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# EFFECT OF FORMULATED DIETS ON GROWTH AND REPRODUCTIVE PERFORMANCE OF THE WEST AFRICAN GIANT SNAIL (*Achatina achatina*)

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**ABSTRACT**

Two experiments were conducted to assess the effect of three poultry diets on growth and reproductive performance of *Achatina achatina* snails. In the first experiment 120 juvenile snails in groups of ten were fed four experimental diets for a period of 182 days. The treatments were $T_1$-Broiler starter, $T_2$ -Grower mash, $T_3$ -Layer mash and $T_4$ Unripe pawpaw fruits. The Completely Randomised Design was used with four treatments and each replicated three times. The second experiment involved 120 adult snails fed the four diets using the same experimental design. The results revealed that juvenile snails fed on broiler starter diet ($T_1$) had significantly ($P<0.05$) higher performance in terms of monthly feed intake, final weight, monthly weight gain, specific growth rate, monthly shell increment, while pawpaw fruit diet ($T_4$) recorded the least. Adult snails fed broiler starter diet ($T_1$) recorded significantly ($P<0.05$) higher mean values for all parameters measured. $T_3$ and $T_4$ were, however, similar ($P>0.05$) in terms of feed intake, final weight, weight gain and feed conversion ratio. Feed intake seemed to follow a trend in the adult snails; feed intake increased as protein content of feed increased. No significant differences ($P>0.05$) were observed in the adult snails in terms of total eggs laid and egg length; however, egg weight and egg width were found to be significantly higher ($P<0.05$) for snails fed layer mash ($T_3$). Therefore, the broiler starter ($T_1$) could be fed to growing snails to improve performance whereas the layer mash ($T_3$) could be fed to enhance reproductive performance in *Achatina achatina*.

**Keywords:** snail, *Achatina achatina*, broiler starter, layer mash, grower mash, pawpaw fruit, hutch box.

## INTRODUCTION

The major sources of meat protein for Ghanaians, which are basically from livestock in the form of poultry, beef, mutton and pork, are being decreased by persistent drought, diseases, high cost of feed, primitive animal husbandry techniques and low productivity of local animal breeds. The increasing growth of human populations (Oyenuga, 1968) together with the rising standard of living has also placed great pressure on the existing sources of animal protein (Fagbuaro, 2006).

The consumption of snails as food in Ghana, a century old practice found within the Akan tribe, has caught up with almost every Ghanaian as a result of its well-known nutritional value. With a crude protein content of about 19% (Fagbuaro, 2006), snail meat compares favourably with other conventional sources of animal protein like beef, pork and poultry meat. The low cholesterol level and high iron content of the meat make it a good antidote for fat related diseases (Bright, 1996).

Snail farming is also an important source of income to farmers (Omole, 2006). There is a flourishing international trade of snails in Europe and North America, which has the capacity to reduce the level of poverty in rural Ghana. In spite of the considerable external and local demand, commercial snail farms such as those in Europe, South-East Asia and the Americas do not exist in West Africa. In Nigeria, Ghana and Cote d'Ivoire where snail meat is particularly popular, most of the snails continue to be gathered from the forest. In recent years, however, wild snail population have declined considerably, primarily because of the impact of such human activities as deforestation, slash and burn, pesticide usage and collection of snails before they have reached maturity.

Many snail farms are being established at the present time, in part to compensate for the decrease in natural populations in certain countries and in part in order to produce good quality snails for consumption (Gomot, 1998). In captivity, snails have been fed leaves, unripe fruits and other plant materials which are of low nutrient content. This has resulted in slow growth and long maturity time. Intensive indoor rearing, supported by formulated served feed may enable the harvesting of matured snails earlier than in their wild state (Akinnusi, 1998).

Some effort has been made to feed compounded diets to the snail in order to enhance productivity (Stievenart, 1992; Omole *et al.*, 2000; Ejidike, 2001). Adeyemo (2005) observed that snails do well when they are fed compounded diets. There is, however, scanty information on the effect of these formulated diets on the growth and reproductive performance of *Achatina achatina*. The current study was, therefore, aimed at investigating the effect of compounded feed on growth and reproductive performance of *Achatina achatina* snails. The specific objectives of this study were;

- To ascertain the effects of formulated feed on the growth performance of juvenile and adult snails
- To investigate the effects of formulated diets on reproductive performance of snails
- To find the relationship between formulated diet and mortality during egg laying

## MATERIALS AND METHODS

### Location of experiments

The field experimentation was conducted at the University of Education, Winneba research farm (Non Traditional Section) at Mampong campus in the Ashanti Region of Ghana from November 2008 to May 2009. Mampong lies between latitude $07^0$ and $08^0$ North of the equator and longitude $01^0$ and $02^0$ West (Meteorological service station-Mampong 2005). The mean daily temperature and monthly rainfall are $30.5^0$C and 91.2mm, respectively (Meteorological service station-Mampong 2005). The soil of Mampong belongs to the Bediase series which is well drained, friable, red, permeable, have moderate organic matter content and moderate water holding capacity (Asiamah, 1998). For the purpose this research, sterilized well drained loamy soil was used.

