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Effects of three leafy vegetables on the growth performance of Giant African Snail *Achatina (Lissachatina) fulica*

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Abstract

This present research was performed to evaluate the effects of three leafy vegetable diets [bitter leaf (*Vernonia amygdalina*), fluted pumpkin leaf (*Telfairia occidentalis*) and pawpaw leaf (*Carica papaya*)] on the growth performance of Giant African Snail (*Achatina fulica*). A total of ninety (90) *A. fulica* were used for the study. Thirty (30) snails each were subjected to three different dietary treatments in three replicates of 10 snails per replicate and fed with the fresh leaves of these vegetables over a period of 12 weeks. Results obtained recorded no significant differences ($P > 0.05$) in terms of weight gain, shell length, shell circumference and shell thickness. On the whole, *A. fulica* fed on *T. occidentalis* leaf performed better in terms of mean weight gain when compared with those fed on *V. amygdalina* and *C. papaya* leaves. Conversely, snails fed on *C. papaya* leaf had the best mean shell length gain, mean shell circumference and mean shell thickness when compared with those fed on *V. amygdalina* and *T. occidentalis* leaves. The study clearly showed that the tested vegetables can be successfully utilised as diets for rearing of *A. fulica*. For farmers to achieve optimum productivity, *Telfairia occidentalis* and *Carica papaya* leaves are recommended in the dietary menus of snails while bitter leaf can successfully serve as an alternative to the other leaves.

Keywords: *Achatina fulica*, *Carica papaya*, Growth performance, *Telfairia occidentalis*, *Vernonia amygdalina*

1 Introduction

The quest for increased animal protein intake in the diets of the rural and urban Nigeria populace has increased the costs of available conventional animal proteins making them inaccessible to the poor (Rahji & Rahji, 2014; Abdulraheem *et al.*, 2016). This increase in cost of conventional animal proteins triggered the need to find alternative sources of animal protein that are cheaper and can compete favourably in providing the required nutrients found in conventional animal proteins like beef and pork. The economic utility for animal protein supply is best assessed by the ability of species to produce consumable food protein and its mass production. Snail rearing, also known as heliciculture, serves as a source of income to peasant farmers in rural areas and as an approach towards realising improved animal protein intake in Nigerian diets (Agbogidi *et al.*, 2008; Okon & Ibom, 2011).

There is now renewed interest in snail farming because of its crucial role in maintaining food security and improving living standard. This is because snail meat is found to be rich in protein and essential minerals like iron, calcium, magnesium and zinc (Ademolu *et al.*, 2004). Besides the high protein content of snail meat, it is found to be low in cholesterol compared to other conventional protein sources like chicken and pork (Omole *et al.*, 2000). Imevbore & Ademosun (1988) examined the nutritive value of snail meat and reported a protein content of 88.37 % on a dry matter

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basis. Their finding also tallies with common animal protein sources which range from 82.42 % (pork) to 92.75 % (beef) (Mogbo *et al.*, 2013). Other proximate analysis of snail meat shows that it contains 70 % of water, essential amino acids such as leucine, lysine, tryptophan, and arginine, and moderate mineral contents (Akinnusi, 1998). Imevbore & Ademosun (1988) stated further that snail meat contains calcium orthophosphate, a chemical substance linked in treating kidney diseases. The meat is recommended for patients suffering from high blood pressure and heart attack. It is also well fortified with anti-tuberculosis substances. The shells are also of economic importance as they can serve as a source of calcium and phosphorous in formulating animal diets and for ornamental uses (Baba & Adeleke, 2006; Houndonougbo *et al.*, 2012).

The Giant African Snail is a highly invasive snail. It is native to East Africa but it has spread to other parts of the world across Africa and the Indian subcontinent, Southeast Asia, the Pacific region, Caribbean, North and South America (Fontanilla *et al.*, 2014). Like other snails, *A. fulica* has voracious appetite and feeds on a wide range of crops, inflicting various degrees of damage to food crops and vegetables (Mead, 1979; Raut & Barker, 2002). It also serves as intermediate host of the rat lungworm (*Angiostrongylus cantonensis*) that causes a human disease known as eosinophilic meningitis (Marquardt *et al.*, 2000).

The inclusion of *Achatina fulica* in snail rearing businesses in Nigeria is linked to its prolific nature and high feeding plasticity of a wide range of available plant materials and detritus (Raut & Barker, 2002). *A. fulica* can lay up to 100 eggs in their first reproductive year; this may rise to 500 in their second year and declines in the subsequent years (Raut & Barker, 2002). Like other snails, they have the ability to utilise a variety of readily available feeding materials to attain appreciable weight under intensive culture (Adeyeye, 1996). They feed mainly on grains, wastes like maize chaff, plantain peels, and vegetable matters like pawpaw, cabbage, cocoyam, soft shoots of vegetables, pineapples, water leaf, lettuce and cherry (Okafor, 2001). They have also developed high tendency to feed on paint and stucco on walls in the absence of fruits and vegetables (Akinnusi, 1998; Akintomide, 2004).

