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Original article

Growth performances of giant African land snail (*Achatina achatina*) fed by formulated diet with different energy level

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A B S T R A C T

In order to assess the effect of energy level on the growth performances of giant African land snails (*Achatina achatina*), a study was conducted between September 2015 and January 2017 at the snailery of the University of Buea-Cameroon. 90 young snails of one month old, weighing between 1 and 1.5 g, of shell length between 15.5-23.85 mm and shell diameter between 12.60-16.85 mm and free from wounds or shell defects were divided into 3 groups of 5 snails each and 6 replicates in cages equipped with feeders and drinking troughs. Each treatment was randomly assigned one of the experimental feed with variable energy levels (2600, 2800 and 3000 kcal/kg) in addition to pawpaw leaves as a staple feed. These were previously weighed as well as the remnants using a 0.5 g precision scale. The cultured substrates were watered daily (0.50 liter/substrate). At the beginning of the test, and then every week, the snails were weighed, and shell measurements done using a digital caliper of 0.05 mm accuracy. The animals were monitored for fourteen months. The results show that feed intake (3.01 ± 1.57), weight gain (25.55 ± 8.43), daily weight gain (0.065 ± 0.019), gain of shell length (29.66 ± 6.07) and shell diameter (21.58 ± 4.38) were significantly higher ($P<0.05$) in snails receiving 2600 kcal/kg of energy compared to snails from the other treatments. The highest consumption index was recorded in snails receiving

3000 kcal/kg of energy in the diet, but the statistical analyses did not find any significant difference. In conclusion, the energy level of 2600 kcal/kg can be retained in the diet of growing snails.

1. Introduction

Snail is one of the mini livestock with great potential. It is a wild animal that lives under debris and shed plant leaves in different agricultural farms, especially during the rainy season in different parts of the tropics (Adeyemo and Borire, 2002). The flesh is a delicacy for many people both in the rural and urban zones of Cameroon and other African countries. It is a major source of proteins to people in the rural communities where the majority cannot afford the cost of livestock meat (Fagbuaro et al., 2006). Snail flesh has a special taste and aroma. It is very rich in iron, calcium and phosphorus; low in fat and cholesterol (Afolayan, 1980); high in quality protein, as it contains all the essential amino acid profile compared favorably to those of broilers, fish and pork (Alabi et al., 2015). This makes its consumption beneficial and safe to the consumers. Apart from serving as a source of food, snail flesh is very important in traditional medicine. In Africa, it is mixed with other ingredients to make concoctions for the treatment of many local ailments and diseases (Fagbuaro et al., 2006).

However, the main source of snails in Africa remains the collection in the wild (Adegbaju, 2000; Kouassi et al., 2007). The demand for snail flesh has also increased tremendously over the years such that at present demand outstrips supply (Ebenso, 2003; Murphy, 2001; Paoletti, 2005). The increase in population and growing enthusiasm for meat consumption is being hampered by a significant reduction in the threatened natural stocks due to the high collection pressure, man’s activities such as deforestation, pesticide use, slash and burning for agricultural purposes and more intensive snail hunting (Raut and Barker, 2002).

As a result of the economic opportunities offered by snail farming and marketing, there is a resurgence of interest in intensive culturing of edible land snails for domestic and foreign markets (Cobbinah et al., 2008; Moyin-Jesu and Ajao, 2008; Raut and Barker, 2002). A breeding operation should supply the needs in animal proteins, and provide financial incomes for the population. One of the important elements in livestock farming is nutrition, which ensures good growth, optimal breeding and reduces mortality. The general objective of the study was to contribute to the preservation and valorization of giant African land snails and more specifically to determine the effects of the energy level on the characteristics of the growth.

2. Materials and methods

2.1. Period and study area

This study was carried out between September 2015 and January 2017 at the University of Buea (South-West Region, Cameroon), located in a humid forest zone with monomodal rainfall (LN 4^{o} 12,773 '- 4^{o} 4, 25' and LE 009^{o} 19, 425'-9^{o} 9, 20 '), at an average altitude of 400 m. The average annual temperature is 20 to 29°C and the relative humidity is between 85 and 95%. The average annual rainfall is 2000 to 4000 mm with a rainy season (March-November) and a dry season (November-March). The photoperiod was 12 hours of light and 12 hours of darkness.

2.2. Animals

Snailets of one-month-old born from breeding animals derived from the snailery, weighing between 1 and 1.5g, of length and shell diameter respectively between 15.5-23.85 mm and 12.60-16.85 mm, free of injury or breakage were used. These are Pulmonate gastropod molluscs. They belong to the order Stylommatophores, Super family of the Achatinideae, the family of the Achatinidae, Genus Achatina and the species *Achatina achatina.*

2.3. Housing

The animals were housed in plastic containers of 30 cm in diameter and 20 cm in height. The bottom of which was covered with 5 cm thick loose soil substrate previously disinfected with virunet (0.5 g/l/substrate) and then covered with wire mesh forming a leakage prevention device and placed in a building constructed in a block, covered with metal sheets.

2.4. Experimental diets

Table 2 below shows the experimental diets used in this study.

Table 1
Bromatological compositions and characteristics of experimental diet.

