American Journal of Agriculture and Forestry
2015; 3(4): 151-155
Published online July 15, 2015 (http://www.sciencepublishinggroup.com/j/ajaf)
doi: 10.11648/j.ajaf.20150304.15
ISSN: 2330-8583 (Print); ISSN: 2330-8591 (Online)

Evaluation of Some Performance Traits and Carcass Characteristics of *Archachatina marginata* Snails Fed Plant Wastes

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To cite this article:
Olubukola Omolara Babalola. Evaluation of Some Performance Traits and Carcass Characteristics of *Archachatina marginata* Snails Fed Plant Wastes. *American Journal of Agriculture and Forestry*. Vol. 3, No. 4, 2015, pp. 151-155. doi: 10.11648/j.ajaf.20150304.15

Abstract: There is inadequate information on quality feedstuffs for large scale production and all year round availability of snails in Nigeria. This study evaluated the performance, carcass analysis and sensory evaluation of cooked meat of growing *Archachatina marginata* snails fed plant wastes as a sole feed ingredient. 120 growing snails of mean weight of 132.91±2.13g were randomly allotted to 4 dietary treatments of pawpaw leaves (PL), whole lettuce (WL), lettuce wastes (LW) and cabbage wastes (CW). Each treatment was replicated thrice with 10 snails per replicate in a completely randomized design. The feeding trial lasted 6 months. Treatment effect on shell length and width was significant ($P<0.05$) with snails on LW recording highest while no significant differences were observed in the shell thickness gain ($P>0.05$). The highest dressing percentage of 43.2% was obtained for snails on LW while the lowest value of 35.19% was recorded for snails on PL. The treatments had no appreciable effect on the nutrient composition and sensory quality of the snail meat. The highest dry matter digestibility of 83.50% was recorded in snails on CW which was statistically similar to those on LW (83.33%) while the least value of 78.33% was recorded in snails on PL. The weight gain and feed per gain followed the same pattern as the dry matter digestibility. It can be concluded that growing snails can utilize lettuce waste as well as cabbage waste as sole feed thereby increasing the feed data base for snail production in the Tropics.

Keywords: Pawpaw leaves, Lettuce, Cabbage, *Archachatina marginata* Snails, Feed per Gain

1. Introduction

Large scale snail farming is needed in order to meet the animal protein need in human diet. There is a dearth in the supply of conventional feed concentrates which has greatly affected animal production in the tropics. This low level of livestock production in the tropics cannot meet the needs of the rapidly growing human populations. There is therefore the need to source for cheaper alternative sources of animal protein.

Snails are invertebrates with a soft body and a covering of hard shell. It is one of the micro livestock that has recently attracted attention among agriculturists in Nigeria as an aftermath of alarm raised by Food and Agricultural Organization (FAO) on animal protein deficiency among Nigerians [1, 4]. It has small body size and is easy to handle and manage. It is found in a cool environment, in gardens, vegetable plantation, refuse heap, orchards, etc. They require humid environment and thrive well on decay materials [3, 7, 12].

Snail meat is tender and tastes good. It is highly nutritious and when eaten serve as a special delicacy in the diet. Several studies have been conducted on snails in the last three decades. Ajayi et al. (1978) indicated that snail meat is particularly rich in protein, iron, calcium and phosphorous [2]. Snail meat has a protein content of about 18-20% [7, 8, 9] which compare quite well with protein contents of conventional meat such as beef (18%), mutton (18%) and poultry (20%) [13] Imevbore and Ademosun (1988) reported a fat content of 1.36% which is lower than the corresponding values of 9.6%, 21.4% and 23% obtained for egg, mutton, and duck respectively [14, 16[]. The study also showed that snail meat is low in saturated fatty acids (28.71%) and cholesterol (20.28mg/100g fresh sample) when compared with beef, goat meat, mutton, pork, broiler meat and fish. The low contents of fat and cholesterol make snail meat a good antidote for vascular diseases such as heart attack, cardiac arrest, hypertension and stroke [5]. Soup prepared with snail meat is a good source of iron for pregnant and nursing mothers [19].

Unfortunately, in spite of the obvious nutritional value of snail in human diet, no significant effort has been made at its large scale production as with other livestock like cattle, goat, sheep, and poultry. The main source of supply to the consumers is through marketers who gather them from the wild making the supply relatively higher during the rainy season than the dry season. FAO (1986) encouraged raising one's own snails, a practice referred to as 'snail farming' with the advantage of continuous supply of fresh snail meat whenever this is desired and sale of excess to other consumers [12].

