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Research article

THE EFFECT FEEDS ON WEIGHT OF AFRICAN GIANT LAND SNAILS *(Archachatina marginata)*

Owoseni, D. O. and Adetunji, A. A.

Department of Mathematics and Statistics, Federal Polytechnic, Ado-Ekiti, Nigeria
E-mail: adecap4u@yahoo.com

Abstract

The authors examine effects of different forages on the weight of African giant land snail (Archachatina marginata) under intensive farming. Different forages used in the study constituted the treatment [Carica papaya (pawpaw) and Talinium triangulare (waterleaf), and the control (waterleaf and pawpaw)]. The aim is to know if there is any significant difference between weights of the snails over the same extended period of time. Ninety (90) snails are divided into 3 treatment groups of thirty (30) snails each in a completely randomized design. These three groups are further divided into three sub-groups of ten each to make a pen. In all, there are three pens each with thirty snails which are randomly divided into three groups where each type of forage is fed to each group. Using analysis of variance, results of the data analysis for the three feeds (each for each sub-group) indicate that there was a significant difference between the weights gained by the snails after twelve weeks of observation. There is significant difference in the weight gained by snails in each pen and also in the effect of feeds in snail. Snails fed with pawpaw had the highest weight followed by those fed with waterleaf only while those that fed on waterleaf and pawpaw (control) had the least.

Keywords: Forages, African Giant Snail, Waterleaf, Pawpaw, Analysis of Variance

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Introduction

Heliculture (snails rearing) is under mini-livestock farming. They exist majorly in abundance in West Africa and Western Europe. Snails exist both in the terrestrial life (on land) and in the aquatic life. This research focuses on the rearing of Giants African Land Snail (GALS). Erinle, 2008 categorized other species of GALS as *achantina fulica, achantina maginata, achantina achantina*. Snails are crawling exo-skeletal invertebrate animals that possess fluid instead of blood. In a typical African setting, snails are fetched in the wild by young boys, girls and adult men and women either for immediate family consumption or for sale if found in large quantities. However, due to environmental destruction, deforestation and bush burning, all of which has reduced the population of snails in the wild to the barest minimum, this lead to the introduction of scientific snail farming technique in the last decade. Snails are the largest group of *molluscs* constituting the largest animal group next to *arthropods.* The giant land snails are non-conventional protein sources whose meat is a highly relished delicacy (also known as *'Congo meat'*) and constitutes an important source of animal protein in many coastal communities of Nigeria and other parts of Africa (Omole et al, 2007) Meat of snail is palatable, nutritious and rich in essential amino acids such as *lysine, leucine, isoleucine and phenylalanine* and also high iron contents [Imevbore, 1990; Stievenart, 1996; Ebenebe, 2000]. Snails have been recommended for the treatment of high blood pressure, anaemia, asthma and other related ailments because they are relatively low in cholesterol levels [Awesu, 1980 and Akinnusi, 2000]. It is reasonable to assume that the relative size and the nutritional quality of snail meat depends on the nutritional quality of feed they consume in the wild or in captivity, which in turn determines their preference and palatability by man. But there is paucity of information on the relationship between the nutritional composition of feed consumed by snails and the nutritional palatability of their edible flesh. Hence, this research investigates the effect of feeding African giant land snail (*Archachatina marginata*) with *Carica papaya* and *Talinium triangulare* with the aim of observing if any significant difference in the effects of the feeds.

Since pre-historic time, snails' meat had been consumed by human worldwide because of its numerous importance. Snail is high in protein (12-16%) and iron (45-50mg/kg) low in fat and contains all amino acids needed by humans. A recent study has also shown that the glandular substances in edible snail meat cause agglutination of certain bacteria, which could be of value in fighting a variety of ailment including whooping cough (CEDVS, 2012). Edible snails also play an important role in folk medicine. In Ghana, the bluish liquid obtain from the shell when the meat has been removed has been used in producing infant feeds because it aids infant development. The high iron content of the meat is considered important in treating anemia, in the past it was recommended for combating ulcers and asthma. In West Africa, snail's meat has traditionally been a major ingredient in the diet of people living in the high forest belt. Estimate in Cote d'Ivoire showed that 7.9 million kg are eaten annually while the demand in Ghana outstrips supply (Odo and Orji, 2010).

Snails are fascinating creatures that are fairly easy to keep as pet and require little attention. African snails can live for ten years but generally live in 3-7 years in captivity, so they live longer than hamster and guinea pig. Native snails can live for 15 years. Snail do react to stimuli and can get bored so it is imperative to keep your snails in a fairly interesting home with nooks and crannies to hide and compost or peat for them to burrow in, they respond well to being handled and though primarily nocturnal (CEDVS, 2012).

