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Growth Performance and Carcass Characteristics of African Giant Land Snail (Archachatina Marginata) Fed Different Vegetable Based Diets

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Abstract
Growth performance and carcass characteristics of Archachatina marginata was investigated using five vegetable leaves namely; Carica papaya, Moring oleifera, Calopogonium mucunoides, Mucuna purensis and Banana, in Makurdi, Nigeria. The aim of the study was to determine which vegetable leaf was most suitable for feeding the snails. 150 healthy snails were weighed and randomly allotted to 5 treatments with 3 replicates per treatment. Each replicate contained 10 snails. The snails were reared in plastic cages measuring 37x25x23cm^3 in a Completely Randomized Design (CRD).Water containers were washed daily before serving clean water to the snails. Vegetables from the environment were fed to the snails on daily basis. The leaves were weighed once every week before and after feeding. Weight of intake and gain was determined by difference. The experiment lasted for 10 weeks, at the end of which two snails per replicate were randomly selected, starved for 24 hours and sacrificed for carcass analysis. Leaves were sundried for three days, milled and stored in air tight container for chemical analysis. Proximate composition of the leaves was determined by Standard Methods (AOAC 2016). Data obtained was statistically analysed using One way Analysis of Variance (ANOVA) in SPSS version 16. Duncan New Multiple Range Test was used to separate means. The results obtained showed that Dry Matter (DM) content of the leaves ranged from 87.4% in Carica papaya (CpLM) to 90.0% in Calopogonium mucunoides (CmLM). Crude protein (cp) ranged from 15.3% in Banana to 22.1% in Mucuna purensis (MpLM). Crude fibre (CF) level of 18.8% in Banana Leaf (BLM) was highest, while the least CF level of 4.7% was observed in Moring oleifera (MoLM). Highest ($p<0.05$) total feed intake (55.90g) was observed in snails fed CpLM, followed by those fed MoLM (34.53g.). Other group of snails fed other leaves all lost weight. Mortality was highest (50%) in snails fed CpLM and least (10%) in snails fed CmLM. Carcasses of the snails showed higher ($p<0.05$) edible weight in snails fed CpLM (34.87%), followed by those fed MoLM (26.80%). Feed did not have any effect ($p<0.05$) on dressing percentage. This study has demonstrated that among the five vegetable leaves, pawpaw leaf was better than all for feeding Archachatina marginata. For better results, high mortality of snails fed pawpaw leaves needs investigation. Supplementation of pawpaw leaf protein could also be investigated for optimum performance.
Keywords*:* Growth performance, Carcass characteristics, *Archachatina marginata*, Vegetable leaves

1. Introduction

High quality dietary protein intake of many low income earners is low leading to under nutrition especially in children of the developing world, Uauy *et. al.;* (2015). A rich source of high quality animal protein in West Africa that has not been fully utilized is snail meat. Cobbinah, (2008), observed that snails are used both as a source of food and in traditional medical practice for curing ailments like hypertension, conjunctivitis, diabetes and iron-deficiency anemia. Fagbuaro *et.al*; (2006) observed that protein content of African giant land snail-*Archachatina marginata is* 20.56%, while that of *Limicolaria* spp. was 18.66%. Developing the snail industry/farm is the latest means of bridging the protein deficiency gap presently prevailing in many countries. In order to make supply of snail meat sufficient, its rearing is very vital to supplement the conventional method of picking from the wild. Snail farming known as heliculture could be practiced using various species of snails. In the West African sub-region, three species of African Giant Land Snail (AGLS) namely: *Achatina achatina, Archachatina marginata,* and *Achatina fulica* have been developed for production. Several authors have investigated the feeding behavior and performance of the snails particularly *Archachatina marginata,* under various feed sources. Ademolu *et. al;* (2004) fed different nitrogenous sources including poultry dropping to *Archachatina marginata* and observed that snails fed on poultry droppings produced higher weight gain than those fed soybean, fish meal and urea supplemented diets. Ani *et.al*; (2014) fed Graded *Moringa oleifera* leaf meal to *Archachatina marginata* and observed that 10% inclusion of the leaf meal in the diet containing groundnut cake, soybeans meal, fish meal and palm kernel cake produced the best results. Omole *et. al*; (2011), used *Centrosema pubescens* and *Mucuna purensis* leaves as a substitute for pawpaw leaves in the diet of *Archachatina marginata* and observed that leaves of *Centrocema pubescens* produced snails with higher final weight, higher shell weight and higher offal weight than those fed *Mucuna purensis* and pawpaw leaves. The above studies showed that snails can be fed with different feed sources including sole vegetable leaves. Since snails are voracious, any feed sources commonly available in an environment could potentially be a source of

