Nutrient Intake Analysis of African Giant Land Snail (*Archachatina marginata*) Fed Formulated Concentrate Diet and Municipal Organic Waste

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Abstract: ***This study was conducted to assess the nutrient intake of African giant land snail (Archachatina marginata) fed formulated concentrate diet (FCD) and municipal organic waste (MOW). Two hundred and twenty (220) hatchlings were used. The snails were divided into five (5) treatments groups and replicated four (4) times. Each replicate contains eleven (11) snails giving a total of 44 snails per treatment group. Five (5) experimental diets were formulated: T_1, T_2, T_3, T_4 and T_5 which contain T_1; 100% formulated concentrate diet (CD), T_2; 75% FCD: 25% MOW, T_3; 50% FCD: 50% MOW, T4; 25% FCD: 75% MOW and T_5: 100% municipal organic waste (MOW), respectively. Each treatment group was given one of the five diets. Daily weight gain, feed conversion ratio and feed intake were determined, while protein, fat and fiber values were measured. Daily weight gain and feed conversion ratio were higher in T_3 followed by T_1, T_2, T_4 and different ($P<0.05$) over T_5. In feed intake, T_5 was significantly ($P<0.05$) higher than other treatment groups. Digestible protein, digestible protein for growth, digestible fat for growth and digestible fiber for growth were higher in T_3 than values observed in other treatment groups. Based on the observation in terms of weight gain, feed conversion ratio, digestible protein for growth, digestible fat for growth and digestible fiber for growth, it is therefore recommended that further studies should be carried on municipal organic waste as feed for other livestock at various inclusion level in order to exploit its potentials as feed ingredients.***

Keywords: Municipal Organic Waste, Nutrient Fat Intake, Digestible Fat, Digestible Protein and Weight Gain

1. Introduction

The problem of protein malnutrition is real among human population in most developing countries. The protein intake per individual per day in Nigeria represents about one tenth the level of intake in advanced countries (Esonu, 2001). Micro livestock's have the potential of being good sources of animal protein in human diet (Oyeagu *et al.*,2018; Merkramer, 1992). The African giant land snail (*Archachatina marginata*)) for instance, is one of the micro livestock that could serve as a ready cheap source of meat for human population where snails thrive widely (Oyeagu*et al.*, 2018). Snails have been known as a valuable source of animal protein in many countries of the world (Akinnusi, 1998).

Snail meat is palatable, nutritious and rich in essential amino acids such as lysine, leucine, isoleucine and phenylalamine as well as high iron contents (Imevbore, 1990). In recent years, however, snail population has declined considerably, primarily by the impact of such human activities such as deforestation, pesticide use, collection of immature snail etc (Monney, 1994). As snails are going into extinction, there is a need to conserve them in order to maintain our life support system. It is therefore, important to encourage snail farming (Heliculture) in order to conserve this important.

Feed formulated to meet the snail's specific nutritional requirement has great effect in enhancing the growth performance of snails. Their maturity and attainment of market weight can equally be achieved within a short time (Ugwuowo, 2009). Snails are known to utilize available feeds for growth (Eze*et al.*, 2011) which each of the feeding materials can influence the growth rate of snails.

Ejidike (2004) reported 15%-25% crude protein in his earlier study on growth performance and nutrient utilization of Africa Giant Land Snail (*Archachatina marginata*) hatchlings fed different protein diets. Babalola and Akinsoyinu (2017) reported a crude protein requirement of 19.53% for *Archachatina marginata* and 17.50% for *Achatina achatina*. Fagbuaro *et al.* (2006) reported a crude protein requirement of 20.56% for *Archachatina marginata*. Omole (2003) reported a crude protein requirement of *Archachatina marginata* to be between 24-26%. Mayaki and Daramola (2013) reported 18% crude protein level as adequate for snails (*Archachatina marginata*). Mayaki and Daramola (2013) reported 2400kcal ME/kg for *Archachatina marginata* snail. Omole (2003) reported energy requirement of snail to be 2200-2400kcalME/kg.Hence, this study seek to assess the nutrient intake analysis of African giant land snails (*Archachatina marginata*) fed formulated concentrate diet and municipal organic waste.