### Experimental diets

Four different diets, $T_1$-Broiler starter, $T_2$-Grower mash, $T_3$-Layer mash and $T_4$-Unripe pawpaw fruits, were fed to the snails as treatments diets. The composition of the diets is as shown in Table-1 below.

**Table-1.** Gross composition of the experimental diets (%) as fed.

| Ingredient | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| Maize | 60 | 58 | 53 | - |
| Wheat bran | 10 | 16 | 21.5 | - |
| Soybean meal | 10 | 7 | 6 | - |
| Russia fish | 9 | 5 | 5 | - |
| Tuna | 8 | 10 | 7 | - |
| Oyster shell | 2.5 | 3.5 | 7 | - |
| Premix | 0.5 | 0.5 | 0.5 | - |
| Pawpaw fruit | - | - | - | 100 |
| Total | 100 | 100 | 100 | 100 |

**Table-2.** Composition of experiment diets (g/100g).

| | **Calculated analysis** (Dry matter basis) | | | |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| Crude protein | 19.7 | 15.4 | 13.9 | 1.0 |
| Dry matter | 50.3 | 53.0 | 49.9 | 12.8 |
| Ash | 37.3 | 39.1 | 35.0 | 2.6 |
| Fibre | 15.3 | 9.5 | 11.2 | 2.9 |
| Fat | 4.5 | 4.5 | 4.3 | 0.7 |
| Nitrogen free extracts | 23.2 | 31.5 | 35.6 | 92.8 |
| Calcium | 4.3 | 6.2 | 8.2 | 1.7 |
| Energy (ME[1]), kcal/kg | 1921 | 2056 | 2130 | 3389 |

[1]ME is Metabolizable Energy

### Experiment-1

A total of 120 juvenile snails with average weight of 0.66g ± 1 were obtained from a local snail farmer at Kumasi in the Ashanti Region of Ghana. In a completely randomized design, the snails were allotted randomly to the four diets as treatments; 30 snails per diet or treatment, each treatment was sub-divided into three replicated groups of 10 snails. Snails on pawpaw fruit diet (control group) received 2 g of dicalcium powder once a week. The snails were reared in wooden hutch boxes of 66 cm x 66 cm x 26 cm covered with wire mesh. These boxes were placed under mango trees. The mean daily temperature during the experiment was 27.6 $^o$C – 31.0 °C. The snails were fed on the control diet for three weeks after they were brought from the local snail farmer for them to be adapted to their new environment.

Snails were fed daily for 182 days. The diet was served to the snails in plastic troughs. Water was also made available to the snails in plastic troughs with foam inside to absorb water for easy accessibility to snails and also prevented drowning of snails. Water was also sprinkled on the mulched soil three times every week.

Parameters measured included feed intake, weight gain, specific growth rate, feed conversion ratio,

survival rate, shell length and shell width increments. Feed intake was measured daily with an electric weighing balance. Shell length and width were measured on weekly basis with the use of vernier caliper while shell thickness was measured every week with micrometer screw gauge.

**Experiment-2**

120 adult snails with an average initial weight of 140.0 g were procured from a Kumasi based farmer and housed in an enclosure with a floor dimension of 5.21 m × 4.21 m providing an area of 21.9 $m^2$ for the snails. The housing unit was built with sandcrete and grass roofing. The floor of the housing unit was cemented and divided into cubicles measuring 0.67 m × 0.67 m. Each cubicle was filled with loamy soil at a depth of 0.14 m, and dried cocoa leaves were put on top of the soil as litter. Each cubicle was supplied with a plastic plate to serve as a feeding trough. Snails were randomly allotted to the cubicles (experimental units) using the Completely Randomised Design. There were four treatments and each treatment had three (3) replicates. Ten adult snails were used in each experimental unit. Water was sprinkled on snails daily using a watering can so as to maintain their body temperature and to prevent dehydration. The snails were fed daily in the evening at 5:00pm. Snails were fed for 182 days.

Weight changes were measured on monthly basis. Feed intake was measured daily with an electric weighing balance. Shell length and width were measured on weekly basis with the use of vernier caliper while shell thickness was measured every week with micrometer screw gauge. Egg length, egg breadth, mean number of eggs laid and mean weight of eggs were also measured.

**Statistical analysis**

All data were subjected to analysis of variance (SAS 2008); sources of variation were treatments and error.

