for *A. marginata.* Lastly, based on breed differences. *A. marginata* performed better than the *A. achatina* and *A. fulica* in foot weight, highest crude protein, highest ash and a moderate fat content is thus therefore recommended.

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