Snails are generally omnivores (they eat vegetables and flesh) but majority of the species are herbivores. They have varieties of food ranging from pawpaw, pawpaw leave, cocoyam leave, water leaves etc. Both water leaf and pawpaw are examined in this research. Snails mature between 12-13 months and they love to be in a cold and cool area since they are cold blooded animals. The rate of reproduction is higher during the wet season and they often lay their eggs in the dry season. Their eggs are laid inside the soils and covered up with soils. They are harmless to animal and people entirely, cheap to house, maintain, feed and rarely suffer from illness and even show outward sign of being unhappy with their condition allowing you to react before they die.

Literature Review and Methodology

In 2011, Kalio and Etela observed the nutritional and organoleptic properties of the African giant land snails (*Archachatina marginata*) using 96 healthy-looking growing snails maintained on broiler starter mash (BSM) as control, waterleaf, centro leaves, and pawpaw leaves for 16 weeks. This study was set up as a completely randomized design (CRD) with the snails allocated to 4 treatment groups and 3 replications each of 8 snails (giving a total of 24 snails per treatment group). At the end of the 16-week period, 4 snails were each harvested at random from the 3 replicates of each of the 4 treatments, sacrificed, processed and analyzed. Dry matter (DM), ash, fat or ether extract (EE) and nitrogen-free extract (NFE) were higher ($P < 0.05$) in the BSM group, while crude fibre (CF) was higher ($P < 0.05$) in centro leaves (34.2 g/100 g) and crude protein (CP) was higher in pawpaw leaves. Meancholesterol level was very low (0.003 ± 0.0006 mg/100 g) in the snail. Their research recorded negative correlation (r = -0.99; $P < 0.05$) was between diet CF and moisture content of the snail meat, while feed EE had a positive correlation (r = 0.98; $P < 0.05$) with snail cholesterol level. Based on tastiness, toughness and tenderness of the snails fried and stewed with spices or only steamed without spices, preference ranking in descending order gave pawpaw leaves > BSM = centro leaves > waterleaf. They concluded that snails fed pawpaw leaves performed better than the control diet and could be exploited as a cheap feed resource for smallholder snail production in the humid tropics. Low fat and cholesterol levels in the African giant land snail make it very suitable for ameliorating human cardiovascular-related diseases.

Baba and Adeleke (2006) studied the features and profitability of snail farming in Osun State. They randomly selected 20 snail farmers from Osogbo, Iwo and Ife-Ijesa townships, where majority of snail farmers in the State were located. Using descriptive statistics, farm budgeting and regression analysis they analyzed data collected from the farmers. Results of the study revealed that snail production was undertaken on a small scale with an average stock size of 650 per farmer. They observed that only 45% of the farmers were in snail farming for earning income. 36.7% of the farmers housed the snails in pens, 35% used baskets, 18.3% used drums and 10% used tyres. The costs and returns analysis revealed that variable costs accounted for 96% of the production costs. Labour was the most costly single item in snail production in the area. The results further showed that snail farming was highly profitable, with the average farmer earning a net return of 40 naira per snail. There was a profit of 1.39 naira on every naira invested in snail production. The results of the regression analysis showed that stock size was the most important factor determining profitability of snail enterprises. Also in 2010, Ahmadu and Ojogo examined the economics of snail production in Edo state of Nigeria. Focuses of their study were the socio-economic characteristics of the respondents; cost & returns and factors affecting revenue generation in snail production. They adopted snow balling sampling technique to identify a total of 95 snail farmers in the study area and this formed the sample size for the study. They also used descriptive statistics, budgetary and regression analyses and the result indicated that the respondents had average stock size of 630 snails. They found that business of snail production required low capital investment and was highly profitable with gross margin and net profit per snail of N68.45 and N63.44 respectively. The results further showed that stock size, labor cost and educational level were the significant factors influencing revenue from snail production. They all correlated positively with the revenue and explained about 79% of the variation in the revenue ($R^2 = 0.785$). The researchers concluded that since snail production required low capital investment, low income earners could comfortably embark on it; and in view of the high profit level of the business, it could be a veritable enterprise for uplifting the living standard of its producers and advance the economy of the nation.