2. Materials and Methods

2.1 Study Area

The study was conducted in the snail unit of the Teaching, Research and Demonstration farm of Akanu Ibiam Federal Polytechnic, Unwana-Afikpo, Ebonyi State. Unwana is in the tropical rainforest zone of Nigeria and has air temperature range of 21^0C-32^0C with a total annual rainfall exceeding 3,500mm (Njoku *et al.,* 2006).

2.2 Materials Used

The ingredients used for the formulation of the concentrate diet were gotten from a feed mill within Enugu main town, Enugu State while the municipal organic waste was obtained from traders at Eke market in Afikpo town, Ebonyi State. The ingredients and composition of experimental diets are presented in Table 1 and 2.

Table 1: Nutrient Composition of Formulated Concentrate Diet (FCD)

Ingredients	Percentage (%)
Maize	30.00
Soybean Meal	28.00
Wheat Offal	15.00
PKC	8.50
Bone Meal	10.00
Limestone	8.00
Salt	0.10
Mineral Premix	0.20
Methionine	0.10
Lysine	0.10
Total	100.00

Table 2: Composition and Calculated Analysis of FCD and MOW fed to African Giant Land Snail (*Archachatina marginata*)

Feed Stuff (kg)	T_1 100% FCD	T_2 75% FCD: 25% MOW	T_3 50% FCD: 50% MOW	T_4 25% FCD: 75% MOW	T_5 100% MOW
MOW	___	25	50	75	100
FCD	100	75	50	25	___
Total	100	100	100	100	100
Chemical Composition (%)					
Moisture Content	7.45	10.25	17.07	24.86	57.14
Crude Protein	14.32	15.41	16.70	18.04	19.84
Crude Fibre	8.33	6.16	4.75	2.12	1.49
Fat	5.86	6.06	6.83	7.13	7.55
Ash content	5.42	5.97	6.45	6.84	6.96
Nitrogen Free Extract	58.63	56.16	48.21	41.02	7.04
Minerals (mg/100)					
Calcium	6.22	5.86	5.02	3.92	2.13
Sodium	23.67	28.43	32.13	35.31	40.37
Magnesium	52.41	88.33	93.51	99.18	139.41
Phoshorus	88.24	101.44	139.66	204.17	318.13
Potassium	103.16	118.44	131.54	203.41	260.24
Iron	3.86	4.01	4.21	5.03	5.42
Zinc	3.07	3.02	2.87	2.64	2.17
Phytochemical (mg/100g))					
Alkaloid	3.46	4.02	5.81	5.13	4.82
Saponin	0.47	0.91	1.18	1.93	3.21
Tannin	1.12	1.47	1.94	2.84	5.21
Flavonin	2.62	2.53	2.32	2.02	1.46
Cyaogenic glycosides	3.64	3.04	2.72	2.15	1.02
Calculated Composition(%)					
Crude Protein	18.91	19.14	19.38	19.61	19.84
Ether Extract	3.55	4.52	5.51	6.17	7.45
Crude Fibre	5.07	4.17	3.29	2.39	1.49

Where FCD is formulated concentrate diet and MOW is municipal organic waste

Feed Preparation

The obtained municipal organic waste was sorted out to remove unwanted materials such as nylon, chopped/cutted and blended into paste for feeding the snails.

Formulate Concentrate Diets

This was formulated according to standard method as presented in table 1.

Experimental Animals

The experimental animals were two hundred and twenty (220) hatchlings from African Giant Land Snails. These hatchlings were housed in a plastic perforated container filled with moisted soil.

Experimental Diets

Five treatments comprising of experimental diets with the following formulations: T_1 = 100% FCD, T_2 = 75% FCD: 25% MOW, T_3 = 50% FCD: 50% MOW, T_4 = 25% FCD: 75% MOW, T_5 = 100% MOW.

Experimental Design

Completely Randomized Design (CRD) was used for the study. The hatchlings were randomly divided into five (5) treatments units in four (4) replications. The treatments which comprised of the five formulated diets were fed each to the respective experimental units.

