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Response of sundried mango seed kernel meal on growth performance of East African land snail (*Achatina fulica*)

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Abstract

Fifty-six (56) days feeding trial was conducted to evaluate the response of feeding sundried mango seed kernel on the growth performance of Achatina fulica snails. The mango seeds kernel used as test ingredient was collected, cracked, sundried for two weeks and after which it was milled to obtain mango seed kernel meal. The mango seed kernel meal was used to formulate four experimental diets that meet the nutrient requirements of snails included at 0%, 5%, 10% and 15% respectively; designated Diet 1, Diet 2, Diet 3 and Diet 4. Diet 1 served as the control. One hundred and twenty (120) Achatina fulica snails of similar sizes were assigned to 4 dietary treatments and replicated 3 times in a completely randomized design (CRD) experiment. Each dietary treatment consisted of thirty (30) snails per treatment with ten (10) snails per replicate. Proximate composition of the mango seed kernel meal and the experimental diets were conducted to determine the nutrient contents of the mango seed kernel meal and that of the experimental diet. Data were collected on growth performance parameters. The data collected were analyzed using one-way analysis of variance (ANOVA). Results showed that significant reduction (P<0.05) were observed on the feed intake in Diet 3 and Diet 4; while weight gain increased in Diet 2, 3, 4. The feed conversion ratio reduced in Diet 2, Diet 3 and Diet 4.Furthermore, significant increases (P<0.05) were also observed on the final shell length [8.81cm (Diet 1) – 9.90cm (Diet 3)], shell length increase [0.80cm (Diet 1) – 1.81cm (Diet 3)], final shell aperture circumference [6.35cm (Diet 1) – 7.98cm (Diet 3)], shell aperture circumference increase [1.31cm (Diet 1) – 2.97cm (Diet 3)] and shell thickness [0.84cm (Diet 1) – 1.57cm (Diet 4)] compared to the control. Results showed that mango seed kernel meal could be included in the diets of Achatina fulica snail up to 15% without adverse effects on the performance.

Keywords: Snail, mango, growth, *archatina fulica,* seed kernel

Introduction

The developing and underdeveloped countries of the world today are faced with the challenge of providing sufficient food in adequate quantity and quality for its citizens. Eneji ***et al.*** (2008) stated that most of the developed countries in Africa are currently being faced with the alarming decline in per capital income and food production. The increasing growth of human population accompanied with the rise in standard of living have placed great pressure on the existing sources of animal protein such as chicken, beef, mutton and pork (Omole *et al.,* 2007; 2011). The importance of protein in the diet of man cannot be over emphasized due to its role in human well-being such as growth, maintenance, hormone regulation, enzymatic activity and improvement in disease defense mechanisms of the body (Ademolu ***et al.,*** 2004).Effort has therefore been made to increase protein intake through conventional animal protein

sources such as poultry, cattle, pig, sheep and goat. Unfortunately, growth in livestock production has failed to keep pace with the increasing human population especially in developing countries. The high demand for animal protein by the teeming population in developing countries and other factors such as persistent drought, environmental degradation, disease, primitive animal husbandry techniques and low productivity of local breeds has further accentuated the cost of meat and other animal protein products (Omole ***et al.,*** 2000). Therefore there is need to look inward and integrate into our farming system some non-conventional sources of animal proteins that can supply the required amount of protein for the teeming population (Ebenebe, 2000). In this way, the desired equilibrium between animal protein demand and its supply in Nigeria might be achieved. This desire has led to recent research interests in micro-livestock sector (Nodu and Adesope, 2002).

Micro livestock are those non-conventional animal protein sources that are rarely used or under-utilized which have great potential as a good source of animal protein. These include snail, grass cutter, guinea pigs, edible insects, giant rat and squirrel. Among these micro livestock species, snail appears most promising because of its small size and low capital return on investment.

Mango (*Magnifera indica*) is a perennial crop of the family *Anacardiacea*. It is grown practically all over tropical and sub-tropical regions of the world. The fruits are oval or kidney shaped with smooth, leathery skin and the color ranges from light or dark green to clear yellow when ripe. The pulp of the fruit is consumed fresh as a dessert or processed in to juices, jams and other products, while the seeds are discarded which often results in environmental pollution (Morton, 1987; Asma, 2017). Mango has been reported by various researchers to contain vitamins, minerals and other essential trace elements (Berardini *et al.,* 2005; Fowomola, 2010; Dakare *et al.,* 2012; Ogunsina *et al.,* 2012). Proximate and chemical screening of mango seed kernel has been shown to contain carbohydrate, protein and many other compounds (El Alaly *et al.,* 1996; Elegbede and Achoba, 1996; Dangoggo, 2001; Diarra *et al.,* 2010, 2011). Furthermore, most of the conventional ingredients used in compounding snail feed such as maize, soya beans, fishmeal, groundnut cake, wheat bran among others are very expensive, competitive, highly demanded and have high human preference. Thus, the seasonality of plant materials and high cost of conventional feed ingredients have necessitated the need for finding cheaper substitutes that are readily available which can be used in snail enterprise. Therefore**,** the objective of this study was to assess the growth performance of *Achatina fulica* **s**nails fed diets containing various levels of mango seed kernel meal.

