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Comparative study 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 South Eastern Nigeria to assess their growth performance and body morphology. The three breeds used were A. Fulica, A. achatina and A. 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 were 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). Parameters measured were body parameters which include body weight, body width, body length, aperture length and aperture width; growth performance parameters obtained were initial weight, final weight, average weekly weight gain, average weekly feed intake and feed conversion ratio. The results showed that the A. achatina and A. marginata similarly recorded higher values in body parameters than the A. fulica. The A. marginata however was longer (12.69 cm) than the 8.95 and 12.32 cm recorded for A. fulica and A. marginata gain was only influenced by interaction effect of the breed x diet. The A. marginata and A. fulica revealed higher foot weight 58.81% and 57.59% respectively in relation to their live weight, which was associated with lower % shell weight (17.17 and 22.33% respectively), whereas, the higher shell weight (36.18%). 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. 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 body size (body length) and foot weight, thus recommended.

Keywords: Giant African land snail

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 has increased the demand and price of animal protein. This is because most of us are yet to discover what nature has endowed us with. 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 animal. (Ani *et al*, 2009).

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). Akinnusi, (2002) 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. Although there are limitations of snail farming which involve pest, diseases and other general problem but there are strategies and control measure which are used to control those limitations. 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* and *Achatina fulica.*

Materials and methods

Experimental site

The study was carried out at Snailery unit of teaching and research farm of Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. Umudike falls within the tropical rain forest ecological zone of south eastern Nigeria, located between altitude 0.5º 29 and 0.5º 43N and longitude 0.7º 35 at a height of 122m above sea level. Umudike is known as high rainfall of more than (900mm per annual having annual rainfall duration of mostly between then months of April and October and five months of dry season with high temperature (>23ºC) that is often accompanied by high relative humidity (>60%) especially in rainy season (NRCRI, 2017).

Experimental animal and management

A total number of 180 growing snails of 3 different breeds *Archachatina marginata, Achatina achatina lime* and *Achatina fulica* 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 were divided into the three breeds with each breed comprising 60 snails. 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 heated and moistened to a depth of 10cm, the snails were provided with feed and drinking water *ad libitum.* They were fed with formulated concentrate and forages such as dried pawpaw leaves, 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 – *Moringa oleifera*; Diet III: Concentrate + *Moringa oleifera* + African spinach + *Amaranthus*; Diet IV: Concentrate + Moringa + *Amaranthus*

Table 3.1: Composition of concentrates fed to the 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
Nael	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 materials

The materials used during the duration of the experiment include: sensitive scale, vernier caliper, board pins, ruler, threat, bowl, baskets, plain sheets, snail, damp cloth and water.

Experimental procedure

The final weights of the snail were obtained at end of the experiment including their shell parameters. The snails were cleaned with a damp cloth to facilitate the removal of the dirty which may have glued of their shell and subsequently affect their weight. The snails were placed on a sensitive scale one after the other to determine their weight after which there were measured directly with the vernier caliper along the length and width. A thread was lined along the length and width. A thread was lined along the length of each whorl found on the snail's shell to determine their width and also used to determine the aperture lengths width. This was possible by placing the thread along the length of a ruler.

Data collection

Data were collected based on the following parameters

Body parameters

The following parameters were measured and data taken: body weight, body length body width, aperture length and aperture width.

Growth performance parameters

Initial weight, final weight, average weekly weight gain, average weekly feed intake and feed conversion ratio.

Experimental model and statistical analysis

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.

Results and discussion

Effect of breeds, diet and breeds and diet interaction on body parameters of giant African snails

Table 2 shows the effect of breeds on body parameters of three Giant African snails. Significant variations ($p<0.05$) were observed in body weight, body length, body width, aperture length and aperture width. The *A. marginata* and *A. achatina* compared similarly in body weight, aperture length and aperture width and were higher than *A. fulica*. However, while the *A. marginata* was the longest ($p<0.05$) in body length, the *A. achatina* was the widest ($p<0.05$) in body width. The *A. fulica* recorded the least ($p<0.05$) body length and body width. These breed differences are important in characterizing the African Giant snails and also necessary for possible genetic improvements. Okon *et al.* (2012a) reported that *A. fulica* snails are genetically heavier and have higher body weight (138.60 g) than *A. marginata* snails (115.80 g). These authors also revealed that *A. fulica* snails with 4 whorls have longer shell

'mouth' length than *A. marginata* snails with 4 whorls from the study area.

