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Performance of Snails *(Archachatina marginatas)* Fed Varying Levels of Calorie — Protein Supplementary Diets

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ABSTRACT

Four diets containing between 6.0 g kg^{-1} and 146.2 g kg^{-1} crude protein in 43.8 g kg^{-1} stepwise increments were compounded by replacing cassava flour with groundnut cake meal. Each diet was fed to 24 mature snails in experiment 1 and 32 snail hatclings in experiment 2 over a period of 12 weeks and 17 weeks, respectively. The control diet constituted the fifth treatment for both experiments. Indices measured were growth and reprodive performances. In experiment 1, optimum body weight gain of 0.83 g d^{-1} was obtained from snails fed supplementary diet 3 (102.45 g kg^{-1} crude protein x 1.15 Kcal ME g^{-1} diet).Clutch number varied between 3 and 24 but mean clutch size was 8.3. The shortest clutch interval of 10days was obtained in snails fed supplementary diet 4 while egg hatchability was best (86.0%) in snails fed supplementary diet 1. In experiment 2, mean body weight gain of hatchlings was 0.21 g d^{-1} and by the seventeenth week, snail hatchlings fed supplementary diet 3 had attained 42.5 g body weight. It appears that diet 3 was balanced in nutrient densities required by snail and can be used to supplement the natural food resources *(Talinum triangulare, Carica papaya, Xanthosoma sagitifolium* and *Centrosema pubescens)* used as control diet.

INTRODUCTION

The deficit in per caput protein consumption for some developing countries continues to worsen due to population growth and attrition of wildlife species hitherto harvested for bushmeat.

The problem of wild animal overexploitation has not only manifested in rarity of species but also in the downward trend of snail supply to urban markets in Nigeria. The few available snails in the markets are even smaller in sizes relative to what was obtainable some years back.

Attempts to arrest the shortfall in snail supply include the culture of the species (Plumer 1975, Ajayi *et al* 1978; Awesu 1980; Elmslie 1982 and Hodasi 1986) but there are conflicting results in the areas of age at maturity. There are also gaps in knowledge on the age at table size, body size at maturity, optimum reproductive and growth performances. These gaps are being investigated under specified dietary regimes by using the African giant land snail (*Archachatina marginata* S). Results obtained will enhance the culture of this wildlife species in the one hand, and one the other, it will arrest wildlife habitat dislocation in forests where snail gathering is carried out.

MATERIALS AND METHODS

This study was carried out in two parts. The first part (Experiment 1) involved the performance of mature snails during early rainy season while the second part (Experiment 2) involved snail hatchlings during late rainy season through the early dry season.

Experiment 1

Five groups of 24 mature snails were raised for twelve weeks in a snail culture unit (20m x 12m). The culture unit has earlier been fenced with teak poles and galvanised wire mesh before being planted to banana (***Musa sapientum*** L), cocoyam (***Xanthosama sagitifolium*** Schott), water leaf (***Talinum triangulare*** Willd), pawpaw (***Carica papaya*** Linn) and ***Centrosema pubescens*** which are the natural sources of food for snail.

The snails in each group further divided into three subgroups of 8 and placed in breeding cages (70 x 25 x 25 cm) inside the snail culture unit. The snails had direct access to the ground soil as the floor of the breeding cage was not reinforced with wire mesh. However, the fifth group of 24 snails which constituted the control was not caged. The weight of snails in each group was initially equalised at 288.83 ± 0.13 g per snail.

There were four test diets (Table 1) and one control diet consisting of ripe pawpaw fruit, pawpaw leaf, leaves of ***Talinum triangulare Centrosema pubescens*** and Okro (***Hibiscus esculentus*** Linn).

All the snails were fed for seven days on the control diet, thereafter, each of the compounded diet (Table 1) was randomly assigned to three subgroups of 8 snails in the breeding cages as dietary supplement to the control diet while the uncaged snails (Group 5) continued solely on the control diet.

The compounded diets which were offered along with copious quantities of the control diet in each of groups 1, 2, 3 and 4 as well as the control which was solely fed on by group 5 snails was on ***ad libitum*** basis. The culture unit was irrigated at 07.00, 11.00 and 17.00 h daily whenever there was no rain. All snails were initially numbered with oil paints and individually weighed on weekly basis. The records on laying performance was equally taken on weekly basis.

