Growth response of African giant land snail (*Archachatina maginata*) to cashew apple waste based diets

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Abstract

Growth response of young African giant land snail (*Achachatina maginata*) fed sundried cashew apple waste (CAW) (otherwise known as cashew bagasse) was investigated with 96 snailets. Dwindling supply of and high prices of conventional animal feedstuffs in Nigeria urgently necessitate sourcing for solution through incorporation of emerging agrowastes into animal feedstuff. Four experimental diets were formulated, using grounded cashew apple waste at maize replacement levels of A(0%); B(10%); C(20%); and D(30%). The twelve weeks experiment was completely randomized in 16 serially arranged wooden boxes with four replicates per treatment. Feed and water were given *ad libitum*. At the end of the experiment, cashew apple waste was found to be biologically utilized up to 30% replacement level. Feed conversion value for diet D was significantly higher (P< 0.05) than those of other diets. Live weight gain, foot weight and dressing percentage of snail fed diet D were found to be higher (P<0.05) than all other diets. Analyzed crude protein and mineral contents of the four snail samples were not significantly different (P< 0.05). Inclusion of cashew apple waste into the snail diet did not show any negative effect on both the live and shell weight percentage as well as shell thickness. No mortality was recorded in all the diets. Results of sensory evaluation of the snail fed CAW were not significantly different (P<0.05) from the control. The outcome of the study established the substitution possibility of cashew apple waste in snail diet up to 30%.

Keywords: Cashew apple waste, African giant land snail, Live and Foot weight, dressing percentage

Introduction

Hunger and malnutrition are the most devastating problems facing the teaming populace in most developing and underdeveloped world. About 80 to 90 million people have to be fed yearly and most of them are in the developing countries (1). According to (2), stunted growth in children in Nigeria ranked second highest in the world, with a national prevalence rate of 32 percent of children under five. As a result, an estimated 2 million children in Nigeria suffer from severe acute malnutrition (SAM). This could be attributed to the daily protein intake of average Nigerian. This thus leaves a serious challenge for both man and animal nutritionists to look for lasting solutions which will ameliorate this problem.

Snail is one of the wild animals whose population and natural habitat has declined so considerably [3] as a result of man anthropogenic activities such as overexploitation, deforestation and urbanization[4] , is now being widely farmed all over the world. This is simply because of the role of snail farming in ameliorating the poverty effect on both rural and urban dwellers. As reported by [5], capital requirement for the establishment of snailry is very small vis-à-vis the little labour involves in its management. [6] observed that most farmers in Oyo State, Nigeria manage their snail farm by family members. As opined by [5], snail farming is environmentally friendly as earlier emphasized by [7]. Origin of snail farming has been traced back to AD 560, when a Roman farmer named Lippius gathered a number of snails from the wild into a confinement for management [8]. Farming of snails was extremely rare until early nineteenth centuries when increasing awareness about its breeding and management came to limelight. According to [9], snails can conveniently cope with adverse environmental conditions ranging from cold, heat, and slight fluctuation in temperature. Snails are also said to possess high immunity against diseases. From the physiological point of view, the African giant land snail is the biggest of all the known land snails. Hence this particular specie is one of the most economically viable for farming, as it grows to its full size of about 800gms in 24 months [10]. Nutritionally, snails has as high as 16% crude protein and between 45-50mg/ kg iron, which makes it preferred by hypertensive patients, particularly when its low fat (0.05-0.8%) [11] profile is considered. In many parts of West and Central African countries, snail meat provides excellent source of animal protein [12] with protein content (20.7%) higher than that of conventional food animals [13]. It has been further reported [14,15] that snails, being a rich source of essential mineral elements can be given to little children to reduce the risk of rickets (bone malformation). In terms of essential amino acids, notable quantities [16,17] are available in snail meat. Snail rearing/ farming becomes germane when a report of [18] emphasized the adverse effects of malnutrition which claims several millions of children in the developing countries (Nigerian inclusive). In any management practice, after a successful breeding, feeding, which produces good growth and body development of animals becomes an issue. In any animal management however, feed (artificial) and feeding usually takes about 60% of the production cost. Keen competition and rationalization of available ingredients between man and animals leads to dwindling supply of most of these feedstuffs. While listing the array of feedstuffs consumable by snails, [19] mentioned Agro -wastes as one of the foods for snails. According to [15] these wide array of natural food for snails and its ability to convert waste to meat (protein) make snails a cheaper source of protein. To address this problem and consequently encourage the mass production of African giant land snails, alternatives to feed ingredients of exorbitant prices need to be sourced for. Just recently, many agro-industrial byproducts found their ways into animal feeds to replace some expensive conventional feedstuffs. Some agro-based feedstuffs on analysis were found to be nutritionally replaceable and suitable in compounding animal feeds. [20] listed Nigeria among the world main cashew producers.