The result of this present study disagrees with their report since the A. marginata are heavier and recorded higher aperture opening in A. marginata than in A. fulica. This present finding however, agreed with the views of CAB (2003) and Venette and Larson (2004) that *A. marginata* is the second largest snail among the giant African land snails and *A. fulica* the smallest. *Achatina achatina* is regarded as the largest gastropod among the giant African land snails recorded in the Guinness Book of records, with a maximum of recorded shell length of 27 cm (Nisbert, 1974; Jennifer, 1975) but however, in Nigeria, *Achatina achatina* is the second most popular breed of snail after *A. marginata* kept and reared (Okon *et al.,* 2012a). The *A. marginata* and *A. achatina* compared in their body parameters in this study but however, while the *A. marinata* is longer, the *A. achatina* is wider. Breed type has a marked effect on performance and productivity of snails than all other factors considered. This is attributed to physiological adaptability to the environment and genetic variations among and within breeds (Okon*et al.,* 2012b).

Table 2: Effect of breeds on body parameters of Giant African snails

Parameter	Breeds			SEM
	A. Fulica	*A. Achatina*	*A. Marginata*	
Body weight (g)	87.57^{b}	208.02^{a}	198.40^{a}	3.88
Body length (cm)	8.95^{c}	12.32^{b}	12.68^{a}	0.06
Body width (cm)	7.11^{c}	12.38^{a}	12.12^{b}	0.06
Aperture length (cm)	4.81^{b}	7.61^{a}	7.60^{a}	0.05
Aperture width (cm)	4.02^{b}	4.62^{a}	4.61^{a}	0.06

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

Table 3 shows the effect of diet on body parameters of African Giant snail. The body parameters varied with respect to the different dietary treatments. Diet II influenced the body weight and body length most significantly ($p<0.05$), whereas, diet IV was the least. The aperture length was similarly influenced most significantly by diets I, II and III, whereas diet IV recorded the least effect. The body width and aperture width was however most influenced by the control diet (diet I) than in the test diets. Thus Ani *et al.* (2009) opined that the use of balanced/standard diets in the feeding of snails would help to increase their growth rates and meat quality. Ejidike (2004) stated shell aperture increased with increase in the diet protein level in *Archachatina marginata*. However, no significant difference was observed in the aperture length of the *A. marginata* in this study suggesting that the snail obtained adequate and comparable protein from the different diets.

Table 3: Effect of diet on body parameters of Giant African Snails

Parameter	Diets				SEM
	I	I	III	IV	
Body weight (g)	165.23^{b}	157.22^{bc}	185.25^{a}	150.96^{c}	4.48
Body length (cm)	11.635^{b}	11.45^{b}	11.93^{a}	10.25^{c}	0.07
Body width (cm)	11.20^{a}	10.82^{b}	10.88^{b}	9.25^{c}	0.07
Aperture length (cm)	6.76^{a}	6.79^{a}	6.69^{a}	6.44^{b}	0.06
Aperture width (cm)	4.78^{a}	4.60^{b}	4.38^{c}	3.90^{d}	0.06

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

Table 4 shows the effect of breed x diet interaction on body parameters of African Giant snails. Significant differences ($p<0.05$) were demonstrated only in body weight, body length and body width. In *A fulica*, the best interaction effect was demonstrated with diet I in body weight and body length. Diet III revealed the highest influence in body weight and body length. Diet I influenced the body width most in *A. achatina*, followed by diets II and III. The *A marginata* revealed significant interaction effects in body weight and body width. Diet III showed the most significant effect in body weight whereas, diets I, II and III similarly influenced the body width most significantly for *A. achatina* and *A. marginata.* Cole (1972) and Fredeen(1972) noted that variation observed within a population is the product of both genetic and environmental factors. Within the different genetic make-ups, the different breeds perform differently within the same environment. In Nigeria, the different breeds of snails vary in performance (Amusan and Omidiji, 1998; Okon *et al.*, 2012b). Thus Ani *et al.* (2009) opined that the use of balanced/standard diets in the feeding of snails would help to increase their growth rates and meat quality.