Experiment 2

The growth performance of snail hatchlings from eggs laid by snails in experiment 1 was monitored for 17 weeks.160 hatchlings with mean liveweight of 2.1 g were divided into five groups of 32. Snail hatchlings in each of groups 1, 2, 3 and 4 were further divided into four subgroups of 8. Each subgroup was placed in a rearing cage (20 cm^3).

The fifth group which constituted the control was reared on the control diet while each of the test diets (Table 1) was randomly assigned to 4 subgroups as dietary supplement to the control diet. Feeding was on ***ad libitum*** basis. Body weight changes and shell measurements were recorded weekly.

Proximate analysis

The compounded diets were analysed for nutrient composition according to the AOAC (1986) procedures while the mineral concentrations were determined on the absorption spectrophotometer after wet digestion with perchloric and nitric acids.

Statistical analysis

Since the control in both experiments could not be replicated, no test of significance was performed on values obtained in each subgroup. Rather, the value, for the subgroups were pooled for each group and whenever applicable,their means were computed. Test of significance followed the simple randomised design described by Snedecor and Cochran (1967).

RESULTS

Proximate Composition of Test Diets

Table 1 shows the proximate nutrient composition of the supplementary diets. Crude protein significantly increased ($P < 0.01$) from 14.8 g kg^{-1} diet in Diet 1 to 146.2 g kg^{-1} in diet 4, whereas the Kcal ME g^{-1} diet in the four diets were similar ($P > 0.05$). The lowest concentration of calcium (1180.8 ppm) and highest concentration of phosporous (400 ppm) were obtained from Diet 3.

Experiment 1.

Average daily supplementary feed intake tended to improve between week 1 and week 12 for each dietary treatment. When means were pooled over the study period, snails fed supplementary Diet 4 consumed about 49.5% of the 8.16 g feed consumed per day by snails fed Diet 1 (Table 2).

The mean daily weight gain is shown in Table 3. Snails lost about 0.27 g body weight per day when fed solely on the control diet. However, when the control diet was supplemented with Diet 3, the snail gained 0.83 g body weigh per day. The weekly body weight changes shown in Fig 1 indicates that body weight loss was a common phenomenon in all the treatment during the 6th to 9th week of the study period. This body weight loss was very pronounced during week 9 when snails fed supplementary Diets 3 and 4 lost about 2.02 and 2.34g body weight respectively.

Data on clutch number of clutch sizes of the mature snails are shown in Table 4. Number of clutches in snails fed Diets 1 and 3 was similar and significantly higher (P 0.05) than the clutch size of 6 obtained from snails fed solely on the control diet. Irrespective of the clutch number, the clutch sizes were similar (P0.05) in all the treatments. The mean weight of eggs and mean weight of hatchlings were significantly greater (P0.05) in treatment 2 than the corresponding weight obtained from either of the other treatments. Period of egg incubation ranged from 25 days in treatment 4 to 31.8 days in treatment 1 while egg hatchability was least (50.0%) in treatment 2 and highest (86.0%) in treatment 1.

Experiment 2.

Table 5. shows the mean daily feed intake of snail hatchlings. Snails fed diet 1 consumed a significantly greater (P0.05) quantity than the quantity consumed by snails fed either Diet 3 or Diet 4 between which there were no differences.

The data on weight gain are shown in Table 6. During the first six weeks of life, no marked difference was observed between treatments. However, between the 6th and 12th week of life, significant (P 0.01) differences in weight gain between treatments were obtained. At the 12th week, cummulative gain ranged from 6.6g $snail^{-1}$ on the control diet to 14.7g $snail^{-1}$ fed the supplementary Diet 3. At essay termination, this pattern of growth resulted in 11.3g body weight $snail^{-1}$ fed solely on the control diet in contrast to the body weight of 45.9g $snail^{-1}$ fed Diet 3.

The gains in shell length and shell width of snail hatchlings are shown in Tables 7 and 8, respectively. Increases in shell length was similar among snails fed the supplementary diets but the mean value obtained from the control was significantly ($P<0.05$) lower than either of the value obtained in snails fed supplementary diets 1, 2, and 3. The relationship between body weight gain and shell length was linear and significant ($P<0.05$) in all the treatments, with treatment 3 having the highest coefficient of determination.

$Y = 9.74\ x - 19.20\ R^2 = 0.95$

Increases in shell width started to show discernible values after the first six weeks of life and by the 17th weeks, snails fed diet 3 had expanded in width by 0.28 mm d^{-1} in contrast to the significantly lower ($P<0.05$) expansion of 0.15 mm obtained from snails fed solely on control diet.