Data Collection: Data on performance indices including weight gain, average feed intake and feed conversion ratio were taken daily for 91 days, while data on carcass yield parameter including average edible carcass, weight of shell and viscera were taken at 120-150 days.

Data on Performance: All data were gathered as weekly live weight and daily feed intake, from where the average daily weight gain, average daily feed intake and feed conversion ratio were calculated. Snails were weighed in groups. Left-over feed were weighed before new feed were given to the snails.

$$\text{Average daily weight gain} = \frac{\text{Final weight} - \text{Initial weight}}{\text{No of days}}$$

$$\text{Average daily feed intake} = \frac{\text{Total feed consumed}}{\text{No of days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Average feed intake}}{\text{Mean weight gain}}$$

Data on nutrient values

Data and nutrient value was based on Anigbogu (2011b), Anigbogu *et al*. (2009a), Anigbogu and Onyejekwe (2010) as shown below.

$$\text{Diet Nutrient intake} = \frac{\text{\% CP in feed x g of feed taken}}{100}$$

$$\text{Digestible Nutrient for growth (g/day)} = \frac{\text{Body nutrient concentration x g of gain/day}}{0.45}$$

$$\text{Digestible Nutrient} = \frac{\text{\%CP of the feed}}{\text{Av. Biological value of 0.775}}$$

$$\text{Gross Nutrient Value} = \frac{\text{Increased gain/g of test nutrient x 100}}{\text{Decreased gain/g of control nutrient}}$$

Total Digestible Nutrient required for gain = Kg gain x1.6

$$\text{Nutrient Replacement Value} = \frac{\text{B-A}}{\text{Nutrient intake}}$$

Where B= Nutrient Value under test in g/ basal kcal
A= Nutrient value for control in g/basal kcal

$$\text{Nutrient Efficiency Ratio} = \frac{\text{Gain in weight (g)}}{\text{Nutrient intake (g)}}$$

Statistical Analysis

Data obtained from the study were subjected to analysis of variance (ANOVA) according to Steel and Torries (2000), while mean separated FLSD (0.05) with SPSS Version 16

3. Results and Discussion

Results for the assessment of nutrient intake of African giant land snails (*Archachatina marginata*) fed formulated concentrate diet and municipal organic waste are recorded in tables 3, 4, 5 and 6, respectively. The results shown that average daily weight gain and feed conversion ratio was higher in T_3 followed by T_1, T_2, T_4 and different ($P<0.05$) over T_5. The high daily weight gain observed in snails fed diet (T_3) could be due to the nutrient composition of the diet. This finding is in line with observation made by Anigbogu *et al.* (2011b), who revealed that nutrient quality is more beneficial and important than the level of nutrient in the diet. The result for average daily feed intake reveals that T_5 was higher significantly ($P<0.05$) than other treatment groups. This could be traced to high acceptability of the diet (T_5). This agrees with the observations made by Reece (2014), who indicated that feed intake does not depend on nutrient composition of feed alone but other factors such as palatability, texture, taste mechanism etc.

Table 4 reveals protein intake of snails fed FCD and MOW. The diet protein intake was significantly different ($P<0.05$) among treatment groups. T_5 has the highest value followed by T_4, T_3, T_2 and T_1, respectively. This could be traced to higher feed intake as a result of palatability, texture and taste mechanism of the diet (Reece, 2014). The digestible protein for growth improved with the highest value recorded in T_3 when compared to T_1, T_2, T_4 and T_5, respectively. This could be attributed to nutrient composition of the diet as earlier reported by Anigbogu *et al.* (2011b). The digestible protein was higher in T_5 when compared to T_4, T_3, T_2 and T_1, respectively. This high value recorded in T_5 could be attributed to high crude protein content in the snail diet which increases the digestible protein. This is in line with the earlier report of Beski (2015), who reported that high protein products are highly digestible. The total digestible protein for gain, gross protein value and protein replacement value was better utilized in T_3, T_1, T_2, T_4 and differently ($P<0.05$) from T_5. The high total digestible protein for gain, gross protein value and protein efficiency in T_3 could be attributed to high digestibility of nutrient composition of the diet Anigbogu *et al.* (2011b). The protein replacement value observed in this study was significantly different ($P<0.05$) among treatment groups. T_5 recorded higher value, followed by T_4, T_3, T_2 and T_1, respectively. This could be traced to high protein intake as earlier reported by Reece (2014).