Nigeria is the world's 4th largest producer of raw cashew[21], with a processing capacity of 24,400 MT of raw nuts per year (30% of its annual production of raw nuts). This is unique in the West African region, where processing capacity is generally at maximum of 5-10% of domestic production. Cashew produces a pseudo apple which occurs as an outgrowth or swollen receptacle around the apex of the branches [22]. This apple is very rich in essential minerals and vitamins (Vit. C in particular). Cashew apple also contains some simple sugars. It has a high percentage of water (85%) in the form of juice [23]. Aside from this, cashew apple waste is a valuable source of pectin which is a useful precursor in the production of jams and jellies [24]. However, a substantial proportion of cashew apple so produced is either lost to wastage or is underutilized [20]. Cashew apple waste – a remnant from cashew apple juice extraction, contains about 18.7% crude protein [25], and can favourably replace some protein based ingredients of plant origin. Cashew apple, from where the waste (otherwise known as bagasse) is obtained as a byproduct is known to be of high percentage of Vitamin C (ascorbic acid). CAW availability is still limited and dwindling in supply but with promising replacement potential as animal feedstuff. This is because its nutritional content has been evaluated in the diet of some classes of livestock catfish-C. gariepinus [26].

Materials and Methods:

Experimental animal: A total of ninety-six growing snails (*Archachatina maginata*), about four months of age were skillfully selected and purchased at Oje market located within Ibadan metropolis. These snails are about the same size and average weight of 75.05gms. were randomly grouped into 4 and allotted into four dietary treatments. The four treatments were Diets A (0%), B (10%), C (20%) and D (30%) dietary maize replacement with cashew apple waste. Each diet has 3 replicates with 6 snailets per replicate. Daily feed administration was done for a period of 84 days.

Diet Preparation: CAW used in this experiment was obtained as a by-product from a cottage cashew juice processing project conducted by scientists at Cocoa Research Institute of Nigeria, Ibadan. Shaft obtained from a manual cashew juice extractor were put into a sieve sack and pressed to further remove the remaining juice. This shaft is then spread on concrete slabs and sundried. This dried shaft named Cashew apple waste is then grounded into fine particles and then mixed with other feed ingredients to compound snail diets (Table 3).

Experimental design and data collection : The snailets were housed in a sixteen serially arranged wooden boxes. The feet of the cage frame were put inside metal containers with used engine oil. Each box is 0.5 x 0.5 x 0.5m^3 square shaped. The base of all the boxes was perforated so as to allow excessive water to drain out of the cage after wetting. Sterilized and sieved top soil was laid on the bottom of all the boxes to about 6cm thickness. Mosquito net, reinforced with chicken net, was used to cover the top end of the cage compartment to prevent escape. Dry cocoa leaves were put in each of the boxes to allow hibernation and banana leaves were put on top of the cages to reduce intense heat from outside. The experimental design was a completely randomized type. Flat plastic lids were used for feeding and water troughs. Wetting is done fortnightly at 8:00am prior to feeding. Weekly feed intake on each treatment was calculated by deducting the leftover feed from the quantity weighed for each week at the end of the week. Growth parameters taken include shell length and weight- measured with vernier caliper, Shell thickness (by micrometer screw gauge). Dressing percentage was as the percentage of edible portion to the whole snail meat.

Snail processing and sensory evaluation: Two snails were taken per replicate and dressed by breaking the shell with stone and then separate the edible portion (foot) from the visceral. Alum (Aluminium sulphate) solution was used to wash the foot, after which they were batch-cooked in brine (0.5gms) for 30minutes. Cut pieces of all treatments were separately presented before ten taste panelists to score points on five hedonic points ranging from dislike extremely to like extremely.

Proximate and Statistical analyses: Proximate analysis of the snail samples were done according to AOAC (1990), while data were statistically analyzed using SAS (2001). Means of values were separated with Duncan multiple range tests of 1955.