DISCUSSION

The ingredient composition of the tested supplementary diets are conventional and similar to those being used in commercial livestock feed milling programme. However, the average daily feed intake by snails in the two age categories studied was rather low. Such a low consumption level of scientifically compounded supplementary feed for snail eliminates the fear of feed ingredients competition between snails and man on the one hand, and on the other, between snails and other livestocks.

The supplementary diets were better utilised by snails when mixed with water or when feed was about to decay, an indication that the fraction of feed ingredients earmarked for loss to rodents and poor storageability in livestock enterprise may be able to meet the snails requirement under an integrated livestock and microlivestock farming enterprise.

There was a stepwise increase of dietary energy level by about 0.1Kcal ME g^{-1} diet which probably accounted for the decreases in feed intake level between the supplementary diets. Despite the decreasing trend in feed intake between Diet 1 and Diet 4, total protein intake in experiment 1 was 120.8, 347.5, 639.0 and 576.0g kg^{-1} feed in diets 1, 2, 3 and 4, respectively. The increases in protein intake was significant ($P<0.01$) between Diets 1 and 3 but average body weight gain in snails fed supplementary Diet 3 was significantly better ($P<0.01$) than gains in snails fed either Diet 1 or Diet 2, between which there were no differences. This response is an indication of dietary nutrient balance especially with regards to calorie and protein of Diet 3.

From the above, it could be inferred that the low level

Table 1: Ingredient Composition of Experimental Diets for Adult and Sanil Hatchlings

	DIETS			
Ingredients	**1**	**2**	**3**	**4,**
Cassava flour	48.0	38.0	28.0	18.0
Groundnut cake	2.0	12.0	22.0	32.0
Bone meal	20.0	20.0	20.0	20.0
Oystershell	30.0	30.0	30.0	30.0
Analysed Value				
Crude Protein (g kg^{-1} diet)	14.8	58.6	102.4	146.2
Kcal ME g^{-1} diet	0.9	1.0	1.1	1.2
Calcium (ppm)	1136.6	1308.7	1180.8	1217.7
Phosphorous (ppm)	378.0	378.0	400.0	350.0
	1.5	5.9	10.2	14.6

Table 2: Average Daily Fed Intake of Mature Snails Fed Supplementary Dies (q $Snail^{-1}$)

Study Period (Weeks)	SUPPLEMENTARY DIETS				
	1	2	3	4	Mean
1	2.14	1.90	2.14	0.95	1.78
2	2.86	2.43	2.52	1.43	2.31
3	3.90	2.62	2.38	1.19	2.52
4	4.05	3.81	3.81	1.67	3.34
5	5.71	4.52	4.76	2.19	4.30
6	6.43	5.48	5.71	3.09	5.18
7	10.24	5.86	6.67	4.52	6.82
8	9.05	5.71	7.14	3.81	6.43
9	8.33	5.24	6.67	8.33	7.14
10	16.67	8.33	9.52	4.76	9.82
11	11.90	11.90	11.09	11.09	11.50
12	16.67	13.33	12.52	4.19	11.68
Mean	8.13	5.93	6.24	3.94	6.07

Table 3: Average Daily Weight Gain of Mature Snails (g snail^{-1})

Study Period (Weeks)	DIETS					
	1	2	3	4	Control	Mean
1	3.03	1.96	1.22	1.82	-1.42	1.32
2	0.95	0.63	1.66	0.69	0.83	0.95
3	0.03	0.54	-0.80	-0.76	-0.51	-0.30
4	-0.41	1.64	1.11	1.20	0.89	0.89
5	0.43	-0.28	0.64	-0.58	-0.65	-0.09
6	-0.33	-0.28	0.64	-0.58	0.37	-0.04
7	-0.49	0.15	-1.31	0.42	-3.68	-0.99
8	0.50	0.25	0.76	-0.38	-2.49	-0.27
9	-2.94	-0.82	2.02	-2.34	0.54	-0.71
10	3.11	0.95	1.96	0.83	1.54	1.68
11	0.95	-0.88	0.04	0.93	0.97	0.40
12	0.20	1.04	2.03	0.76	0.34	0.87
Mean	0.42	0.41	0.83	0.17	-0.27	0.31