Okon *et al.* (2012c) recommended that intensive domestication and massive production of *A. marginata* be embarked upon since it appears to have higher potentials to meet the animal protein supply of the populace than *A. achatina* because of its larger size. This study however has demonstrated that both breeds have equal and greater potentials for meat production than the *A. fulica.* The differences in the interaction result are due to influence of genes on body traits which differ from one to another and thus showing that variability exist in the snails considered (Okon *et al.*, 2008).

Since selection efficiency depends on the variability in a population in terms of gene x environment interaction, it may be pertinent to state that while the *A. achatina* and *A. marginata* can be placed on diet III for better performance. *A fulica* may require a blend of diet I and diet III for better performance.

Table 4: Effect of Breeds x diet on body parameters of African Giant Snails

Breeds	Parameter	Diets				SEM
		I	I	III	IV	
A. Fulica	Body weight	104.63^{a}	78.13^{c}	98.17^{b}	69.38^{d}	0.58
	Body length	10.20^{a}	8.52^{ab}	9.05^{ab}	8.04^{b}	0.58
	Body width	7.34	6.85	7.28	6.94	0.58
	Aperture length	4.93	4.86	4.71	4.74	0.58
	Aperture width	4.90	4.08	3.69	3.39	0.58
A. achatina	Body weight	203.75^{b}	157.22^{bc}	230.63^{a}	199.37^{c}	0.58
	Body length	12.32^{ab}	11.45^{b}	13.17^{a}	11.07^{b}	0.58
	Body width	12.99^{a}	10.82^{b}	12.63^{ab}	10.98^{b}	0.58
	Aperture length	7.81	6.79^{a}	7.91	7.10	0.58
	Aperture width	4.72	4.60^{b}	4.66	4.33	0.58
A. marginata	Body weight	187.33^{c}	195.20^{b}	226.95^{a}	184.13^{d}	0.58
	Body length	12.42	13.09^{b}	13.56	11.64	0.58
	Body width	13.22^{a}	12.70^{a}	12.72^{a}	9.84^{b}	0.58
	Aperture length	7.56	7.89	7.46	7.48	0.58
	Aperture width	4.74	4.94	4.78	3.97	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

The effect of breeds, diet and breeds x diet interaction on growth performance of African Giant snails shown in Table 5. Significant differences ($p<0.05$) were observed among the breeds in initial weight, final weight, average weekly feed intake and feed conversion ratio. The *A. achatina* and *A. marginata* had higher initial weight and final weight than the *A. fulica.* The *A. marginata* recorded higher average intake of forage and concentrate, singly and in combination, whereas, the *A. achatina* recorded the least and best feed conversion ratio (0.92) compared to 1.89 and 1.38 in *A. fulica* and *A. marginata,* respectively. This result has shown that the *A. achatina* has an edge over *A. marginata,* since it is a better converter of feed to meat. Okon *et al.* (2012b) did not observe any significant difference in feed intake among the three genotype groups which contradicts the findings of this study. Daily feed intake calculated from the result of Amubode (1994) was 33.95 g/week for *A. achatina* (L) and 131.25 g/week (Ogogo, 1989) for *A. marginata* which are far higher than the results obtained in this study. The differences in growth trait (weight gain, feed intake) studied and previous results may be attributed to differences in nutrient contents of the diets and the age of the snails among others.

Table 5: Effect of Breeds on growth performance of African Giant Snails

Parameter	Breeds			SEM
	A. Fulica	*A. Achatina*	*A. Marginata*	
Body weight (g)	66.67^{b}	164.00^{a}	161.50^{a}	5.81
Final weight (g)	100.83^{b}	235.83^{a}	224.38^{a}	5.23
Average weekly weight gain (g)	4.94	10.30	8.98	1.95
Average weekly feed intake	9.34^{c}	9.50^{b}	12.37^{a}	0.49
Feed conversion ratio	1.89^{a}	0.92^{b}	1.38^{b}	0.14