**RESULTS**

The growth performance of the juvenile snails is presented in Table-3. The formulated diets used in the experiment influenced the performance of juvenile snails.

**Table-3.** The effect of compounded diets on growth performance of juvenile snails[2].

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Feed intake, g/month | $124.8^a$ | $88.1^b$ | $98.3^b$ | $74.7^c$ | 3.16 |
| Initial weight, g | 0.667 | 0.677 | 0.668 | 0.658 | 0.00388 |
| Final weight, g | $58.0^a$ | $47.1^b$ | $49.1^b$ | $35.9^c$ | 4.54 |
| Weight gain, g/month | $9.56^a$ | $7.74^b$ | $8.07^b$ | $5.88^c$ | 0.34 |
| Specific growth rate | $1.44^a$ | $1.35^b$ | $1.36^b$ | $1.27^c$ | 0.035 |
| Shell length increment, mm/month | $19.8^a$ | $18.3^b$ | $19.2^b$ | $17.0^c$ | 0.25 |
| Shell width increment, mm/month | $13.2^a$ | $12.5^{ab}$ | $12.9^a$ | $11.9^b$ | 0.22 |
| Feed conversion ratio | $13.1^a$ | $11.4^c$ | $12.2^b$ | $12.7^{ab}$ | 0.366 |
| Survival rate, % | 100 | 100 | 100 | 100 | |

[2] means (n=30)
[abc] means with different superscripts along the same row are significantly different ($P < 0.05$).

The results revealed that snails fed on treatment $T_1$ had significantly higher performance in terms of monthly feed intake, final weight, monthly weight gain, specific growth rate, monthly shell increment while $T_4$ recorded the least. $T_2$ and $T_3$ had similar ($P>0.05$) performance but higher ($P<0.05$) than $T_4$. Monthly shell width increment was similar for $T_1$, $T_2$ and $T_3$ but different between $T_2$ and $T_4$. Feed conversion ratio varied significantly ($P<0.05$) among treatment diets with diet II recording the highest. Survival rate of 100% was recorded for all the treatments throughout the experimental.

Table-4 shows the effect of treatment diets on growth performance of adult snails. Significant differences were observed in all parameters measured except for specific growth rate, which was similar ($P>0.05$) for all treatments.

**Table-4.** The effect of compounded diets on growth performance of adult snails[3].

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Total feed intake, g | 184.9[a] | 126.8[b] | 68.8[c] | 62.5[c] | 28.64 |
| Initial weight, g | 140.3 | 140.0 | 140.0 | 140.0 | 0.0788 |
| Final weight, g | 159.7[a] | 152.9[b] | 146.7[c] | 146.1[c] | 3.179 |
| Weight change, g | 19.7[a] | 12.9[b] | 6.7[c] | 6.1[c] | 3.175 |
| Shell length gain, mm | 12.1[a] | 11.3[d] | 11.7[b] | 11.5[c] | 0.171 |
| Shell width gain, mm | 6.24[a] | 5.86[c] | 6.04[b] | 5.67[d] | 0.122 |
| Specific growth rate | 0.58 | 0.57 | 0.56 | 0.56 | 0.00478 |
| Feed conversion ratio | 9.40[c] | 9.81[b] | 10.2[a] | 10.3[a] | 0.205 |

[3]means (n=30)
[abc] means with different superscripts along the same row are significantly different (P < 0.05).

**Table-5.** The effect of compounded diets on reproductive performance of adult snails[4].

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Total eggs collected | 505 | 398 | 552 | 460 | 32.8 |
| Egg weight, g | 0.13[a] | 0.11[b] | 0.12[ab] | 0.14[a] | 0.00646 |
| Egg length, mm | 0.68 | 0.65 | 0.70 | 0.65 | 0.0122 |
| Egg width, mm | 0.61[b] | 0.58[c] | 0.63[a] | 0.54[d] | 0.0196 |

[4]means (n=30)
[abc] means with different superscripts along the same row are significantly different (P < 0.05).

$T_1$ recorded significantly (P<0.05) higher mean values for all parameters. $T_3$ and $T_4$ were similar (P>0.05) in terms of feed intake, final weight, weight gain and feed conversion ratio. Feed intake seemed to follow a trend in the adult snails; feed intake increased as protein content of feed increased. $T_1$ registered the highest feed intake, followed by $T_2$ and then $T_3$ and $T_4$. It was observed from the results that snails that fed on $T_1$ recorded the heaviest weight gain followed by $T_2$, $T_3$ and then $T_4$.