For effective performance, nutrition in snail production cannot be underestimated. African giant land snails (A. marginata) are naturally herbivores. They feed mostly during the night because they are nocturnal animals. However experience has shown that they can eat at any time of the day if served with their delicacy in a cool, humid environment. Their conventional feed comprises of fresh leaves/shoots (pawpaw, lettuce, cabbage, cassava, cocoyam, African spinach, waterleaf); Ripe fresh fruits (pawpaw, banana, plantain, mango) and household/agro wastes (poultry litter, rice bran, palm kernel meal) etc. [8, 11]. These are mostly of plant origin and there is possibility of scarcity during the dry season. Sourcing for these feeds in the urban areas may be very difficult. There is therefore the need to source for acceptable feed that is available all year round.

Feed accounts for at least 70% of total cost of livestock production. The high cost of producing animal products due to the exorbitant prices of feed ingredient has forced animal nutritionists to explore the use of agricultural byproducts hitherto referred to as wastes as feed resources in order to reduce cost of production [18].

There is paucity of information on quality feedstuffs for large scale production of snail. Hamzat (2004) evaluated the use of kola testa, a byproduct of kola fruit, for feeding snails in Nigeria [15]. Lettuce waste, an inedible foliage after harvesting was found to be cherished by snails. It is succulent and available all year round. Lettuce has been reported to contain water (94g); energy (18kcal); protein (1.3g); fat (0.3g); carbohydrate (3.5g); fibre (1.9g) and ash (0.9g) per 100g of edible portion. It also contains (mg) Ca (68); Fe (1.4); Mg (11); P (25); Cu (0.044) per 100g of edible portion [21]. There is a dearth of information on the use of lettuce waste by snails, hence this study was embarked upon to evaluate the performance of African giant land snail fed lettuce waste in comparison with cabbage waste and pawpaw leaves.

2. Materials and Method

One hundred and twenty (120) growing A. marginata snails of mean weight of 132.91±2.13g were used for the experiment. The snails were randomly allotted into 4 dietary treatments of pawpaw leaves, whole lettuce, lettuce wastes and cabbage wastes. Each treatment was replicated thrice with 10 snails per replicate in a completely randomized design. The snails were reared in wooden cages of 0.5x0.5x0.5m3 compartments. Feed and water were supplied ad libitum. Egg shell powder was added to the soil weekly to supply calcium. Feed intake and weight gain were measured on a daily and weekly basis respectively. Shell length and width were measured with vernier caliper while micrometer screw gauge was used to measure the shell thickness. Other parameters determined were mortality and feed conversion ratio. The feeding trial lasted six (6) months.

2.1. Digestibility Trial

Three (3) snails per replicate were put inside cages demarcated into different compartments devoid of soil but lined with foam. The snails were fed with the same diet fed during the feeding trial. Daily feed intake and excreta voided were recorded for each treatment. The daily excreta for each treatment was dried in the oven at 600C and dry matter determined. The trial lasted 10 days, including 3 days for acclimatization and 7 days for excreta collection.

2.2. Carcass Analysis

Nine growing snails per treatment (3 per replicate) were used at the end of the feeding trial for carcass analysis. The snails were starved overnight and their weights taken. They were killed by striking iron rod on their shell after which the visceral, shell, haemolymph and foot were separated. Parameters determined were: dressing percentage, visceral to live weight percent, shell to live weight percent and haemolymph per live weight percent.

2.3. Chemical Analysis

Proximate composition of the experimental diets as well as that of the foot of the snails was carried out [6]. Parameters analysed were dry matter, crude protein, crude fibre, ash and ether extract.

2.4. Organoleptic Evaluation of the Cooked Meat

The snail meat from each treatment was washed with alum and cooked separately in pots containing 3g of salt dissolved in 300mls of water at 1000c for 20minutes. A twelve –member taste panellist was set up. They were trained prior to serving of the meat. The snail meat from each treatment was served in individual plates and given to the panellist. They were also served with drinking water to rinse their mouth after tasting each treatment of the meat. There was partitioning in between the panellists in such a way that there was no interaction with one another. Questionnaires were given to the panellist for rating of the samples according to the method of Larmond (1977) [17]. The ratings were based on a 9 point hedonic scale of 1(dislike extremely) and 9(like extremely). The evaluation was based on colour, taste, flavour, tenderness, and overall acceptability.

2.5. Data Analysis

All data were subjected to analysis of variance while the treatment means were separated "using Duncan multiple range test (SAS 2003) [20]. All snails in the cage by replicate represent the experimental unit.

3. Results

3.1. Proximate Composition of Test Ingredients.

The proximate composition of experimental diets is as shown on Table 1. The crude protein of PL was significantly higher than that of the other test diets. Crude fibre and ash follow the pattern WL >PL >LW >CW with CW recording the highest Nitrogen Free Extract (NFE) while PL had the lowest.