food for them. This study was therefore designed to evaluate the growth performance and carcass characteristics of *Archachatina marginata* fed different vegetable leaves commonly available in Makurdi, a Guinea savanna ecological region of Nigeria.

2. Materials and Methods

2.1 Experimental House

The snails were reared in a backyard house constructed under a *Gmelina aborea* tree, at Federal Housing Estate in the North Bank Area along the road to the University of Agriculture Makurdi. The house was built with burnt bricks to 1.25metres height and completed to the roof with poles and poultry wire mesh, reinforced with a 5cm x 5cm galvanized wire to allow good aeration. The roof was constructed using corrugated iron sheets and ceiling board to provide cooling effect inside the house. Wooden tables were designed and installed inside the house on which plastic cages were placed to ease management.

2.2 Cage Design:

Snails were reared in plastic cages purchased from modern market Makurdi, measuring 37cm x 25cm x 23cm (LXBXH). The base was perforated to allow drainage of water from moist soil. The cages were filled to 10cm depth with loamy soil that was heat treated (sterilized) to get rid of harmful soil microorganism. The soil was moistened (sprinkled) regularly to ensure a favorable moisture for the growing snails.

2.3 Experimental Design:

African giant land snails (*Archachatina marginata*) purchased from Mandella market, Niger state were transported to Makurdi and used in this study. The snails were allowed to acclimatize for two weeks at the end of which they were sorted and the active snails selected for the experiment. Initial weight measurement for all the snails was taken after which 150 healthy looking snails were divided into 5 groups of thirty snails each, and allotted to 5 treatments with 3 replicates each in a completely randomized design. Each replicate contained 10 snails in a basket. There was no statistically significant difference ($p<0.05$) in the mean weight of snails between treatments.

2.4 Experimental Procedures and Management:

Five vegetable leaves viz: *Mucuna purensis*, Banana, *Carica papaya*, *Calopogonium mucunoides* and *Moringa oleifera* were harvested from the environment, washed in clean water and fed to the snails on a daily basis. Clean water was served to each cage and the containers washed the following day before filling them with clean water again. On a weekly basis, initial weight of leaves were taken and recorded before feeding. Remnants were collected the following day, weighed and recorded. Snails were also weighed on weekly basis per replicate and recorded.

2.5 Carcass Analysis:

At the end of 10 weeks, 2 snails per replicate were randomly selected, starved for 48 hours, weighed and sacrificed by use of hot water for carcass analysis. Flesh of the snails were carefully removed from the shells and separated into the edible parts (head & foot) and offal (visceral). Shell weight, edible weight and offal weight were taken and recorded. Dressing percentage was determined by expressing the edible weight as a percentage of live weight, edible weight and offal weight respectively were also expressed as a percentage of the live weight.

2.6 Chemical Analysis:

Vegetable leaves used for feeding the snails were plucked, washed, and sundried for 3 days, milled and stored in specimen bottles ready for chemical analysis. Proximate composition of vegetable leaves and carcasses of snails were determined using standard methods (AOAC 2016).

2.7 Statistical Analysis

All data collected on performance were subjected to One - Way analysis of variance (ANOVA) using SPSS Version 16. Separation of treatment means was done using Duncan's New Multiple Range Test. Mortality rate of snails during the period of experiment was calculated in percentages. Growth rate was determined by dividing the increase in weight of snails by the period (weeks). Graphs were drawn using Microsoft Excel Window 7. Results were tabulated and presented for discussion.