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

The effect of diet on growth performance of African Giant snails is shown in table 6. Significant differences ($p<0.05$) were observed in final weight, average weekly feed intake and feed conversion ratio. Diets III influenced the final weight most significantly ($p<0.05$). Diet III influenced the feed intake more significantly than the other diets. However, in terms of feed conversion ratio, diet IV recorded the least and best FCR (1.01), followed by diet III (1.24) whereas, diet II recorded the poorest FCR. Diet III influenced the feed intake more significantly than the other diets. However, in terms of feed conversion ratio, diet IV recorded the least and best FCR (1.01), followed by diet III (1.24) whereas, diet II recorded the poorest FCR (1.36). Adegbola and Akinwande (1981) Okon *et al.* (2012b) observed that protein and energy levels of a diet has strong influence on body weight and body weight gain. This study did not reveal any strong influence of diet on weight gain which disagrees with their report. Omole (2000) reported a calculated mean weekly body weight gain of 2.87 g, 1.4 g and 0.84 g for *A marginata, A achatina* and *A fulica* breeds respectively which are lower than the values 8.98g, 10.30g and 4.94g, respectively. The differences may be due to differences in the diets fed among others. Meanwhile, Ebenebe *et al.* (2011), has earlier on reported that the body weights of these snails has remained inconsistent.

Okon and Ibom (2012) reported that snails

of all ages can perform optimally within acceptable dietary protein and energy bench mark levels. Previous researchers has stated that weight gain and feed conversion efficiency increased with increasing diet protein level (Ejidike, 2004) but reduces with increasing level of fibre (Omole*et al.*, 2009;Fraga, 1990; Wilfart*et al.*, 2007). Ejidike (2004) reported FCR which ranged between 1.02 – 1.34 in *A marginata*hatching which occurs closely to the value established in this study.

Ani *et al.* (2004) observed that body weight and body weight gain increased as the level of *Moringa oleifera* increased. Diet II containing solely *Moringa oleifera* leaf meal did not significantly increase the obey weight and weight gain in comparison to the other diets in this study. This shows that the other diets containing no or mixture of *Moringa oleifera* may have superior dietary potentials.

Table 6: Effect of diet on growth parameters of African Giant Snails

Parameter	Diets				SEM
	I	I	III	IV	
Body weight (g)	133.67	137.00	144.67	107.56	6.84
Final weight (g)	187.11^{ab}	178.89^{b}	206.22^{a}	175.83^{ab}	7.54
Average weekly weight gain	7.64	6.37	8.79	9.50	2.26
Average weekly feed intake (forage+cone)	10.49^{b}	10.61^{b}	10.90^{a}	9.60^{c}	0.15
Feed conversion ratio	1.37^{c}	1.67^{a}	1.24^{c}	1.01^{d}	0.07

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

The effect of breed x diet interaction on African Giant snails is presented in Table 7. Significant interaction effects were demonstrated in average weekly weight gain and feed conversion ratio in *A. fulica,* whereas significant (p<0.05) interaction effects were demonstrated in average weekly weight gain, average weekly feed intake and feed conversion ration in *A. Achatina* and *A. marginata.* Diets III demonstrated the strongest influence in average weekly gain of *A. achatina* and *A. marginata,* whereas diets I and III had strong influence in *A. fulica.* While diet II produced the highest average weekly feed intake in *A. achatina,* diet I recorded the highest intake of *A. marginata*. There was no interaction effect (p>0.05) on average weekly feed intake in *A. fulica.* Feed conversion ratio was least in *A. achatina* and *A. Marginata* breeds fed diet III, whereas, diet I produced the best FCR in *A. fulica.*

This result has shown that the influence of gene and environment supersedes the single effect of diet in this study. For instance, while the FCR was best with diet 1 in Table 6, the result of the interaction showed otherwise, since, diet III recorded a better FCR due to the better interaction of effect of diet III with the genes in *A achatina* and *A marginata.* The performance of any animal or the variation observed within a population is dependent upon the inherent genetic make-up and the environment in which it is raised (Cole, 1972 and Fredeen, 1972). Breed effect was still apparent despite the interaction effect, since the *A. fulica* performed differently from the other two breeds. Okon *et al.* (2012a) opined that breed type has a marked effect on performance and productivity of snails than all other factors considered. This is attributed to physiological adaptability to the environment and genetic variations among and within breeds. Besides, Amusan

and Omidiji (1998) and Okon *et al*. (2012b) has earlier on noted that different breeds of snails vary in performance in Nigeria which is in consonance with the findings of this study.