Table 1. *Proximate composition of the snail diet (% dry matter).*

Nutrients	Pawpaw Leaf (PL)	Whole Lettuce (WL)	Lettuce Waste (LW)	Cabbage Waste (CW)
Dry matter	25.43	5.96	7.04	10.10
Crude protein	33.25	11.20	7.35	9.80
Crude fibre	7.26	8.96	6.32	5.48
Ether extract	0.78	0.56	0.27	0.23
Ash	10.86	11.65	9.67	6.94
Nitrogen free extract	47.85	67.63	76.39	77.55
Gross energy (kcal/kg)	3.25	3.16	3.23	3.33

3.2. Feeding and Growth Performance

The results obtained for the feeding and growth performance for growing A. marginata snails is as presented in Table 2. The mean dry matter feed intake showed that there were significant differences among the treatment means (P<0.05). The mean weekly feed intake of 6.45, 8.79, 8.18 and 7.81g were recorded for snails placed on PL, WL, LW and CW respectively. The highest mean weekly feed intake was recorded in WL (8.79g) while the lowest was recorded in PL (6.45g).

The weights gained by the experimental snails were affected by the dietary treatments (P<0.05). Snails on CW recorded the highest mean weekly weight gain of 3.55g which was statistically similar to that of LW (3.50g) while those on PL recorded the least weekly weight gain of 2.35g.

Treatment effect on monthly shell length gain was significant. It was observed that the highest mean monthly shell length gain of 3.85mm occurred in snails on LW while the least value of 3.21mm was recorded in snails on PL. The mean monthly shell length gain of snails on WL and CW were similar (P>0.05). There were also significant differences in the mean monthly shell width gain (P<0.05) with snails on WL recording the highest value of 3.26mm which was statistically similar to that of LW (3.13mm). Snails on PL recorded the lowest monthly shell width gain of 2.56mm. No significant differences were observed in the mean monthly shell thickness gain (P>0.05). The values ranged between 0.21 and 0.24mm.

The result of the dry matter digestibility showed significant differences amongst the treatments. The highest digestibility of 83.50% was recorded in snails on CW which was statistically similar to those on LW (83.33%). The least digestibility of 78.33% was recorded in snails on PL.

The best feed per gain of 2.20 was obtained in snails on CW which was similar to that of snails on LW (2.34) while snails on PL recorded a value of 2.74. No mortality was recorded in all the treatments.

Table 2. *Performance characteristics of growing snails fed the experimental diets.*

Parameters (mean values)	Pawpaw Leaf (PL)	Whole Lettuce (WL)	Lettuce Waste (LW)	Cabbage Waste (CW)	SEM
Weekly dry matter feed intake (g)	6.45d	8.79a	8.18b	7.81c	0.32
Initial weight (g)	135.08	132.15	131.91	132.50	0.38
Final weight (g)	191.48b	213.99a	215.97a	217.60a	1.95
Weekly weight gain (g)	2.35c	3.41b	3.50a	3.55a	0.57
Total weight gain (g)	56.40c	81.84b	84.06a	85.10a	2.05
Monthly shell length gain (mm)	3.21b	3.60a	3.85a	3.65a	0.20
Monthly shell width gain (mm)	2.56d	3.26a	3.13b	2.86c	0.09
Monthly shell thickness gain (mm)	0.21a	0.23a	0.21a	0.24a	0.01
Mortality (%)	0.00	0.00	0.00	0.00	
Dry matter digestibility (%)	78.33c	81.18b	83.33a	83.50a	0.71
Feed per gain	2.74a	2.58b	2.34c	2.20d	0.10

a, b, c, d: means along the same row with different superscripts are significantly different (p<0.05)
SEM – Standard Error of Means
n = 3 per diet

3.3. Carcass Analysis

Table 3 presents results of foot yield, visceral, shell and haemolymph components of growing snails. The highest foot weight was recorded for snails on PL. There were significant differences (P<0.05) in the dressing percentages of the snails.

The highest dressing percentage of 43.20% was obtained for snails on LW while the lowest value of 35.19% was recorded for snails on PL. The mean weight of the shell followed the same trend as the dressing percentage. The shell to live weight for snails PL and LW were similar and were significantly higher than the values obtained for snails on WL and CW.