3. Results

Table1, Proximate Composition of Vegetable Leaves Used in Feeding the Snails.

Proximate composition(%)	VEGETABLE LEAVES				
	MpLM	MoLM	BLM	CpLM	CmLM
Moisture Contain (%)	10.6	11.3	11.9	12.6	10.0
Crude protein (%)	22.1	19.7	15.3	18.8	19.7
Ether extract (%)	5.0	5.4	2.1	6.4	5.0
Crude fiber (%)	11.9	4.7	18.8	7.8	13.9
Ash (%)	7.4	7.6	9.3	11.5	8.1
Nitrogen free extract (%)	43.0	51.3	42.6	42.9	43.3

MpLM= *Mucuna purensis* leaf meal, MoLM= *Moringa oleifera* leaf meal, BLM =Banana leaf meal, CpLM= *Carica papaya* leaf meal, CmLM= *Calopogonium mucunoides* leaf meal

Table 1, is the proximate composition of vegetable leaves used for feeding the snails.

On the table, *Mucuna purensis* leaf meal -MpLM had the highest (22.1%) crude protein content followed by *Moringa oleifera* leaf meal -MoLM (19.7%) and *Calopogonium mucunoides* leaf meal –CmLM (19.7%). *Carica Papaya* leaf meal –CpLM had 18.8% crude protein, While Banana leave meal -BLM had the least (15.3%) crude protein content. Ether extract was highest in CpLM (6.4%), while BLM had the lowest Ether extract (2.1%). Crude fibre was highest (18.8%) in BLM and lowest (4.7%) in MoLM. Crude fibre content of CmLM, MpLM and CpLM were 13.9%, 11.9% and 7.8% respectively. Ash content of MpLM, MoLM and CmLM were 7.4%, 7.6% and 8.1% respectively and were comparable, but higher in BLM (9.3%) and CpLM (11.5%). Carbohydrate content of MoLM (51.3%) was higher than the rest of the leaf meals which were 43.3%, 43.0%, 42.9% and 42.6% for CmLM, MpLM, CpLM and BLM respectively. These values were however, not statistically determined.

Table 2: Growth Performance of *Archachatina marginata* fed Different Vegetable Leaf based Diets

Performance variables	VEGETABLE LEAF BASED DIETS					
	CpLM	MoLM	MpLM	CmLM	BLM	*P.Val*
Initial weight of snails (g)	87.67±0.07	87.27±0.14	86.80±0.00	87.80±0.00	87.73±0.03	0.061
Final weight of snails	114.57±5.79^{a}	99.50±4.01^{b}	80.57±1.32^{c}	83.20±2.21^{c}	76.07±4.88^{c}	0.000
Total weight gain (g)	26.90±7.75^{a}	12.23±4.02^{b}	-6.23±1.32^{c}	-4.60±3.82^{c}	-11.67±8.88^{c}	0.000
Average weight gain/day (g)	0.38±0.08^{a}	0.17±0.06^{b}	-0.09±0.02^{c}	-0.67±0.03^{c}	-0.17±0.07^{c}	0.000
Total feed Intake (g)	55.90±4.36^{a}	34.53±1.61^{b}	5.73±0.16^{c}	7.20±1.01^{c}	8.80±0.31^{c}	0.000
Average Feed Intake/day (g)	2.80±0.22^{a}	1.73±0.08^{b}	0.30±0.02^{c}	-0.67±0.88^{b}	-0.44±0.69^{b}	0.018
FGR	2.27±0.43^{ab}	4.30±2.25^{a}	-1.03±0.28^{ab}	-2.50±1.02^{c}	-1.30±0.71^{b}	0.011
Mortality rate of snails (%)	50	17	20	10	30	