Materials and methods

Experimental location

This research was conducted at the Snail and Edible insect unit of the Teaching and Research farms of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra State. The location lies in the rainforest region of the South eastern Nigeria, having annual rainfall of 1500mm and mean ambient temperature of about 34^{0} within the longitude of 7^{0} 08'31.9" E and latitude **6**^{0}1510.1"N. It experiences seven months of heavy tropical rains (April-October), followed by five months of dryness (November-March).

Collection and preparation of mango seeds

Dried mango seeds (***Mangifera indica***) were collected from different locations around Awka, Anambra State metropolis. Thereafter, the seeds were broken with a hammer, the kernels removed and sundried for 2 weeks to reduce the anti-nutritional factors, and to make the kernels easier to grind. The dried mango seed kernels were milled using a hammer mill to produce mango seed kernel meal. The mango seed kernel meal was stored in an airtight container, in a cool dry environment until when needed. The mango seed kernel meal was used in formulating the experimental diets. *Four experimental diets were formulated to meet the nutrient requirements of snails included at 0%* mango seed kernel meal, 5% mango seed kernel meal, 10% mango seed kernel meal and 15% mango seed kernel meal; representing *Diet 1,* Diet 2, Diet 3 and Diet 4, *respectively.* Diet 1 served as the control. The gross composition and proximate compositions of experimental diets are presented in Table 1 and 2, respectively while the proximate analysis of the mango seed kernel meal is presented in Table 3.

Table 1: Gross Composition of the experimental diet

Ingredients (%)	Diet 1 (0%)	Diet 2 (5%)	Diet 3 (10%)	Diet 4 (15%)
Maize	43.25	36.25	31.25	26.25
Mango seed kernel	0.00	5.00	10.00	15.00
Soybean cake	30.00	30.00	30.00	30.00
Fishmeal	5.00	5.00	5.00	5.00
Wheat offal	10.00	10.00	10.00	10.00
Palm kernel cake	3.00	5.00	5.00	5.00
Bona meal	5.00	5.00	5.00	5.00
Limestone	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vit/min. Premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100

***Premix composition (per kg of diet): vitamin A, 12,500 IU; vitamin D3, 2500 IU; vitamin E, 50. 00mg; vitamin K3, 2.50mg; vitamin B1, 3.00mg; vitamin B2, 6.00mg; vitamin B6, 6.00mg; niacin, 40mg; calcium pantothenate, 10mg; biotin, 0.08mg; vitamin B12, 0.25mg; folic acid, 1.00mg; chlorine chloride,300mg; manganese, 100mg; iron, 50mg; zinc, 45mg; copper, 2.00mg; iodine, 1.55mg; cobalt, 0.25 mg; selenium, 0.10mg; antioxidant, 200mg.**

Table 2: Proximate composition of the dietary treatments

Parameter (%)	Diet 1	Diet 2	Diet 3	Diet 4
Crude protein	23.01	23.05	22.93	22.80
Crude fibre	4.08	4.50	4.73	4.95
Ether extract	3.54	3.95	4.32	4.70
Calcium	3.37	3.38	3.39	3.40
Phosphorus	1.16	1.16	1.16	1.15
Lysine	1.49	1.49	1.47	1.46
Methionine	0.65	0.64	0.63	0.62
Energy (ME Kcal/Kg)	2693.05	2706.25	2744.75	2783.25

Table 3: Proximate analysis of sundried mango seed kernel meal

Nutrient Composition	Percentage composition (%)
Moisture content	13.70
Ash content	4.03
Fibre content	5.64
Fat content	15.93
Protein content	2.10
Carbohydrate content	58.60
Total	100

Experimental animals and management

Housing and management of snails

A platform made from bamboo sticks constructed inside the snail house were used to hold the bowels which served as improvised housing unit according to treatments and replicates. The housing was roofed with zinc to prevent intrusion of rainfall as the experiments were carried out during the rainy season. Hundred and fifty (150) snails of similar sizes, twelve (12) plastic bowels and mosquito netting materials were purchased from Ochanja market, Onitsha, Anambra State. The bowels were used as alternative housing unit for the snails. The bowel was covered with mosquito netting material to avoid intrusion of insects and mites and to prevent the snails from escape. The snails were acclimatized for one week after which hundred and twenty (120) snails of similar weights were used for the experiment. Care was taken during transportation and handling of snails to avoid cracking or breaking of the shells. The snails were fed *ad-libitum* once a day during the evening hours between 4.00-5.00pm local time. The feed was served with a feed saucer which was thoroughly cleaned daily and the soil subsequently watered.