The potentials of snail domestication and its mass production in Nigeria have not been fully exploited and also, snail rearing is one of the least harnessed aspects of micro-livestock production in Nigeria (Okafor, 2001). Given that information on the exact feed that can boost snail farming business for commercial purposes has received little attention, the current study attempted to bridge the gap in knowledge on suitable common leafy vegetables and their nutritive properties that can be incorporated in the daily diets of snails for maximum yield.

2 Materials and methods

2.1 Study site

The study was conducted at a commercial snail farm sited in Iyi-Enu, Ogidi town, in Idemili North Local Government Area, Anambra State, Nigeria. Okafor (2011) states that Ogidi lies in the tropical region experiencing an annual rainfall of 1000–1500 mm with two seasons – the dry and rainy season, and 26.8 °C as average yearly temperature.

2.2 Experimental set-up, leaves and snails

Juveniles of *Achatina fulica* were obtained from the Ministry of Agriculture Awka, Anambra State, Nigeria, and transported to the study site in baskets covered with banana leaves. Three different common leaves [bitter leaf (*Vernonia amygdalina*), fluted pumpkin leaf (*Telfairia occidentalis*) and pawpaw leaf (*Carica papaya*)] were used fresh as feed sources for the snails and analysed for their proximate composition according to AOAC (2005) methodologies.

Ninety (90) *A. fulica* specimen were used for the study. Prior to the feeding trial, the snails were acclimatised for two weeks, fed with maize chaff and water supplied in a closed system. Thirty (30) *A. fulica* individuals were subjected to each of the three dietary treatments in three replicates of 10 snails per replicate. Each group of snails was placed in a mini-paddock pen measuring 120 cm × 60 cm × 30 cm (the height of the walls between the mini-paddocks). This is in agreement with the standard stocking density as explained by Cobbinah *et al.* (2008). Each mini-paddock pen was housed in a roofed enclosure protected from direct rain and sunlight. Also, there was vegetation in the farm to provide further shade and control wind. The bedding was made of humus soil to a depth of 20 cm, sprinkled daily to keep it moist and to avoid estivation of snails occasioned by hot weather. In addition, each treatment received 50 g of ground egg shell which was administered repeatedly in the bedding humus.

2.3 Data collection and statistical analysis

Data were collected on the growth performance of *A. fulica* by measuring the following parameters at the beginning of the experiment and then weekly till the end of the experiment – body weight which was taken with the aid of a sensitive weighing balance, shell length, which was measured along the axis of the snail using a veneer caliper, shell circumference, which was determined by measuring the widest part of the snail using a veneer caliper (Okonta, 2012). Shell thickness was assessed with the aid of a micrometer screw gauge. The data obtained were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS, 2001). To determine significant differences between means, Least Significant Difference (LSD) (ibid.) was used.

3 Results

3.1 Proximate composition of experimental diets

Table 1 shows the results of the proximate analysis of the experimental diets. The results show high dry matter and crude protein contents with low crude fat and calcium concentrations in all the three experimental diets. Highest dry matter was recorded in *Vernonia amygdalina* leaf while highest protein content was found in *Telfairia occidentalis* leaf. *Carica papaya* leaf had higher contents of crude fibre, ash, crude fat and phosphorus compared to the other leafy vegetables.

Table 1: *Proximate composition of experimental diets (%) used in the snail feeding trial.*

Parameter	*Vernonia amygdalina*	*Telfairia occidentalis*	*Carica papaya*
Dry matter	23.40	19.75	21.84
Crude protein	20.94	23.08	22.53
Crude fibre	12.26	6.39	13.98
Ash	9.38	8.94	9.76
Crude fat	0.08	0.12	1.24
Calcium	0.18	0.19	0.16
Phosphorus	1.15	1.20	1.21

3.2 Growth performance

Table 2 shows that in all treatments there was a progressive increase in all growth parameters studied over time, despite recording insignificant statistical differences. There was no statistical difference ($P > 0.05$) in the mean weight gain of *A. fulica* subjected to each feeding treatment throughout the feeding trial. The results also show that *A. fulica* fed with fluted pumpkin leaf had the highest mean weight gain while the least gain was recorded for snails fed with bitter leaf. Also, no significant differences were observed for mean shell length increase, but snails fed with pawpaw leaf had the best mean shell length compared to the other two treatments. The different vegetable diets showed no significant differences ($P > 0.05$) in shell circumference increase and in shell thickness.

4 Discussion

4.1 Proximate composition of experimental diets

The appreciable amount of crude protein (CP) in the experimental diets shows that these diets can provide the required protein needed to replace worn out tissues and in promoting enzymatic activities necessary for body growth. The crude protein contents of the experimental diets of 20.94–23.08 % slightly agree with other reports on the crude protein contents of these three leafy vegetables. The protein content of *V. amygdalina* in this study compares well to the 20.1 % reported by Opega *et al.* (2016). In *T. occidentalis*, the protein content recorded in this study is close to the 25.49 % reported by Abu *et al.* (2014), whereas the present crude protein content of *C. papaya* is far from the finding (33.4 %) of Maisarah *et al.* (2014). The variations in proximate composition could be a result of processing methods deployed during the proximate analyses and on the leaves before being fed as these can alter the results of the data to be generated. It could also relate to the nutritional composition of the substrates on which the plants where grown, since fertile soils or substrates are expected to yield plant leaves that are richer in nutrients than less fertile soils or substrates.