Table 4: Reproductive Performance of Mature Snails During Early Rainy Season

	DIETS					
Reproductive Indices	1	2	3	4	Control	Mean
Number of Clutches	18	3	24	9	6	12.0
Clutch size	8.5	8.0	9.5	7.3	8.0	8.3
Interval between clutches (days)	11.8	21.3	20.4	10.0	28.0	14.0
Mean egg weight (g)	2.7	4.5	2.7	3.0	2.6	3.1
Mean egg length (mm)	19.0	23.0	19.2	20.5	17.8	19.9
Mean egg width (mm)	15.1	18.0	15.4	16.3	14.0	15.8
Mean Incubation period (days)	31.8	28.0	31.2	25.0	30.5	29.3
Total Number of eggs hatched	21.9	12.0	153.0	39.0	39.0	53.1
Mean % hatchability	86.0	50.0	67.1	59.5	81.2	68.8
Mean Weight of hatchlings (g)	2.1	3.5	2.2	2.5	2.4	2.5
Mean Shell length of hatchlings	20.2	21.0	20.2	20.2	20.0	20.3
Mean Shell width of hatchlings (mm)	15.4	16.8	15.4	15.6	15.8	15.8

Table 5: Feed Intake of Snail Hatchlings from 0 – 84 days (q/snail)

Growth Period (days)	SUPPLEMENTARY DIETS				
	1	2	3	4	Mean
0-7	1.3	0.9	0.7	0.7	2.5
7-14	1.3	1.1	0.7	0.7	1.0
14-21	1.8	1.3	0.9	0.7	1.3
21-28	2.2	1.4	0.9	1.1	1.4
28-35	3.0	1.8	1.1	1.6	1.9
35-42	2.2	1.8	1.4	1.2	1.7
42-49	2.9	2.2	2.0	1.8	2.2
49-56	3.8	2.7	2.6	2.2	2.8
56-63	4.7	3.6	3.2	3.1	3.9
63-70	5.7	3.2	2.9	2.8	3.4
70-77	4.9	3.3	3.5	2.5	3.6
77-84	5.2	3.7	3.6	2.8	3.8
Mean	3.3	2.3	2.0	1.8	2.5

Table 6: Average Daily Weight Gain of Snail Hatchling ($g\ Snail^{-1}$)

Growth Period	DIETARY TREATMENTS					
(days)	1	2	3	4	Control	Mean
0-7	0.08	0.04	0.11	0.04	0.06	0.06
7-14	0.04	0.04	0.08	0.04	0.06	0.07
14-21	0.08	0.11	0.10	0.10	0.06	0.09
21-28	0.07	0.18	0.07	0.16	0.11	0.12
28-35	0.11	-0.01	0.16	0.06	0.02	0.07
35-42	0.07	0.08	0.08	0.14	0.06	0.09
42-49	0.44	0.34	0.27	0.17	0.11	0.26
49-56	0.11	0.28	0.37	0.14	0.13	0.20
56-63	0.23	0.67	0.46	0.28	0.10	0.35
63-70	0.13	0.08	0.41	0.68	0.20	0.30
70-77	0.20	0.20	0.20	0.20	0.01	0.16
77-84	0.36	0.30	0.50	0.30	0.01	0.29
Mean	0.16	0.19	0.25	0.19	0.08	0.17

Table 7: Average Daily Gain in Shell Length of Sanil Hatchlings (mm)

Growth Period	DIETARY	TREATMENTS				
(Days)	1	2	3	4	Control	Mean
0-7	0.26	0.10	0.01	0.10	0.13	0.12
7-14	0.01	0.11	0.05	0.07	0.10	0.07
14-21	0.17	0.11	0.15	0.11	0.08	0.12
21-28	0.30	0.15	0.28	0.12	0.11	0.19
28-35	0.11	0.40	0.40	0.18	0.08	0.23
35-42	0.00	0.27	0.18	0.25	0.07	0.15
42-49	0.74	0.35	0.32	0.24	0.23	0.38
49-52	0.28	0.27	0.25	0.21	0.10	0.22
56-63	0.21	0.24	0.24	0.17	0.11	0.19
63-70	0.21	0.28	0.25	0.11	0.07	0.18
70-77	0.23	0.28	0.24	0.13	0.09	0.19
77-84	0.22	0.27	0.29	0.15	0.12	0.21
Mean	0.23	0.23	0.22	0.15	0.11	0.20