There were significant (P>0.05) differences in shell length and shell width. The highest increase in shell length was recorded in $T_1$ fed snails and the least was recorded in $T_2$ fed snails. Final body weight was highest in $T_1$ followed by $T_2$; and the least were $T_3$ and $T_4$. Feed conversion efficiency was highest (P<0.05) for $T_1$, followed by $T_2$; but significantly (P<0.05) lower for $T_3$ and $T_4$.

The effect of the diets on reproductive performance of the snails is shown in Table-5. No significant differences (P>0.05) were observed in terms of total eggs collected and egg length, however, egg weight and egg width were found to differ among treatments. Egg weight and egg width were significantly (P<0.05) lower for $T_2$ fed snails. However, the difference between $T_2$ and $T_3$ in terms of egg weight was not significant (P>0.05).

## DISCUSSIONS

In juvenile and adult snails (Tables 3 and 4), final body weight, body weight gain, feed intake, shell length and width increment were significantly higher for broiler starter diet ($T_1$) and lowest for pawpaw fruit diet ($T_4$). This could be attributed to the different levels of protein in the diets (Table-2). The higher performance observed in snails fed broiler starter diet was not surprising, since this diet contained the highest protein and optimum energy levels and would have met the snails' optimal requirement for growth. Considering the superior performance of snails fed the broiler starter diet, it does appear therefore, that the diet produced a better energy: protein synergy. Although feeding snails with diets containing 22.60% CP and 23% CP resulted in increased growth rate in earlier studies (Radrizzani, 1992; Bright, 1996), decreasing the crude protein level below 18% as in the present study led to reduction in performance. Ani *et al.* (2013) observed that decreasing dietary protein levels below 18% resulted in reduced performance in snails. Sang-Min and Tae- Jun (2005), however reported that a diet containing 22% and 3.3Mcal/kgME was optimal for snail growth. Also Hodasi (1979) and Omole *et al*. (2000) reported that diets containing 28% CP and 2200Kcal/kgME were optimal for the growth of snails. The energy content of the compounded diets in the present study ranged between 1921 to 2130 kcal/kg ME. Feed conversion efficiencies of 11.4 to 13.2 recorded in the present study compares favourably with values (9.24 to 15.01) reported by Ani *et al* (2013) for *A. achatina* snails fed 18% compounded diets.

The superior shell length and width increments observed among snails fed on broiler starter diet could be attributed to the enhanced growth performance of snails on

this diet and the positive correlation between growth performance, shell length and shell width. A positive correlation between live weight gain, shell length gain, and shell width gain had been established especially in growing snails (Odunaiya and Akinnusi, 2008; Ani *et al*., 2013). The range of monthly increment of shell length and width (17.0 to 19.8 and 11.9 to 13.2 mm, respectively) obtained in the present study are above the values (8.77 to 11.4 and 3.67 to 6.60 mm) reported by Omole *et al.* (2004) for growing snails fed fruit peels and pawpaw leaves. The disparity with these reports could arise from such factors as differences in age of snail, species as well as management and environment. The 100% survival rate observed in the present study confirms the report of Oluokum *et al*. (2005) that snails are hardy (Cobbinah 2008) and therefore, have relatively low mortality rate if proper management is observed compared to other conventional livestock.

Snails were found to be influenced in their laying by the experimental diets; however values recorded for number of eggs and egg length were similar. Egg laying, therefore, may be genetically determined. According to Cobbinah (2008), the average size of egg mass produced by the various ecotypes of *A. achatina* studied in Ghana ranged from 38 to 563 eggs. An earlier study (Hodasi, 1979) reported 30-300 eggs per clutch for *Achatina achatina*. These values are in conformity with the present study. Considering the parameters measured, layer mash ($T_3$) seemed to have supported reproduction in the snails better. Pawpaw fruit diet gave the poorest results. This was not surprising since pawpaw fruit as a sole diet is not nutritionally balanced enough to meet snails' requirements for reproduction. The highest egg width recorded by layer mash fed snails could be attributed to the presence of wheat bran in an adequate quantity (Table-1). Abaza (2009) reported that, moderate to high wheat bran supply to poultry improved the egg number, egg weight and feed conversion ratio. In the present study egg length was not affected by the diets, which confirms the report of Omole (2007).

It seemed the mineral content, which is responsible for shell growth and development (Daouda, 1995; Bright, 1996), was adequate in all treatments diets. Though grower mash ($T_2$) had the highest mineral content, it did not support the highest egg shell length. This is an indication that mineral supply might not be the only factor necessary for increased egg length in snails.

## CONCLUSIONS

The study revealed that *A. achatina* snails would consume and respond to compounded diets. Snails on compounded diets showed remarkable performance in terms of growth and reproduction over snails fed pawpaw fruit diet. Broiler starter diet seemed to favour growth in both juvenile and adult snails whereas layer mash favoured reproductive performance in the snails.

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