CpLM= *Carica papaya* leaf meal, MoLM= *Moringa oleifera* leaf meal, MpLM= *Mucuna purensis* leaf meal, CmLM= *Calopogonium mucunoides* leaf meal and BLM =Banana leaf meak
Numbers are means and standard deviation from the mean
Means with different superscripts within the same row are significantly ($p<0.05$) different

Table 2, is the growth performance of *Archachatina marginata* fed different vegetable leaf based diets. Snails fed CpLM had the highest (55.90±4.36) total feed intake ($p<0.05$), followed by the snails which fed on MoLM (34.53±1.61). However, no significant difference was observed in the intake of snails fed BLM (8.80±0.31) CmLM (7.20±1.01) and MpLM (5.73±0.16). Snails fed CpLM also had the highest (114.57±5.79) final mean weight ($p<0.05$), followed by those fed MoLM (99.50±4.01). There was no significant difference ($p>0.05$) in the final mean weight of snails fed CmLM (83.20±2.21), MpLM (80.57±1.32) and BLM (76.07±4.88). Average weight gain per day of snails fed CpLM (0.38±0.08) was significantly higher ($p<0.05$) than those fed MoLM (0.17±0.06). It was observed that mean weight gain of snails fed CmLM (-4.60±3.82),

MpLM (-6.23±1.32), and BLM (-11.67±8.88) all were negative, meaning that the snails in those groups lost weight in the course of the experiment. Snails that fed on CpLM had the highest mortality rate (50%), followed by those that fed on BLM (30%), while those that fed on CmLM had the lowest percentage mortality rate 10%.

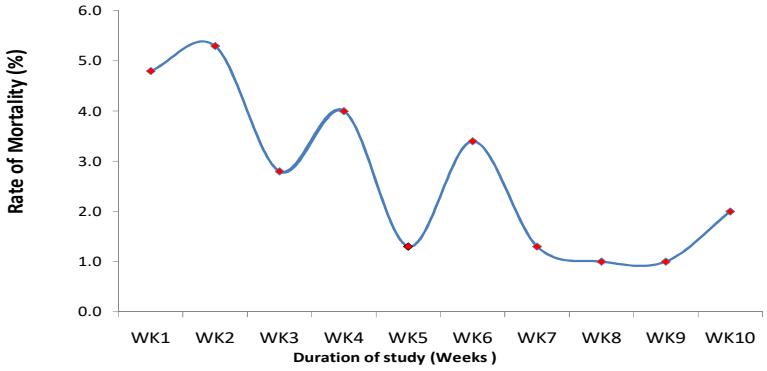

Figure 1, Weekly mortality rate of snails fed vegetable leaves

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Figure 1, Weekly mortality rate of snails fed different vegetable leaves.

Figure 1, is the percentage weekly mortality rate of snails fed sole vegetable leaves. High mortality rate (4.8%) was observed in week 1, followed by week 2 (5.3%). Thereafter, the mortality rate became undulating and progressively reduced to 1.0% in week 8 and 9. The mortality rate rose again to 2.0% in week 10 before termination of the experiment.