Results and Discussion: The results obtained on proximate analysis of cashew apple waste corroborated earlier findings [25], and thus raised a hope for this test ingredient as a feedstuff (Table 1). The crude protein and fibre which are vital to this study were 14.96 and 9.71 percent respectively. These values were at pal with that reported by [27]. Although slightly fibrous, the ether extract value (32.68%) of CAW justified the rationale for replacing maize with it in snail diet. Table 2 shows progressive substitution levels of maize for dried cashew apple waste in snail diet formulation. The four isonitrogenous diets containing an average of 25.99%, 9.50%, 88.52% and 2374.25(Kcal/kg) respectively for C.P, C.F, DM and Metabolizable energy. A gradual increase was observed in the dry matter content of the diets as dietary levels of CAW increased. Conversely, there was a progressive reduction of dietary metabolizable energy values as the levels of maize replacement in the diet increased. The report of [7] buttressed these findings as snails growth performance on Cashew apple waste was similar to the control. Although maize is a conventional feedstuff in animal diet with lower crude fibre but higher proportion of essential macronutrients like methionine and lysine when compared with CAW, snail fed 30% maize substituted diet performed significantly better(P>0.05) than the control. This might probably be due to higher crude protein (14.96 %) in the waste compared to maize (10% CP). This fact was supported by [7] Bright (1996), when he reported that snail performance is enhanced by high dietary protein feeds. It could as well be alleged that other essential vitamins present in CAW (like vit. C) also encouraged the observed growth performance. Table 3 shows the statistical analysis of the growth response of *Archachatina maginata* fed cashew apple waste based diets.Feed conversion ratio which indicates how a diet is being efficiently utilized was found to be best and significantly higher (P> 0.05) on Diet D (30%) than even the control. Similar observation was earlier observed when this same feedstuff was fed to growing rabbits at 30% dietary level (Fanimo *et.al.* 2003). As expected, feed intake decreased with increasing inclusion of CAW in the diet. Although the general belief is that high fibre diets are naturally disliked by most livestock, due to its fibrous texture, non-palatability and depressive effect on animal growth. Data on both mean weight gain (5.45) and feed conversion ratio (7.48) of diet D shows that it was better utilized when these values for other diets were compared (even the control). Similar observations were reported when Cocoa pod husk (CPH); Adeyemo (2005) and Cocoa bean shell (CBS); Owosibo *et. al* (2008) another fibrous feedstuffs were fed to snails. This seemed to be very peculiar to snails, when compared to other breeds of livestock (particularly monogastrics). This had in a way identified snail as a good converter of fibrous feedstuffs. Values taken on shell parameters (length, width, and thickness inclusive), were similar and did not reflect any negative effect of substituting CAW in the snail diet.

Values for organoleptic analysis showed no significant difference (table not shown) in all the four samples. This was reflected in the values obtained for overall acceptability which ranged between 7.58 in snail fed diet D to 7.65 in snail meat fed diet C. Dietary inclusion of Cashew apple waste in snail feed reduced the total cost incurred in producing snail in this study (Table 2). Although cashew apple waste is just an emerging feedstuff, it is not yet available in commercial quantity. Hence, dwindling in supply. This is because CAW availability is restricted to cashew processing industries (being a byproduct). Further studies on both processing and dietary inclusion of CAW can make it a commodity of commerce.

Conclusion and Recommendations

The cost of feed per kilogramme weight gain of snail decreased with increasing inclusion of dietary CAW and the total cost of producing CAW based feed in this study shows the justifiable need to substitute maize with cashew apple waste in snail diet where possible. Farmers who grow cashew are hereby encouraged to establish snailry under their plantations so as to enhance additional income as well as output with a plantation. Additionally, the global drive in harnessing agrowastes into goods of commerce can be made possible through uptake of research findings such as this. It is herby recommended that the government should encourage cashew farmers all over the country by providing necessary incentives which will enhance rapid multiplication of cashew apple waste. This is because this emerging feedstuff (cashew apple waste/ baggasse) is still scanty, yet to become a produce of commerce. Thus its use by snail farmers in the country is still dwindling. Secondly, snail farmers too should be ready to make use of this findings to boost their snail farming business. Finally, more study on the processing and preservation of cashew apple waste as well as means of improving the nutritive value is herby recommended.

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Table 1: Chemical composition (%) of cashew apple waste (CAW) and Whole cashew apple (CA)

	CAW	**CA**
Dry matter (%)	24.90	13.10
Crude protein (%)	14.96	12.50
Crude fibre (%)	9.71	3.86
Ash (%)	2.40	2.21
Calcium (%)	0.20	0.03
Phosphorus (%)	0.40	0.05
Total sugars (%)	26.50	54.70
Soluble N, % total N	10.90	25.60
N-NH_3, % total N	1.82	2.07

Table 2: Ingredient composition of the experimental diets (%) kg

DIETS	**A (0%)**	**B (10%)**	**C (20%)**	**D (30%)**
Ingredients (kg)				
Maize	25.00	22.50	20.00	17.50
Cashew Apple Waste (CAW)	-	2.50	5.00	7.50
Palm kernel cake	7.50	7.50	7.50	7.50
Groundnut cake	20.00	20.00	20.00	20.00
Soya bean meal	35.00	35.00	35.00	35.00
Bone meal	8.00	8.00	8.00	8.00
Oyster shell	4.00	4.00	4.00	4.00
Salt (NaCl)	0.30	0.30	0.30	0.30
Grower Premix	0.20	0.20	0.20	0.20
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**
% Dry matter	86.20	88.42	89.16	90.32
Calculated crude				
Protein level (%)	25.40	26.01	26.05	26.50
Crude fibre	9.67	8.91	9.36	10.06
ME (Kcal/kg)	2462.0	2382.0	2339.0	2314.0