Experimental Site and Design

A 12-week completely randomized design (CRD) feeding trial was conducted at the site of Centre for Entrepreneurial Development, Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria. The work used ninety (90) healthy-looking growing *Archachatina marginata* snails allocated to 3 treatment groups. The snails were fed with *Talinium triangulare* leaves or waterleaf, *Carica papaya* or pawpaw leavesand control (pawpaw and water leaf). Digital measuring scale was used to observe the initial weight of the snail in grams. Each group of the snails was fed with 200 grams of feed (water leaf, pawpaw and control) on weekly basis and their weight was observed after 12 weeks of feeding.

Principles of Experimental Design

Randomization: It is essential in experimentation that every allocation of treatments to experimental units be done in an objectives manner so as to avoid bias. The only way to achieve this is through randomization. Randomization is a process by which the allocation of treatment to experimental units is done by means of some chance device in order to ensure that no particular treatment is consistently favored or handicapped.
Replication: Replication refers to a situation where treatment is applied to more than one experimental unit. Either over space or over time, it provides a basis of experimental error, and may also be used to increase the scope of inference or an experimental.

Local control: This refers to the amount of grouping or blocking of the experimental unit that is employed in the adopted experimental design. It entails grouping the experimental units into blocks such that the units within a block are relatively homogenous while the units between the blocks are heterogeneous.

Analysis of Variance
The analysis of variance (ANOVA) is an arithmetic method for breaking down the total variation of the collected data into component representing the sources of variation of the collected data into component representing the sources of variation observed in the experiment (Dowdy and Cox, 1983).

Table 1: ANOVA data layout

	1	**2**	**3**	**-**	**-**	**B**
1	Y_{11}	Y_{12}	Y_{13}	-	-	Y_{1b}
2	Y_{21}	Y_{22}	Y_{23}	--	--	--
3	Y_{31}	Y_{32}	Y_{33}	-	-	-
T	-	-	-	-	-	y_{tb}

Table 2: ANOVA Table

Source of Variation	**df**	**Sum of Squares**	**Mean SS**	$\mathbf{F_{ratio}}$
Treatment	t-1	SSt	MSt	MSt/MSe
Block	b-1	SSB	MSb	MSb/MSe
Error	(b-1)(t-1)	SSE	MSe	
Total	bt-1	SST		

ANOVA model

$Y_{ij} = \mu + \tau_i + \beta_j + e_{ij}$
Y_{ij} = i_{th} treatment in the j_{th} block
μ = grand mean
β_j = j_{th} block effect
τ_i = i_{th} treatment effect
e_{ij} = random error term which is assumed to be normally and independently distributed with a mean of 0 and a constant variance σ^2

The Sum Of Squares

$$SST = \sum Y_{ij}^2 - \frac{Y_{..}^2}{bt}$$

$$SSt = \sum \frac{Y_{i.}^2}{b} - \frac{Y_{..}^2}{bt}$$

$$SSb = \sum \frac{Y_{.j}^2}{t} - \frac{Y_{..}^2}{bt}$$

SSE = SST – SSt – SSb

Assumptions of ANOVA

- The observation in each group comes from a normal distribution (normal assumption).
- The population variance of each group is the same (homogeneity of variance).
- The observations are independent of each other (independent variable).

Hypothesis Statement
$H_0 : \tau_i = 0$ for all *i* (The feed has no effect on the mass of the snail)
$H_1: \tau_i \neq 0$ (The feed has effect on the mass of the snail)

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Analysis and Results

Table 3 displays descriptive statistics for each combination of factors in the model. The N column in the table shows there are equal cell sizes. The table shows that in all the pens, weight gained by snails that were fed pawpaw is the highest. Also, snails in pen 1 has the highest weight

Table 3: Descriptive Statistics

Pen	Treatment	Mean	Std. Deviation	N
Pen 1	Pawpaw	80.1000	5.98182	10
	Waterleaf	62.0700	2.67127	10
	Control (Waterleaf and Pawpaw)	67.5200	5.08632	10
	Total	**69.8967**	**8.96205**	**30**
Pen 2	Pawpaw	76.0600	12.03829	10
	Waterleaf	58.7300	8.81855	10
	Control (Waterleaf and Pawpaw)	53.9200	6.97405	10
	Total	**62.9033**	**13.33141**	**30**
Pen 3	Pawpaw	69.0900	10.64628	10
	Waterleaf	59.5900	9.65821	10
	Control (Waterleaf and Pawpaw)	56.3100	6.53256	10
	Total	**61.6633**	**10.38037**	**30**
Total	Pawpaw	75.0833	10.61362	30
	Waterleaf	60.1300	7.57446	30
	Control (Waterleaf and Pawpaw)	59.2500	8.52804	30
	Total	**64.8211**	**11.50985**	**90**

Table 4 tests the null hypothesis that the variance of the error term is constant across the cells defined by the combination of factor levels. Since the significance value of the test, 0.09, is greater than 0.05, there is no reason to believe that the equal variances assumption is violated. Thus, the small differences in group standard deviations observed in the descriptive statistics table are due to random variation.