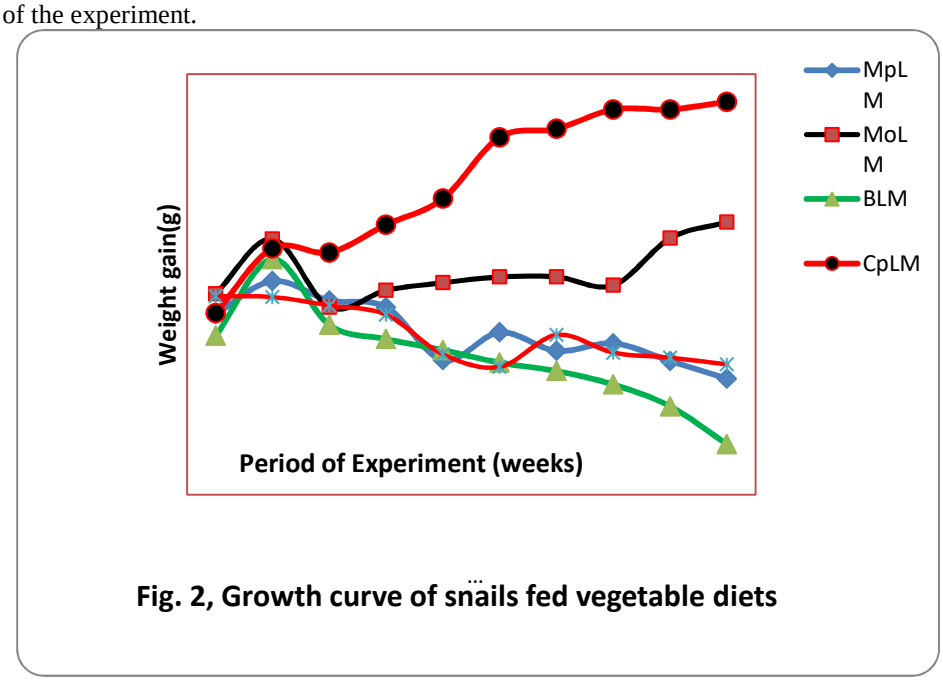

Fig. 2, Growth curve of snails fed vegetable diets

CpLM= *Carica papaya* leaf meal, MoLM= *Moringa oleifera* leaf meal, MpLM= *Mucuna purensis* leaf meal, CmLM= *Calopogonium mucunoides* leaf meal and BLM =Banana leaf meal

The growth curve in figure 2, revealed that, snails fed CpLM had the highest growth rate followed by those fed MoLM. Growth of snails that fed on all leaves picked up from week 1 to week 2, but quickly declined after week 2. At the end of week3, snails that fed on BLM had lost all that they had gained in week 1 and week 2; and thereafter continued to lose weight till the end of the experiment (week 10). Snails that fed on CmLM and MpLM crashed below their take off point between week 4 and 5, and continued losing their weight till the end of the experiment (week 10). Snails that fed on CpLM had the most impressive growth rate with a curve similar to the ogive curve (typical of the growth pattern of biological species). Snails fed MoLM picked up between week 8 and 9 and continued, but were not observed beyond week 10 at which time the experiment terminated.

Table 3, Shell development of *Archachatina marginata* fed different vegetable leaf diets

	VEGETABLE LEAF BASED DIETS					
Performance variables	CpLM	MoLM	MpLM	CmLM	BLM	P.Val
Initial shell length (cm)	7.37±0.08	7.35±0.08	7.34±0.08	7.56±0.08	7.48±0.08	0.109
Final shell length (cm)	7.91±0.10^{a}	7.54±0.10^{b}	7.64±0.10^{b}	7.64±0.10^{b}	7.53±0.10^{b}	0.017
Shell length increase (cm)	0.74±0.08^{a}	0.45±0.08^{b}	0.40±0.08^{b}	0.42±0.08^{b}	0.45±0.08^{b}	0.009
Initial shell diameter (cm)	3.79±0.13	3.79±0.13	3.74±0.13	3.93±0.13	3.90±0.13	0.566
Final shell diameter (cm)	4.08±0.06^{a}	3.84±0.77^{b}	3.87±0.77^{ab}	3.93±0.56^{a}	3.78±0.40^{b}	0.102
Shell diameter increase(cm)	0.28±0.09^{a}	0.05±0.09^{bc}	0.13±0.09^{ab}	0.00±0.09^{c}	-0.11±0.09^{c}	0.012

CpLM= *Carica papaya* leaf meal, MoLM= *Moringa oleifera* leaf meal, MpLM= *Mucuna purensis* leaf meal, CmLM= *Calopogonium mucunoides* leaf meal and BLM =Banana leaf meal.
Numbers are means and standard deviation from the mean.
Means with different superscripts within the same row are significantly ($p<0.05$) different