Table 8: Average Daily Gain in Shell Width of Snail Hatchlings (mm)

Growth Period	DIETARY	TREATMENTES				
(Days)	1	2	3	4	Control	Mean
0-7	0.08	0.10	0.25	0.08	0.08	0.12
7-14	0.11	0.04	0.25	0.07	0.06	0.11
14-21	0.11	0.13	0.11	0.11	0.08	0.11
21-28	0.21	0.10	0.11	0.11	0.04	0.11
28-35	0.12	0.08	0.11	0.07	0.04	0.08
35-42	0.11	0.13	0.08	0.11	0.03	0.09
42-49	0.37	0.23	0.17	0.24	0.23	0.26
49-56	0.10	0.31	0.20	0.28	0.25	0.23
56-63	0.15	0.25	0.21	0.21	0.28	0.22
63-70	0.11	0.28	0.28	0.25	0.35	0.25
70-77	0.14	0.28	0.28	0.26	0.30	0.25
77-84	0.13	0.29	0.30	0.27	0.32	0.26
Mean	0.15	0.19	0.20	0.17	0.17	0.17

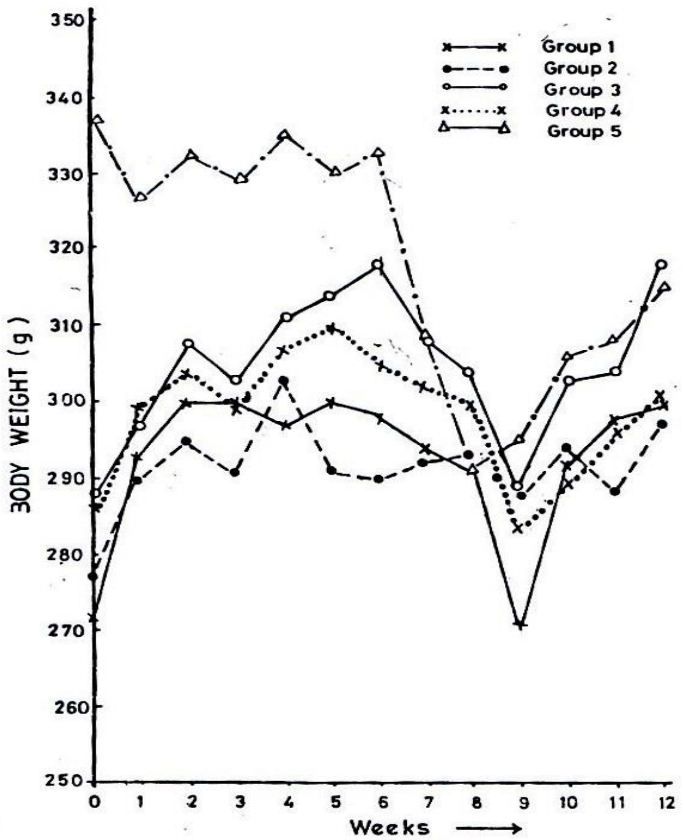

Fig 1: Mean Weekly Body Weight Of Adult Snails.