The dietary fat intake was high in T_5 when compared to T_4, T_3, T_2 and T_1, respectively. This could be attributed to high fat content of municipal organic waste. This was in line with the observation of Kalu (2014) who reported high fat content for municipal organic waste fed to goats.

The digestible fat for growth was high in T_3 (1.152g), followed by T_1 (1.125g), T_4 (1.058g), T_2 (1.057g) and differed significantly ($P<0.05$) from T_5 (0.895g). This could be due to nutrient composition of the diet as earlier noted in this study. It was also in line with earlier report of Anigbogu *et al.* (2011b). The digestible fat and fat replacement value was significantly ($P<0.05$) higher in T_5 compared to other treatment groups. This could be that fat of municipal organic waste is more of unsaturated fat which led to high digestibility and fat replacement value (Tancharoenrat *et al.*, 2014).Fat efficiency ratio was high in T_1 compared to other treatment groups. This was also due to nutrient composition as earlier noted in this study.

The highest dietary fibre intake ($P<0.05$) was recorded inT_1 (0.479g) when compared to T_2 (0.354g), T_3 (0.271g), T_4 (0.142g) and T_5 (0.116g. This could be high crude fibre content of T_1 diet. The digestible fibre for growth was high in T_3, followed by T_1, T_4, T_2 and differed ($P<0.05$) from T_5. The high digestible fibre for grow recorded in T_3 could be attributed to higher weight gain noted in this study. T_1 recorded highest digestible fibre when compared to other treatment growth. Variations in the utilization of dietary bfibre could be attributed to their origin and composition of various feed ingredients. This was in line with the observations made by Chabeauti *et al.* (1991), who worked on digestion of plant cell walls from different sources in growing pigs. The fibre replacement value and fibre efficiency ratio were higher (P<0.05) in T_5, than what was obtained in other treatment groups. This could traced to high crude protein and mineral content of the diets

4. Conclusion

The snail fed 50% FCD: 50%MOW had better weight gain, feed conversion ratio, digestible protein for growth, digestible protein, and digestible fat for growth and digestible fibre for growth. The diet was better utilized by snails under this treatment group.

References

[1] Akinnusi, O (1998).A practical approach to back yard snail farming in Nigeria *Journal Animal Production* 25:193:197.

[2] Anigbogu, N.M., Onyejekwe, I.E., Agbara, D.O., Nnochiri, I.U. and Chinedu-Ekeh, I. (2009a). Study on Fibre Values (NDF) of *Zymomonas mobilis* Degraded Rice Hull fed to Goats. *Tropical Journal of Agricultural Research.andBiotechnogy*. 1:30-39.

[3] Anigbogu, N.M. and Onyejekwe, I.E. (2010). Direct-fed microbe (*Zymomonas mobilis* Degraded rice Hull) as feed for maradi goats. *Proceedings of the 15th Annual Conference ofAnimal Science Association of Nigeria*, Sept. 13th-15th. University of Uyo, Nigeria. 15:88- 90.

[4] Anigbogu, N.M., Onyejekwe, I.E. and Ndukwe, C.O. (2011b). Metabolism of protein and Energy by maradi goat fed *Zymomonas mobilis* degraded rice hull diets. *Proceedings of the 16th Annual Conference of the Animal Science of Nigeria*, Kogi State University, Faculty of Agriculture Theatre, Anyiba, Kogi State. Pp. 99-103.

[5] Babalola, O.O. and Akinsoyinu, A.O. (2017). Proximate composition and mineral profile of snail meat from different breeds of land snail in Nigeria. *Pakistan Journal of Nutrition*.8(12).

[6] Beski, S.S.M. (2015). Specialized Protein Products in broiler chicken nutrition: A review. Animal Nutrition. Vol1 (2): Pp 47-53

[7] Chabeauti, E., Noblet, J. and Carre, B. (1991). Digestion of plant cell walls from different sources in growing pigs. *Animal Feed Science and Technology*. 32:207-213.