The ash content of a diet is a measure of its mineral contents (Usunobun & Egharebva, 2014). The high ash content of the three diets shows that they were richly endowed with minerals (Antia *et al.*, 2006) needed for optimum growth of the snails. The crude fibre was found to be at moderate concentrations in all diets. Appreciable amount of dietary fibre aids in maintaining bulk, motility and normal bowel movements; thereby preventing constipation and enhances nutrient absorption (McDonald *et al.*, 1995; Sizer & Whitney, 2003; Meyer, 2004; Lunn & Buttriss, 2007).

4.2 Growth performance

The roles of food in the life of an organism can never be over-emphasised. One of the major roles of food includes the supply of energy needed for growth as an anabolic process. In *Achatina fulica*, the similar effects of *Vernonia amygdalina*, *Telfaria occidentalis* and *Carica papaya* leaves on its growth performance agree with the finding of Mogbo *et al.* (2014). The latter authors observed that *A. fulica* fed with three different leaves – *Moringa oleifera*, *Carica papaya* and *Talinum triangulare* – showed no significant differences in the mean weight gain. On the other hand, the results of Okonta & Agbogidi (2011) contradict our result as they observed significant increases in mean weight gains when three vegetable feeds (*Amaranthus cruetus*, *C. papaya* and *T. triangulare*) where administered to two different species of snails, *Achatina achatina* and *Archachatina*

Table 2: *Growth performance of snails (Achatina fulica) during the 12-weeks feeding trial.*

Variable	*Vernonia amygdalina*	*Telfairia occidentalis*	*Carica papaya*	*SEM*
Initial mean weight (g)	29.20	31.40	30.40	0.250
Final mean weight (g)	63.30	70.20	65.80	4.200
Mean weight gain (g)	34.20	38.80	35.40	5.550
Initial shell length (cm)	4.67	4.60	4.88	0.295
Final shell length (cm)	6.32	6.33	6.63	0.290
Mean shell length gain (cm)	1.65	1.73	1.75	0.245
Initial shell circumference (cm)	7.15	7.03	7.19	0.170
Final shell circumference (cm)	13.43	13.52	14.24	0.420
Mean shell circumference gain (cm)	6.28	6.50	7.05	0.305
Initial shell thickness (mm)	24.30	24.42	24.28	0.405
Final shell thickness (mm)	29.92	31.08	31.06	0.840
Mean shell thickness gain (mm)	5.63	6.66	6.78	0.730

SEM: Standard error of mean

marginata. The authors observed that snails fed on *T. triangulare* performed significantly better in terms of weight gain compared to those fed on *A. cruetus* and *C. papaya*. That snails fed with *T. occidentalis* leaf yielded the best result in terms of weight gain was probably due to the higher crude protein content of these leaves (Essien *et al.*, 1992), which is important for tissue growth and development; in addition, fluted pumpkin leaf was slightly more succulent, and probably more palatable and digestible than the other two leaves.

Also, insignificant differences were observed in both the mean shell length and circumference of snails fed on the three different leafy vegetables. Our findings are in line with the observations of Mogbo *et al.* (2014). These authors observed insignificant differences in both the mean shell length and circumference of *A. fulica* fed with three different vegetable diets. The observed insignificant change in both the shell length and circumference could be a result of body size increase. As the body weight increases, there seems to be a corresponding increase in size leading to expansion of the shell (Omole & Kehinde, 2005).

The insignificant increase in mean shell thickness is also in agreement with the results of Mogbo *et al.* (2014). The extra addition of calcium supplement (ground egg shell) in the bedding might be the reason for the improved shell thickness of the snails. Though, it was discovered that snails fed with *C. papaya* leaf had the best mean shell thickness. This could be related to higher phosphorous content (1.21 %) in *C. papaya* leaf as compared to *T. occidentalis* leaf (1.20 %) and *V. amygdalina* leaf (1.15 %). Phosphorous alongside with calcium are the major minerals that constitute the calcareous shell of snails, hence their efficient utilisation by snails fed with *C. papaya* leaf.

5 Conclusions

This study has shown that the utilisation of leafy vegetables (*Vernonia amygdalina*, *Telfairia occidentalis*, *Carica papaya*) in the diets of *Achatina fulica* has similar effects on growth performance; therefore all three leaves can be used in snail rearing in Nigeria and beyond. Performance is however better with fluted pumpkin and pawpaw than with bitter leaf. Additional studies using these three leafy vegetables as snail feed to ascertain their roles in the haemolymph (blood) formation of snails should be considered.

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