Table 3, shows Shell development of *Archachatina marginata* fed different vegetable leaf diets. There was no significant difference ($p>0.05$) in the initial shell length of snails in all the treatments. However, Snails fed (CpLM) had the highest (7.91±0.10) final shell length ($p<0.05$), when compared with those that fed on other leaves. There was no significant difference ($p>0.05$) in the shell length increase of snails fed MoLM (0.45±0.08), BLM (0.45±0.08), CmLM (0.42±0.08) and MpLM (0.40±0.08). Snails fed CpLM (4.08±0.06) and CmLM (3.93±0.56) had higher Final shell diameter ($p<0.05$) than those that fed on MpLM (3.87±0.77), MoLM (3.84±0.77), and BLM (3.78±0.40). However, there was no significant difference in shell diameter of snails that fed on MpLM (3.87±0.77), MoLM (3.84±0.77) and BLM (3.78±0.40). Snails fed CpLM had the highest (0.28±0.09) Shell diameter increase but were not significantly different ($p>0.05$) from those that fed on MpLM (0.13±0.09). Snails that fed on CmLM (0.00±0.09) and BLM (-0.11±0.09) had the least Shell diameter increase ($p<0.05$).

Table 4. Carcass analysis of *Archachatina Marginata* fed vegetable leaf diets

	VEGETABLE LEAF BASED DIETS					
Variables value	CpLM	MoLM	MpLM	CmLM	BLM	P.val
Live weight (g)	95.48±3.68^{a}	83.82±5.85^{ab}	65.78±4.07^{c}	72.40±5.39^{bc}	63.82±8.17^{c}	0.004
Shell weight (g)	17.73±2.27	16.78±0.70	16.63±1.19	13.52±2.01	14.32±1.77	0.367
Shell thickness (mm)	1.133±0.076	1.300±0.238	1.283±0.145	1.133±0.156	1.450±0.195	0.658
Edible weight (g)	34.87±1.85^{a}	26.80±1.96^{b}	17.50±1.49^{c}	21.32±1.85^{bc}	16.10±2.84^{c}	0.000
Weight of offal (g)	13.48±1.39^{b}	19.80±2.40^{a}	8.93±1.53^{b}	14.98±1.86^{ab}	9.85±2.75^{b}	0.007
Dressing percentage	36.10±3.60	32.33±2.35	27.68±3.76	29.42±2.22	30.97±9.97	0.826

CpLM= *Carica papaya* leaf meal, MoLM= *Moringa oleifera* leaf meal, MpLM= *Mucuna purensis* leaf meal, CmLM= *Calopogonium mucunoides* leaf meal and BLM =Banana leaf meal.
Numbers are means and standard deviation from the mean.
Means with different superscripts within the same row are significantly ($p<0.05$) different

Table 4, contains Carcass analysis of *Archachatina marginata* fed vegetable leaves. There was no significant difference ($p>0.05$) in the shell weight and shell thickness of snails fed different vegetable leaves.

However, the general trend in the shell weight showed that snails fed CpLM> MoLM> MpLM> BLM> CmLM with the values: 17.73±2.27, 16.78±0.70, 16.63±1.19, 14.32±1.77 and 13.52±2.01 respectively. Edible weight of snails fed CpLM (34.87±1.85) was significantly higher than the rest of the snails fed other vegetable leaves. However, edible weight of snails fed MoLM (26.80±1.96) were similar ($p>0.05$) to those fed CmLM (21.32±1.85).Offal weight of snails fed MoLM (19.80±2.40) was significantly higher ($p<0.05$) than those fed CpLM (13.48±1.39), BLM (9.85±2.75), MpLM (8.93±1.53) but similar ($p>p.05$) to those fed CmLM (14.98±1.86). There was no significant difference ($p>0.05$) in the dressing percentage of snails fed different vegetable leaves. However, the general trend showed that snails fed CpLM> MoLM> BLM> CmLM> MpLM, with the mean values: 36.10±3.60> 32.33±2.35> 30.97±9.97> 29.42±2.22> and 27.68±3.76 respectively.