Premix composition/kg diet. Vitamin A - 10,000,000 i.u, Vit D3 - 200, 000 i.u, Vit E - 23,000 mg; Vit K3 2000 mg, Vit B1 - 3000 mg, Vit B2-6000 mg, Niacin 50,000 mg, calcium pantotherate - 10,000 mg, Vit B6 - 5000, Vit B12 - 25 mg, folic acid 1000 mg, Biotin - 50 mg, choline chloride - 400,000 mg, Mn - 120000 mg, Fe 100000 mg, Zn - 80,000 mg, Cu - 8,500 mg, I - 1500 mg, Co - 300 mg, Se - 120 mg

Table 3: Growth performance of growing snail fed Cashew apple waste based diets

	Level of cashew apple waste inclusion				
	DIETS				
	A (0%)	B (10%)	C (20%)	D (30%)	
Mean initial wt. (g)	175.06	174.01	175.20	174.61	n.d
Mean final wt. (g)	232.53^{b}	230.15^{b}	233.24^{b}	240.12^{a}	1.16
Mean live wt. gain(g)	4.78^{a}	4.73^{c}	4.84^{b}	5.46^{a}	0.21
Mean foot wt. (g)	112.29^{b}	110.47^{b}	109.62^{b}	115.26^{a}	1.12
Mean feed intake	42.68^{a}	42.95^{a}	40.62^{b}	40.78^{b}	0.46
Mean feed conversion ratio	8.93^{c}	9.28^{c}	8.44^{b}	7.48^{a}	0.32
Mean visceral wt. (g)	57.14^{b}	55.86^{b}	54.46^{b}	57.65^{a}	0.47
Mean shell wt. (g)	59.62^{a}	57.24^{c}	59.63^{a}	59.21^{a}	0.11
Dressing percentage	32.69^{cb}	31.89^{b}	34.94^{ac}	35.34^{a}	0.08
Shell/ live wt. %	25.64^{a}	24.87^{c}	25.57^{a}	24.66^{b}	1.03
Visceral/ live wt. %	15.95^{a}	14.95^{c}	15.56^{b}	16.02^{a}	0.22
Mean shell thickness (mm)	0.07	0.05	0.05	0.07	n.d
₦/kg feed	450.98	450.46	403.76	366.20	n.d
Cost(₦) / kg wt.gain	94.35	95.23	83.42	67.07	n.d

*abc: Means on the row with different superscripts are significantly different (P< 0.05)

* n.d = Not determined.

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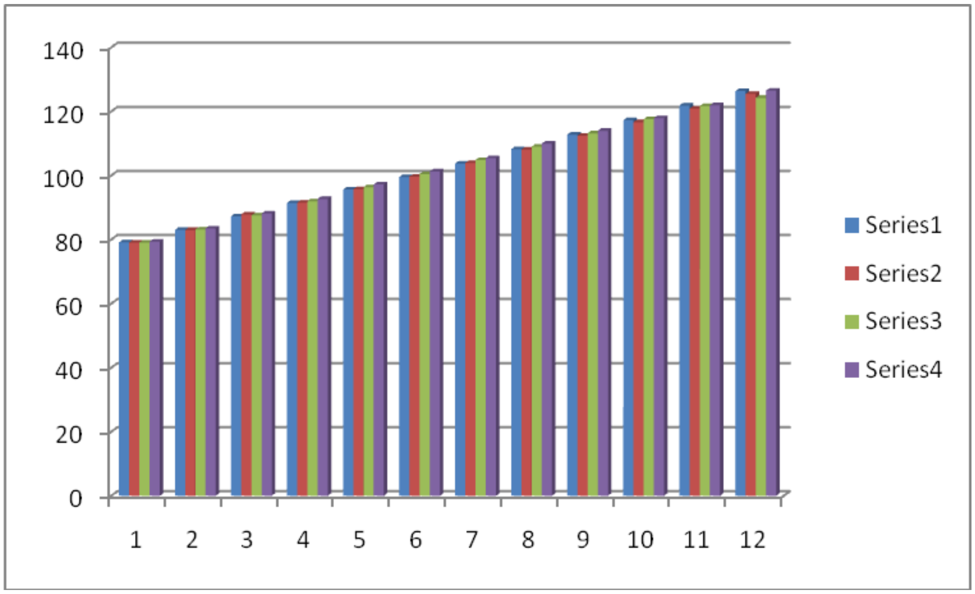
Fig. 1 Chart of Weekly Growth Performance of Snail fed Cashew AppleWaste Based Diets



Key : Series 1= Diet 1; Series 2 = Diet 2; Seires 3 = Diet 3; Series 4 = Diet 4