Table 4: Levene's Test of Equality of Error Variances

F	df1	df2	Sig.
3.226	8	81	.09

Table 5 an analysis of variance table. Each term in the model, plus the model as a whole, is tested for its ability to account for variation in the dependent variable. The significance value for each term, except Pen*Treatment, is less than 0.05. Therefore each term, except Pen*Treatment, is statistically significant (There is significant difference in the weight gained by snails in each pen and also in the effect of feeds in snail). The partial eta squared statistic reports the "practical" significance of each term, based upon the ratio of the variation (sum of squares) accounted for by the term, to the sum of the variation accounted for by the term and the variation left to error. Larger values of partial eta squared indicate a greater amount of variation accounted for by the model term, to a maximum of 1. Here the individual terms are statistically significant and have great effect on the effect of treatments.

Table 5: Tests of Between-Subjects Effects

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6485.725	8	810.716	12.379	.000	.550
Intercept	378159.880	1	378159.880	5774.299	.000	.986
Pen	1182.321	2	591.160	9.027	.000	.182
Treatment	4750.710	2	2375.355	36.270	.000	.472

Pen*Treatment	552.694	4	138.173	2.110	.087	.094
Error	5304.705	81	65.490			
Total	389950.310	90				
Corrected Total	11790.430	89				
R Squared = .550 (Adjusted R Squared = .506)						

Post Hoc Tests

The tests of between-subjects effects determine the significance of a factor. However, they do not indicate how the levels of a factor differ. The post hoc tests show the differences in model-predicted means for each pair of factor levels. The first column of table 6 displays the different post hoc tests. The next two columns display the pair of factor levels being tested. The table reveals that there is significant difference in comparing the effects of feeding snail with pawpaw and both waterleaf and control (waterleaf and pawpaw). However, there is no significant difference in the effect of waterleaf and control (waterleaf and pawpaw)

Table 6: LSD Multiple Comparisons

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower	Upper
Pawpaw	Waterleaf	14.9533*	2.08950	.000	10.7959	19.1108
	Control	15.8333*	2.08950	.000	11.6759	19.9908
Waterleaf	Pawpaw	-14.9533*	2.08950	.000	-19.1108	-10.7959
	Control	.8800	2.08950	.675	-3.2775	5.0375
Control	Pawpaw	-15.8333*	2.08950	.000	-19.9908	-11.6759
	Waterleaf	-.8800	2.08950	.675	-5.0375	3.2775

The homogenous subsets table (table 7) shows the results of the post hoc tests in a more easily interpretable form. In the subset columns the factor levels that do not have significantly different effects are displayed in the same column.

Table 7: Homogeneous Subsets

Treatment	N	Subset	
		1	2
Control (Waterleaf and Pawpaw)	30	59.2500	
Waterleaf	30	60.1300	
Pawpaw	30		75.0833
Sig.		.675	1.000

Conclusion

This research focuses on the rearing of Giants African Land Snail (GALS). The work used ninety *Archachatina marginata* (African giant land snails) allocated to 3 treatment groups. The snails were fed with *Talinium triangulare* leaves (waterleaf), *Carica papaya* (pawpaw) leaves and control (pawpaw and water leaf). Digital measuring scale was used to observe the initial weight of the snail in grams. Each group of the snails was fed with 200 grams of feed (water leaf, pawpaw and control) on weekly basis and their weight was observed after 12 weeks of feeding. Analysis showed that in all the pens, weight gained by snails that were fed pawpaw leaf is the highest. Also, snails in pen 1 has the highest weight.

Test of the hypothesis that the variance of the error term is constant across the cells reveals that there is no reason to believe that the equal variances assumption is violated. Analysis of variance of the observed weights shows that except Pen*Treatment, all the factors considered have significant effect on the weight gained by the snails. There is significant difference in the weight gained by snails in each pen and also in the effect of feeds in snail. The partial eta squared statistic reports reveals that the individual terms are statistically significant and have great effect on the effect of treatments. The post hoc test shows that that there is significant difference in comparing the effects of feeding snail with pawpaw and both waterleaf and control (waterleaf and pawpaw). However, there is no significant difference in the effect of waterleaf and control (waterleaf and pawpaw)

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