Collection and treatment of soil substrate

Humus soil was collected from the garden of Crop Science farm at the depth of 3cmand was sterilized by heating to kill soil micro-organisms and insects which might pose a threat to the performance and development of the snails. The top soil was removed weekly to prevent the soil from sticking together which is caused mostly by their slime, while the remaining soil is being tilled and moistened with water.

Identification of snails

The snails were marked with a permanent marker from 1-120 for easy identification and were randomly placed inside the bowl. The bowls were marked to identify the treatments and replicates.

Proximate analysis

The proximate analysis of the experimental diets and the mango seed kernel meal was carried out using the method of A.O.A.C (2000) and the following parameters were determined: moisture content, carbohydrate, crude protein, crude fiber, fat content, ash content, ether extract, calcium, phosphorus, lysine and methionine.

Experimental design

The study was a CRD with 4 treatments *consisting of 0%* mango seed kernel meal, 5% mango seed kernel meal, 10% mango seed kernel meal and 15% mango seed kernel meal; representing *Diet 1, Diet 2, Diet 3 and Diet 4 respectively.* Each treatment was replicated 3 times in a completely randomized experimental design. Diet 1 served as the control. After one week acclimatization, 120 snails were randomly assigned to twelve (12) bowels according to the level of mango seed meal inclusion *Diet 1, Diet 2, Diet 3 and Diet 4.* Ten (10) snails were placed into each bowel with dimensions 15cm depth and a diameter of 56cm in a circular pattern filled with sterilized humus soil. The experimental model is as follows:

$Y_{ij} = U + T_i + e_{ij}$

Where Y_{ij}= individual observation on the snail characteristics.

μ = overall mean
T_i = treatment effect
e_{ij} = random error assumed to be independently, identically and normally distributed with zero means and constant variances.

Data collection and evaluation

Initial weights, Shell length, Shell aperture, Spire length, Shell circumference**,** Shell thickness of the snails were measured on arrival to the experimental site. Subsequently, all growth performance parameter were taken at weekly interval throughout the study. All weights were measured using a sensitive electronic weighing scale. The weight gain was determined by the difference between the initial and final weight. The weekly weight gain was determined by dividing the weight gain with the experimental seven weeks. Daily feed intake was measured and recorded. The feed intake was determined by the difference between the feed given and the leftover. The feed conversion ratio (FCR) was calculated by dividing the average quantity of feed consumed by the average weight gain. The shell length, shell width, shell aperture circumference and shell thickness were determined as follows: shell length of the snail was measured from the apex to the tip of the aperture using a venire caliper. Shell width was measured with a venire caliper. Shell aperture circumference was measured with a twine round the aperture and then stretched on a meter rule. Shell thickness was measured using a micrometer screw gauge on the open side of the shell around the aperture. The increase in shell length, width, and aperture circumference and shell thickness were determined by difference between the initial and final measurement obtained, respectively.

Data analysis

Data collected on different parameters were subjected to analysis of variance *(*ANOVA) in accordance with the methods of Steel and Torrie (1980). Significant means were separated using Post Hoc Test according to Duncan's Multiple Range Test (Duncan, 1955).

Results and discussion

Growth performance of ***Achatina fulica*** snails fed varying levels of sundried mango seed kernel meal is presented in Table 4. There were significant differences ($P<0.05$) in the final weight, weight gain, daily weight gain, feed intake and feed conversion ratio among the dietary treatments. Diet 1 had the least daily weight gain (0.26g), while Diet 3 had the highest daily weight gain (0.42g). The daily feed intake reduced from 0.64g in Diet 1 to 0.45g in Diet 4. The feed conversion ratio also reduced from 2.46 in Diet 1 to 1.07 in Diet 3. It was observed that the daily feed intake reduced as the levels of sundried mango seed kernel meal increased, while the daily weight gain increased as the level of sundried mango seed kernel meal increased. From these observations, the increase on the test diet increased the weight gain of the snails and reduced the feed consumption. Snails fed mango seed kernel meal performed better than the control. The feed conversion ratios also confirm that snails fed the experimental diets perform better than the control. The test ingredient reduced the feed conversion ratio across the treatments. It has been proved that treatment having a lower feed conversion ratio compared to the control is better. The ability of the snail to utilize the test ingredient might be due to the high carbohydrate content of the mango seed kernel meal. This might also be due to the ability of snails to possess varieties of digestive enzymes, making it possible to tolerate and digest substances that contain high anti-nutritive factors. From the results obtained it shows that snails fed with mango seed kernel meal performed better than the control. This means that there was a better