Table 3. *Carcass evaluation of growing snails (A. marginata) fed the experimental diets.*

Parameters (mean values)	Pawpaw Leaf (PL)	Whole Lettuce (WL)	Lettuce Waste (LW)	Cabbage Waste (CW)	SEM
Number of snails	9	9	9	9	
Live weight (g)	190.80^{b}	211.70^{a}	210.90^{a}	213.20^{a}	1.98
Foot (edible portion) (g)	67.14^{d}	85.17^{b}	91.11^{a}	82.38^{c}	2.48
Visceral (g)	42.42^{a}	38.50^{b}	39.60^{b}	41.12^{a}	2.07
Shell (g)	50.84^{b}	51.40^{b}	54.10^{a}	51.10^{b}	1.68
Haemolymph (ml)	30.40^{b}	36.63^{a}	26.09^{c}	38.60^{a}	1.26
Dressing (%)	35.19^{d}	40.23^{b}	43.20^{a}	38.64^{b}	1.09
Shell/live weight (%)	26.65^{a}	24.28^{b}	25.65^{a}	23.97^{b}	0.75
Visceral/live weight (%)	22.23^{a}	18.19^{b}	18.78^{b}	19.29^{b}	1.01
Haemolymph/live weight (%)	15.93^{b}	17.30^{a}	12.37^{c}	18.10^{a}	1.39

a,b,c,d: means along th same row with different superscripts are significantly different ($p<0.05$), SEM – Standard Error of Means

3.4. Nutrient Composition of the Meat

The percentage crude proteins in all the treatments were similar with values ranging from 17.82 to 18.53% (Table 4). The percentage ash contents ranged between 2.14 and 2.33 and the differences among the treatments were not significant. The values obtained for the fat content were also similar and ranged between 2.11 and 2.44. There was however significant differences in the nitrogen free extract with the highest value of 3.85% obtained for snails on CW while the lowest (2.80%) was recorded for snails on WL.

Table 4. *Nutrient composition (g/100g fresh meat) of snail meat from growing snails fed the experimental diets.*

Nutrient (%)	Pawpaw Leaf (PL)	Whole Lettuce (WL)	Lettuce Waste (LW)	Cabbage Waste (CW)	SEM
Dry matter	26.33	25.89	25.32	26.01	0.11
Moisture content	73.67	74.11	74.68	73.99	0.13
Crude protein	18.53	18.32	17.95	17.82	0.08
Ash	2.26	2.33	2.14	2.23	0.02
Ether extract	2.31	2.44	2.21	2.11	0.03
Nitrogen free extract	3.23^{b}	2.80^{b}	3.02^{b}	3.85^{a}	0.06

a,b: means along the same row with different superscripts are significantly different ($p<0.05$)
SEM – Standard Error of Means

3.5. Organoleptic Evaluation of Cooked Meat

The dietary treatments had no significant effect on the colour, taste, flavour, texture and overall acceptability of the snail meat (Table 5).

Table 5. *Organoleptic properties of snail meat from growing snails fed the experimental diets.*

Properties	Pawpaw Leaf (PL)	Whole Lettuce (WL)	Lettuce Waste (LW)	Cabbage Waste (CW)	SEM
Colour	7.34	7.58	7.92	7.39	0.07
Taste	8.65	8.31	8.14	8.62	0.06
Flavour	8.11	8.34	8.94	8.03	0.10
Texture	8.62	8.57	8.62	8.42	0.02
Overall acceptability	8.45	8.21	8.50	8.55	0.04

SEM – Standard Error of Means

4. Discussion

The findings of this study were similar to those obtained in an earlier experiment reported by Babalola and Akinsoyinu, 2010 for snailets fed the same set of experimental diets. The zero mortality recorded in all the treatments indicates that growing snails are more resilient than their snailets counterpart which recorded some mortality [10]. This means that any of the feed could be used in feeding growing snails without adverse effect.

Snails on LW recorded the highest shell weight and also high shell per live weight. This may be as a result of the high mineral content of LW most especially calcium which supported shell growth [21]. LW also enhanced the highest dressing percentage. The organoleptic properties of the snail meat were similar, an indication that the feed had no appreciable effect on the meat quality of the snails.

Snailets are better converter of the experimental feeds than their growing counterparts as the values obtained for the feed conversion ratio of snailets were generally lower than those obtained for the growing snails. One can therefore suggest the feeding of these plant wastes to snailets and as they grow older supplementing with compounded ration to meet their energy needs.

It can be concluded that lettuce wastes contain high nutrients which favour snail growth and development as evidenced in the total weight gain, feed per gain, shell weight and dressing percentage and incorporation of the dried lettuce waste into the feed could enhance better growth of snails and increase in the supply of animal protein in Nigeria and so prevent these animals from going into extinction.

Acknowledgement

The author is grateful to Landmark University, Omu-Aran for providing a conducive environment to embark on the write-up.

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