4. Discussion

Chemical composition of the vegetable leaves in this study showed that Pawpaw (*Carica papaya*) leaves had crude protein (cp) content of 18.8% at 12.6% moisture level which when expressed on dry basis is 21.5%. This compared favourably with Omole *et al*; (2011), who observed cp. of 22.5% in the pawpaw leaves he used in feeding *Archachatina marginata.* The result of cp in this study was however at variance with Ogunkunle and Lamidi (2014), who observed 0.78% cp at 8.55% moisture level in the pawpaw leaves. Pawpaw leaves in the present study and those used by Ogunkunle and Lamidi (2014), were sourced from different ecological regions in Nigeria. Provenance, maturity of leaves or handling prior to determination of chemical composition may be responsible for the observed differences in the cp level. However this postulation is subject for further research. Cp content of MoLM 19.7% was lower than 32.7% observed by Ani et. al. (2014) ,but comparable with CmLM 19.7% . High fibre level in BLM (18.8%), CmLM (13.9%) and MpLM (11.9) are capable of limiting digestibility and absorption of nutrients in snails. High feed intake by snails fed CpLM and the corresponding high growth performance observed in this study has alluded to the superiority in performance of snails fed pawpaw leaves compared to those fed other type of leaves, (Ufele 2015, Omole *et.al.*; 2011, Ufele 2015 and Imran *et.al.*; 2009). In his study, Omole *et.al;* (2011) was worried that a continuous use of pawpaw leaves by snail farmers could bring a rift between them and pawpaw farmers, if alternative feed sources were not explored. In Benue State, Conventional pawpaw plantations are rare. Fruits of pawpaw are normally harvested from few trees that grow on backyard manure in villages. Harvesting of pawpaw leaves in this manner is associated with reduction in the yield of fruits. Supplementation of CpLM with conventional protein supplements could reduce the demand for pawpaw leaves by the snail farmers and at the same time improve the feeding value of pawpaw leaves. Though snails fed MoLM were second in their growth performance, their average gain of 0.17g/snail/day was not impressive. Their improvement in week 9 and 10 did not have much influence on the overall performance. The low intake of snails fed other vegetables namely MpLM, CmLM and BLM was accompanied by weight loss which is indicative of the presence of a factor(s) that could be anti-nutritional to the snails. Snails have a simple digestive tract which may not be endowed with the capacity to digest fibre effectively. High level of fibre observed in these thee vegetables may have caused low intake and hence weight loss in the snails. In spite of the superior feeding value of CpLM compared to other vegetable leaves in this study, it was not accompanied by shell thickness. Since snails were exposed to soil from a common source as their bedding material, they may have supplemented their need for calcium from the soil. Legumes generally are known to contain phytates and tannins which when not deactivated cause poor performance in simple stomached animals. Omole et. al.; (2011) observed impressive weight gain in *A. marginata* after feeding leaves of *Centrosema pubescens* (147g) and *Mucuna purensis* (141g) and recommended that leaves of any of the two leguminous plants could replace Pawpaw leaves (143g) in feeding *A. marginata.* The loss in weight of snails fed MpLM and CmLM in this study casts a doubt in the superiority of sole leaves of these leguminous plants over pawpaw leaves in the nutrition of *Archachatina marginata*. Obua *et. al*; (2012) observed that *Calopogonium mucunoides* had 1.24% of its content made up of Tannin, 0.82% Phytate, 0.81% Oxalate, 0.38mg/kg HCN and 0.44% Saponin. In spite of the high content of protein observed in CmLM (19.7%) and MpLM (22.1%); their content of anti-nutritional properties may need to be investigated.

5. Conclusion

1. Snails fed Pawpaw leaves (*Carica papaya*) had higher feed intake, growth performance and carcass edible weight compared to those fed leaves of *Moringa oleifera*, *Mucuna purensis*, Banana and *Calopogonium muconoides*.
2. Leaves of *Calopogonium mucunoides*, *Mucuna purensis* and Banana were found not suitable for feeding *Archachatina marginata* as sole feed if weight loss is to be avoided.
3. High fibre level in Banana leaves, *Calopogonium mucunoides* and *Mucuna purensis* may have caused the low intake and poor feed utilization by *Archachatina marginata.*
4. Short period of acclimatization (2weeks) in a more challenging environment, may be responsible for the high mortality rate of snails in this study. However, this factor needs further investigation.