[8] Edijike, B. N (2004). Growth performance and nutrient utilization of African giant land snail (*Archachatina marginata*) hatchling fed different protein diets. *Food, Agriculture and Environmental Journal* vol. 2(1): 160-162, 2004.

[9] Esonu, B.O. (2001). Comparative evaluation of raw and urea/toasted velvent bean (*Mucuna pruriens*) for broiler. *Nigerian Journal of Animal Production*.28(1):40-44.

[10] Imevbore, E.A. (1990). Management techniques in rearing African giant land snail.

[11] Eze, J.N., Eruvbetine, D., Akpodiete, O.J. and Okonkwo, J.C. (2011). Feeding pattern, carcass and shell quality of snail (*Archachatina marginata*) fed different materials. *Journal of InnovativeEnergy Policies.* 1(1):111-120. (*Archachatina marginata*) P.H.D Thesis, University of Ibadan, Nigeria.

[12] Kalu, C.N. (2014).Utilization of main/Reciprocal degraded Municipal organic waste with torula yeast/Zymo as feed for goat, Unpublished Project, Department of Animal Nutrition and Forage Science. Micheal Okpara University of Agriculture, Umudike.

[13] Mayaki, O.M. Daramola, A.O (2013). Effect of sources of fibre on performance of growing snail. *Nigeria Food Journal* vol. 31(1) pp 28-32.

[14] Markramar, (1992).Golden snail as food and feed.*Proceedings of seminar on invertebrate.* ECC.Philippines P. 244.

[15] Monney, K.A. (1994). Notable notes on giant African snail. Snail farm Res. 5:1-13.

[16] Njoku, L.J., Evere, H.G. and Manu, P. (2006). Climate change and soil condition in the tropical rain forest of the south eastern Nigeria. *International Journal of Agricultural Research* 2(1):62-68.

[17] Omole, A.J. (2003). Nutient requirement of different classes of snail (*Archachatina marginata*) at different stages of growth. Ph.D Thesis, Department of Animal Science, University of Ibadan (Unpublished)

[18] Oyeagu, C.E., Udeh, F.U., Uzochukwu, I.E., Osita, C.O., Ugwu, S.O. and Obinna, H. (2018).Effect of dietary *Centrosema pubescens* leaf meal on

[19] Tancharoentat, P., Ravindran, V., Zaefarian, F and Ravindran, G. (2014). Digestion of fat and fatty acids along the gastro instestinal tracts of broiler chickens. *Journal of Poultry Science*.93:371-379.

[20] Reece, W.O. (2014).Duke Physiology of Domestic Animals. 12thEdn Comstock publishing Associates a division of Cornell University Press. Ithaca, London.

[21] Ugwuowo, L.C. (2009). Effects of different problem sources on the growth performance and carcass characteristics of African Giant land snail (*Archachatina marginata*). Msc. Thesis of the dept. of Animal Science, University of Nigeria, Nsukka.

Table 3: Performance Analysis

	T_1 FCD 100%	T_2 FCD 75%: MOW 25%	T_3 FCD 50%: MOW 50%	T_4 FCD 25%: MOW 75%	T_5 MOW 100%
Initial Weight of Snail (g)	5.973±0.0144	5.963±0.0218	5.955±0.0210	5.988±0.0296	5.955±0.0185
Final Weight of Snail (g)	24.713±0.8431^{ab}	23.673±1.5158^{ab}	25.285±1.5039^{a}	23.66±1.6032^{ab}	20.93±0.8464^{b}
Average Daily Weight Gain (g)	0.208±0.0103^{ab}	0.195±0.0156^{ab}	0.213±0.0170^{a}	0.195±0.0156^{ab}	0.165±0.0096^{b}
Average Daily Feed Intake	5.760±0.1822^{c}	5.748±0.1377^{c}	5.710±0.0634^{c}	6.708±0.1812^{b}	7.803±0.0851^{a}
Feed Conversion Ratio	0.310±0.0147^{a}	0.328±0.0266^{ab}	0.300±0.0196^{a}	0.383±0.0263^{b}	0.525±0.0239^{c}