conversion of feed to edible meat on Diet 2, Diet 3 and Diet 4 than the control. This observation agreed with the findings of Odunsi (2005) who reported that mango seed kernel meal can be used successfully to replace maize up to **10**% in poultry diets without affecting the feed consumption and weight gain of the birds negatively.

Table 4: Growth performance of *Achatina fulica* snails fed varying levels of sundried mango seed kernel meal

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	SEM
Final weight (g)	61.40^{c}	66.40^{b}	70.40^{a}	67.47^{ab}	1.87
Initial weight (g)	47.08	47.10	47.05	47.20	2.17
Weight gain (g)	14.32^{c}	19.30^{b}	23.35^{a}	20.27^{b}	0.49
Daily weight gain (g)	0.26^{c}	0.34^{b}	0.42^{a}	0.36^{b}	0.07
Daily feed intake (g)	0.64^{a}	0.62^{a}	0.45^{b}	0.45^{b}	0.35
FCR*	2.46^{a}	1.82^{b}	1.07^{b}	1.25^{b}	0.20

^{abc}: means with different superscripts along rows are significant (P<0.05). *FCR= Feed conversion ratio. SEM= standard error of mean

The linear body measurements of *Achatina fulica* snails fed varying levels of sundried mango seed kernel meal is presented in Table 5. Significant differences (P<0.05) were observed on the final shell length (8.81cm – 9.90cm), shell length increase (0.80cm – 1.81cm), final shell aperture circumference (6.35cm – 7.98cm), shell aperture circumference increase (1.31cm – 2.97cm) and shell thickness (0.84cm – 1.57cm) compared to the control. This means that sundried mango seed kernel meal increased shell length, shell aperture circumference and shell thickness of *Achatina fulica* snails. This result showed that snails fed sundried mango seed kernel meal had better growth performances than the control. The test ingredient enhanced the growths of the shell. The ash, calcium and phosphorus content of the test ingredient and that of the experimental diets might have contributed to the growth and developments of these parameters. The significant increase on these parameters when compared to the control might have also resulted from the increase in growth of the internal mass of the snails. This supports the findings that African Giant Land snails eat to increase the shell length so as to make room for the growth of the internal mass (Hodasi 1986; Awesu, 1988; Imevbore *et al.*, l993). This means that mango seed kernel meal can be used to replace maize up to 15% inclusion with respect to the shell growth and developments of *Archachatina fulica* snails.

Table 5: Linear body measurement of *Achatina fulica* snails fed varying levels of sundried mango seed kernel meal

Parameters (cm)	Diet 1	Diet 2	Diet 3	Diet 4	SEM
Final shell length	8.81^{c}	9.04^{b}	9.90^{a}	9.25^{b}	0.23
Initial shell length	8.01	8.07	8.09	8.03	0.19
Shell length increase	0.80^{c}	0.97^{b}	$1.8l^{a}$	1.22^{b}	0.09
Final SAC*	6.35^{b}	6.89^{b}	7.98^{a}	6.99^{b}	**0.29**
Initial SAC*	5.04	5.02	5.01	5.04	0.22
SAC increase	1.31^{c}	1.87^{b}	2.97^{a}	1.95^{b}	0.39
Final shell width	**6.86**	6.82	6.97	6.90	0.12
Initial shell width	5.00	5.01	5.02	5.01	0.18
Shell width increase	1.86	1.81	1.95	1.89	0.24
Shell thickness	0.84^{c}	1.32^{ab}	1.10^{b}	1.57^{a}	0.16

^{abc}: means with different superscripts along rows are significant (P<0.05). *SAC= shell aperture circumference. SEM= standard error of mean

Conclusion and recommendation

From the result of this study, it could be concluded that sundried mango seed kernel meal enhanced the growth performance of *Archachatina fulica* snails. Sundried Mango seed kernel could be incorporated up to 15% in the diets of *Archachatina fulica* snails as replacement for maize without any adverse effect on the performance. Therefore, the use of mango seed kernel meal as feed ingredient for snails will assist in the recycling of mango seed waste in our environment and reduce the overdependence on conventional feed resources for animal ration formulation.

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