5. For better results, amino acid profile of pawpaw leaves needs to be investigated and supplemented with other protein sources to see if that would ensure higher growth performance in *Archachatina marginata*.

References

AOAC (2016) Official Methods of Analysis of AOAC INTERNATIONAL, 20 Edition

Ademolu, K. O., Idowu, A. B., Mafiana, C. F., and Osinowo , O. A. (2004), Performance, proximate and mineral analyses of African giant land snail (*Archachatina marginata*) fed different nitrogen sources. *African Journal of Biotechnology. Vol. 3(8) 412-417*

Ani, A. O., Ogbu, C. C. and Okonkwo, A. M. (2014). Growth Response of African Giant Snail (*Archachatina marginata*) to Varying Dietary Levels of *Moringa oleifera* Leaf Meal. Advances in Life Science and Technology, Vol. 27 ISBN2224-7181 (Paper) ISSN 2225-062X (Online)

Fagbuaro, O., J. A. Oso, J. B. Edward, and R. F. Ogunleye, (2006). Nutritional status of four species of giant land snails in Nigeria. *J.Zhejiang Univ Sci B. 7(9): 686-689*. Published Online doi:10.1631/jzus.2006.B0686

Imran, G. T., Ayeni, O. D., Okunade, A. S. and Oyeleye, B. (2009). Potentials of replacing pawpaw fruit and leaves with cabbage peels as a natural feedstuff in the diet of *Achatina achatina* (African giant land snail). *African Journal of Biotechnology Vol. 8 (21), pp. 6000-6003*

Obua, B. E., Okocha, C. N. and Nwaoha, L. E. (2012). Proximate Composition and Anti-nutritional Factors of Some Forage species used in feeding Rabbits in Umudike, Humid South Eastern Nigeria. *NT'L Journal of Agric. and Rural Development, Vol.15 (3)1275-1286*

Ogunkunle and Lamidi (2014). Growth Response of *Archachatina marginata* (Swainson) to Brown Pawpaw Leaf Meal (BPLM) and Groundnut Cake (GNC) Mixture. *Global Journal of Bio-Science and Biotechnology Vol.3 (4) 406-410.*

Omole A J; A M Ogungbesan*, J A Fayenuwo and Y A Popoola (2011). Comparative utilization of *Centrosema pubescens* or *Mucuna purensis* as a substitute for pawpaw leaf by growing snails. *Livestock Research for Rural Development 23 (3).*

Siyanbola Mojisola Funmilayo (2008). Preliminary investigation of growth performance of giant land snail *(Archachatina marginata)* fed with selected household wastes. *African Journal of Agricultural Research Vol. 3 (9), pp. 647-649,* ISSN 1991- 637X
Available online at http://www.academicjournals.org/AJAR

Ufele Angela Nwogor, (2015), Effect of Pawpaw (*Carica Papaya*) and Plantain (*Musa Paradisiaca*) Leaves on Growth Performance of *Archachatina marginata* (AGLS) *European Journal of Biophysics* 3(4): 23-26. Published online (http://www.sciencepublishinggroup.com/j/ejb

Ogunkunle, T. and A. A. Lamidi (2014). Growth Response of *Archachatina marginata* (Swainson) to Brown Papaw Leaf Meal (BPLM) and Groundnut Cake (GNC) Mixture. *Global Journal of Bio-Science and Biotechnology Vol.3 (4)2014: 406-410.*

Uauy, R.; Kurpad, A. Tano-Debrah, K, Otoo G.E. Aaron, G.A. Toride, Y. (2015). Role of Protein and Amino Acids in Infant and Young Child Nutrition: Protein and Amino Acid Needs and Relationship with Child Growth. *Journal of Nutritional Science and Vitaminology*. Vol. 61 Issue Supplement Pages S192-S194 Online ISSN : 1881-7742 . Print ISSN : 0301-4800