Odo and Orjio (2010) investigated the growth performance of snails fed different forages including fluted pumpkin (*Telfaioria occidentalis*) leaves (T_A). African Spinach *(Amaranthus sinensis)* leaves (Ta), Pawpaw (*Carica papaya*) leaves (Tc) and formulated mash (Tn). They observed significant differences in feed intake, weight gain and feed conversion ration which concurs with this present finding except in weight gain which did not vary in this study. Feed intake was highest in *T. occidentalis* followed by pawpaw leave and lastly formulated ration. Weight gain was highest in formulated ration, followed by papaw leave and then *T. occidentalis* leave. The papaw leaves performed lower in this present study in comparison to the mixture of *Moringa oleifera* and African spinach. FCR was lease and best in formulated ration followed by pawpaw leaf but poor in African spinach and *T. occidentalis* leaf. The FCR in this study was improved in the diet containing African spinach and pawpaw probably because they are mixed with concentrate as against the feeding of sole forage diet by these researchers. These researchers found that the higher the feed intake, the higher the FCR which disagrees with the present finding which revealed an association such that the higher the feed intake, the lower the FCR. The difference in this present result and their result may be as a result of the dietary mixtures as well as the breed and age of snails used among other factors.

Table 7: Effect of Breeds x diet Interaction on African Giant Snails

Breeds	Parameter	Diets				SEM
		I	I	III	IV	
A. Fulica	Initial weight (g)	65.00	75.00	60.00	66.67	12.25
	Final weight (g)	120.00	90.00	113.33	80.00	12.08
	Average weekly weight gain	7.86^{a}	24.14^{b}	7.62^{a}	2.14^{b}	0.58
	Average weekly feed intake (forage + cone)	9.34	8.67	9.34	10.00	0.58
	Feed conversion ratio	1.19^{d}	4.05^{b}	1.22^{c}	4.67^{a}	0.48
A. achatina	Initial weight (g)	170.00	168.00	190.00	128.00	10.96
	Final weight (g)	233.33	226.67	253.33	230.00	9.87
	Average weekly weight gain	9.05^{b}	9.52^{b}	9.05^{b}	13.57^{a}	0.58
	Average weekly feed intake (forage + cone)	9.99^{c}	10.33^{a}	10.14^{b}	7.63^{d}	0.33
	Feed conversion ratio	1.10^{b}	1.09^{b}	1.12^{a}	0.56^{c}	0.07
A. marginata	Initial weight (g)	166.00	168.00^{b}	184.00	128.00	10.96
	Final weight (g)	208.00	220.00	252.00	217.50	7.64
	Average weekly weight gain	6.00^{c}	7.43^{c}	9.71^{b}	12.79^{a}	0.58
	Average weekly feed intake (forage + cone)	12.25^{c}	12.83^{b}	13.23^{a}	11.17^{d}	0.23
	Feed conversion ratio	2.64^{a}	1.73^{b}	1.36^{c}	0.87^{d}	0.13

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

Conclusion and recommendations

Single effects of breed and diet were observed in all body parameters including body weight, body length, body width, aperture length and aperture width. Interaction effect of breed x diet and observed only in body weight, body length and body width. The *A. marginata* and *A. achatina* compared similarly in body weight, aperture length a d aperture width and were higher than *A. fulica.* However, *A. marginata* was longer while *A. achatina* was wider when compared to each other. The findings of this study shows that diet I may be more ideal for improving body width, aperture length and aperture width while diet II recorded higher body weight and body length compared to the other diets.

Single effects of breed and diet affected the growth performance parameters including final weight, average feed intake and feed conversion ratio except weekly weight gain. The weight gain however was only affected by interaction effect. This result has shown that the *A. achatina* has an edge over *A. marginata*, since it is a better converter of feed to meat. Diet IV recorded the least and best FCR (1.01) followed by diet III (1.24) whereas, diet II recorded the poorest FCR (1.36). *A. achitina* and *A. marginata* portrayed similar interaction effects on average weekly weight gain and feed conversion ratio. Feed conversion ratio was best in *A. achatina* and *A. marginata* breeds fed diet III, whereas, diet I produced the best FCR in *A. fulica.*

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