Table 4: Protein Intake

	T_1 FCD 100%	T_2 FCD 75%: MOW 25%	T_3 FCD 50%: MOW 50%	T_4 FCD 25%: MOW 75%	T_5 MOW 100%
Diet Protein Intake (g/d)	0.823±0.0070[e]	0.888±0.0194[d]	0.954±0.0104[c]	1.210±15.0741[b]	1.548±0.0168[a]
Digestible Protein for Growth (g/d)	9.006±0.4474[ab]	8.463±0.6747[ab]	9.223±0.7385[a]	8.462±0.6747[ab]	7.161±0.4155[b]
Digestible Protein (%)	18.477±0.0000[e]	19.884±0.0000[d]	21.548±0.0000[c]	23.277±0.0000[b]	25.600±0.0000[a]
Total Digestible Protein required for Grain (g/day)	0.000332± 0.000016[ab]	0.000312±0. 000025[ab]	0.000340± 0.000027[a]	0.000312± 0.000025[ab]	16.778± 0.000015[b]
Gross Protein Value (%)	100±0.0000[ab]	94.090±5.9398[ab]	102.304±5.5530[a]	94.107±6.9838[ab]	81.460±7.9612[b]
Protein Replacement Ratio (%)	0.000±0.0000	1.229±1.1440[d]	2.496±2.4110[c]	3.081±2.8225[b]	3.587±3.4654[a]
Protein Efficiency Ratio (%)	0.252±0.2069[a]	0.220±0.1570[a]	0.222±0.1734[a]	0.165±0.1282[b]	0.107±0.0876[c]

Table 5: Nutrient Fiber Intake

	T_1 FCD 100%	T_2 FCD 75%: MOW 25%	T_3 FCD 50%: MOW 50%	T_4 FCD 25%: MOW 75%	T_5 MOW 100%
Diet Fiber Intake (g/d)	0.479±0.0039[a]	0.354±0.0085[b]	0.271±0.0030[c]	0.142±0.0040[d]	0.116±0.0013[e]
Digestible Fiber for Growth (g/d)	0.830±0.0412[ab]	0.780±0.0622[ab]	0.850±0.0681[a]	0.780±0.0622[ab]	0.660±0.0383[b]
Digestible Fiber (g/day)	10.742±0.0000[a]	7.942±0.0000[b]	6.123±0.0000[c]	2.735±0.0000[d]	1.916±0.0000[e]
Fiber Replacement Value (%)	0.000±0.0000[e]	6.141±0.1479[d]	13.215±0.1430[c]	43.800±1.2083[b]	59.116±0.6828[a]
Fiber Efficiency Ratio	0.434±0.0241[c]	0.510±0.0141[c]	0.783±0.540[b]	1.369±0.0861[a]	1.426±0.0820[a]

Table 6: Nutrient Fat Intake

	T_1 FCD 100%	T_2 FCD 75%: MOW 25%	T_3 FCD 50%: MOW 50%	T_4 FCD 25%: MOW 75%	T_5 MOW 100%
Diet Fat Intake	0.337±0.0026[d]	0.349±0.0083[d]	0.390±0.0043[c]	0.478±0.0129[b]	0.589±0.0063[a]
Digestible Fat for Growth (g/d)	1.125±0.0559[ab]	1.057±0.0844[ab]	1.152±0.0924[a]	1.058±0.0844[ab]	0.895±0.0519[b]
Digestible Fat (g/day)	7.561±0.0000[e]	7.819±0.0000[d]	8.81±0.0000[c]	9.200±0.0000[b]	9.742±0.0000[a]
Fat Replacement Value	0.000±0.0000[e]	0.575±0.0138[d]	2.488±0.0270[c]	2.663±0.0699[b]	2.870±0.0314[a]
Fiber Efficiency Ratio	0.617±0.0346[a]	0.561±0.0495[a]	0.543±0.0373[a]	0.407±0.0257[b]	0.280±0.0162[c]