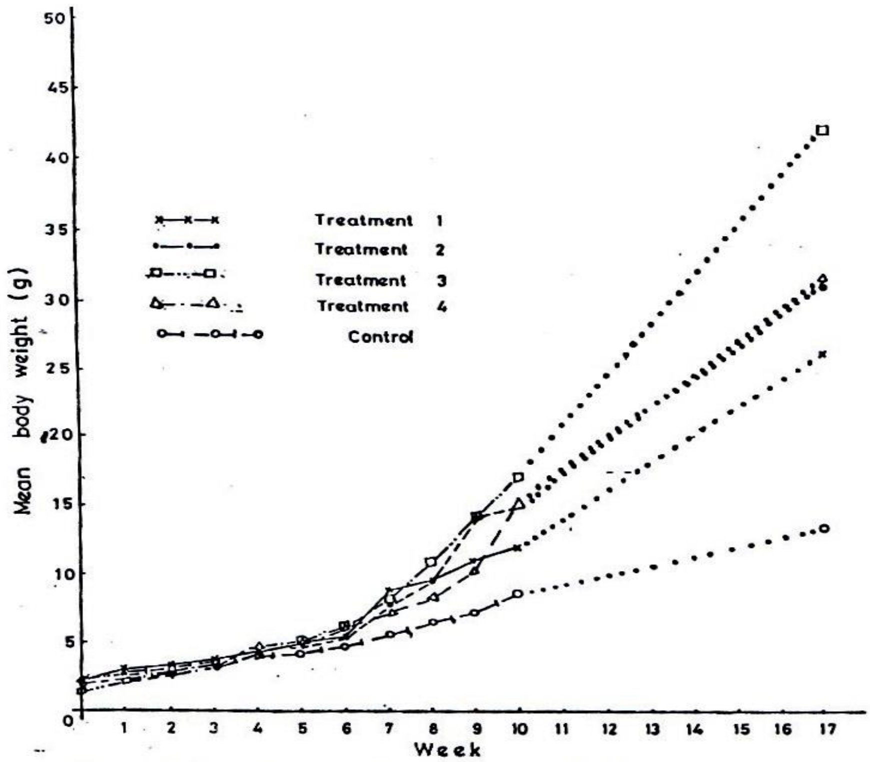

Fig 2: Mean Weekly Body Weight Of Snail Hatchlings (g)

of feed consumption by snails fed Diet 4 in experiment 1 was a function of inadequate dietary energy level. Consequently, most of the 576.0 g protein kg^{-1} diet might have undergone catabolism to liberate energy for the snails, thereby making protein unavailable for body building.

The mean body weight loss of 0.27 g $snail^{-1}$ fed solely on the control diet is a pointer to the inadequacy of simulated environments for snail culture and the need for supplementary feeding from compounded diets or household wastes.

The information gathered on snail reproductive characteristics in experiment 1 can be useful from two angles. First it was Diet 3 which enhanced the best growth rate that also produced the highest number of clutches. Secondly, the interval of 20.4 days obtained in snails fed Diet 3 was among the closest to the interval of 28.0 days obtained from snails fed solely on the control diet. Despite the number of clutches obtained from snails fed Diet 3, body weight loss was not frequent and pronounced, suggesting that 20.4 days interval between clutches could be used in the feasibility of profitable captive snail rearing programme.

In experiment 2, feed intake of snail hatchlings also decreased with increasing level of dietary protein while boby wei[illegible] [illegible]in only improved between Diet 1 and Diet 3. Despite th[illegible] trend in feed intake with increasing dietary protein level, protein intake by snails fed Diet 4 was higher than those fed Diet 3 b[illegible] 66.0 g kg^{-1} diet. Such a higher level of protein intake did not result in better weight gain which is a further manifestation of inbalance caloric-protein ratio in Diet 4.

Both the shell-length and shell-width of snail hatchlings, in experiment 2, increased with time but only shell-width showed an increasing trend with increases in dietary protein level. This observation suggests that snail meat will grow more laterally than vertically when nutrient densities are adequate in the culture unit.

The foregoing account suggest that the performance of snail could be enhanced if the natural food resources are supplemented with diets containing 102.4 g crude protein kg^{-1} diet x 1.1 Kcal ME kg^{-1} diet. Despite the performance records of mature snails and snail hatchlings fed this diet, the experiment had to be discontinued to allow for the superimposition of specific dietary calcium and phosphorous requirement levels which are under investigation.

REFERENCES

Ajayi, S.S.; Tewe, O.O.; Moriarty, C. and Awesu, M.O. (1978) Observations on the biology and nutritive value of the African giant snail (Archachatina marginala) East African Wildlife Journal 16: 85 –95

*Association of Official Agricultural Chemist (1986) AOAC: **Official methods of analysis**. Washington, D.C.*

*Awesu, M.O. (1980) **Observations on the biology and management of the West African giant snail** (Archachatina marginata M. Phil Dissertation, University of Ibadan, Nigeria.*

*Elmsile, L.J. (1982) Snails and snail farming. **World Animal Review** 41 : 20 – 26*

*Hodasi, J.K.M. (1986) Some observations on the feeding behaviour and food preference of the gaint West African snail (**Archachatina marginata Swainson**) **Snail Farming Research** 1 (1) : 54 – 66.*

*Plumer, J.M. (1975) Observations on the reproduction, growth and longevity of a labbratory colony of **Archachatina Calachatina marginata** (Swanson) sub-species ovum. Proceeding of the Mal. Soes London 41 : 395 – 413*

*Snedecor, G.R. and Cochran, W.L. (1967) **statistical methods**. The Iowa state University Press.*