	Energy level		
Ingredients	**E_1**	**E_2**	**E_3**
Corn flour	20.10	21.9	22.20
Cassava flour	18.6	22.05	20.00
Soybean cake	2.3	4.20	5.00
Groundnut cake	37.50	38.50	38.50
Palm kernel cake	13.90	4.80	3.00
Fish flour	2.00	2.05	2.00
Shell	1.42	1.42	1.42
Bone meal	2.83	2.83	2.83
Palm oil	1.10	2.00	4.80
Vitamin premix 2%	0.25	0.25	0.25
Total (kg)	100.00	100.00	100.00
Calculated bromatological characteristics (g/MS)			
Crude protein	24.00	24.00	24.00
Metabolizable energy (kcal/kg)	2600.36	2800.18	3000.85
Fat	7.07	8.06	10.75
Calcium	1.85	1.84	1.83
Phosphorus	0.91	0.88	0.86
Lysin	0.96	0.98	0.99
Methionine	0.32	0.31	0.31

2.5. Experimentation and data collection

Snailets (*Archatinaachatina*) aged 1 month were divided into 3 groups of 5 snails and 6 replicates in cages equipped with feeding and drinking troughs. At each treatment, one of the randomly selected experimental diets was assigned in addition to the pawpaw leaves as a staple feed. These were previously weighed as well as the remnant using a 0.5 g precision scale. The same quantity of forage placed under the same experimental conditions without animals made it possible to make the corrections of weight due to the desiccation of the plant material. The cultured substrates were watered daily (0.50 liters/substrate) in order to maintain a constant relative humidity (85-95%). They were regularly cleared of dead animals and faeces to avoid the development of possible pathogens. The dead animals were inventoried by treatment and replaced by those of similar age and weight. At the beginning of the test, and then every week, the snails were weighed and shell measurements made using a 0.05 mm precision digital caliper. Animals were monitored for fourteen months.

2.6. Data presentation

The growth performance of snails in relation to the level of protein in the diet was estimated from the weight gain, daily average weight gain (g/j), length and shell diameter gains calculated according to the following formulae:

Food Consumption (FC)
(FC = Amount of feed distributed - Remnant)
Weight Gain (WG)
(WG = Final weight - Initial weight)

Average Daily Gain (ADG)
(ADG = Weight gain / Duration of experiment)
Consumption Index (CI)
(CI = Food consumption / Body weight gain)
Shell Length Gain (SLG)
(SLG = Final length - Initial length)
Shell Diameter Gain (SDG)
(SDG = Final diameter - Initial diameter length)
Survival Rate (SR)
(SR (%) = (Ne – Nm) x 100 / Ne)
Ne = Total number of snails
Nm = Number of dead snails

3. Results and discussion

3.1. Effects of energy level on the characteristics of growth of *Achatina achatina*

The effects of the energy level on the growth characteristics are summarized in Table 2 and illustrated in figures 1 to 5. Body weight gain and average daily weight gain were significantly higher ($P<0.05$) in snails receiving 2600 kcal/kg of energy in the diet compared to those receiving 3000 kcal/kg. Negative and strong correlations ($P<0.01$) were found between weight gain and normal body weight (r^2 = -0.418), weight gain and shell length (r^2 = -0.370), weight gain and the shell diameter (r^2 = -0.325).

The lowest consumption index was obtained in animals receiving 2800 kcal/kg of energy, but statistical analysis revealed no significant difference ($P>0.05$). The highest shell length gain was found in snails receiving 2600 kcal/kg of energy in the diet, though it was not statistically different ($P>0.05$). Significantly higher shell diameter gain ($P<0.05$) was obtained in snails receiving 2600 kcal/kg of energy in the diet, compared to those receiving 2800 and 3000 kcal/kg of energy in the diet.

Table 2
Effects of energy level on the growth characteristics of snails.

	Energy level (kcal/kg)		
Characteristics	**2600 (n=30)**	**2800 (n=30)**	**3000 (n=30)**
Weight gain	25.55 ± 8.43^{b}	24.03 ± 6.51^{ab}	23.30 ± 7.09^{a}
Average daily weight gain	0.065 ± 0.019^{b}	0.060 ± 0.017^{ab}	0.059 ± 0.016^{a}
Consumption index	9.93 ± 26.99^{a}	7.80 ± 38.13^{a}	10.78 ± 40.24^{a}
Shell length gain	29.66 ± 6.07^{a}	29.16 ± 4.57^{a}	27.90 ± 5.64^{a}
Shell diameter gain	21.58 ± 4.38^{b}	19.63 ± 2.89^{a}	18.63 ± 2.67^{a}

(a.b): On the same line, the values assigned to the same letter do not differ significantly ($P>0.05$); n = number of snails.

3.2. Effects of energy level on the consumption of pawpaw leaves in snails

Fig. 1 shows the evolution of the consumption of pawpaw leaves with respect to energy level in the diet. Irrespective of the experimental period, the consumption of pawpaw leaves increased irregularly from the beginning until the end of the test whatever the treatment. Considering the periods, during the twelfth and thirteenth periods of the test, it decreased in snails receiving 2600 and 3000 kcal/kg of energy in the diet compared to those receiving 2800 kcal/kg of energy. A positive and strong correlation ($P<0.01$) was found between the energy level and the consumption of pawpaw leaves (r^2 = 0.079). At the end of the trial, leaf consumption was significantly lower ($P<0.05$) in animals receiving 3000 kcal/kg of energy in the diet compared to other treatments.

3.3. Effects of energy level on food consumption in snails

The evolution of food consumption with respect to energy level is illustrated in Fig. 2. It emerges that, irrespective of the test period, the consumption of food increased irregularly in all treatments. Considering periods, during the fourteenth period of the test, food consumption decreased in animals receiving 2600 kcal/kg in the diet but remained high in other treatments. A positive and strong correlation was found between the consumption of food and the consumption of pawpaw leaves (r^2 = 0.328). At the end of the test, the highest food consumption was recorded in snails receiving 3000 kcal/kg of energy in the diet compared to other treatments, but the statistical analysis revealed no significant differences (P>0.05).

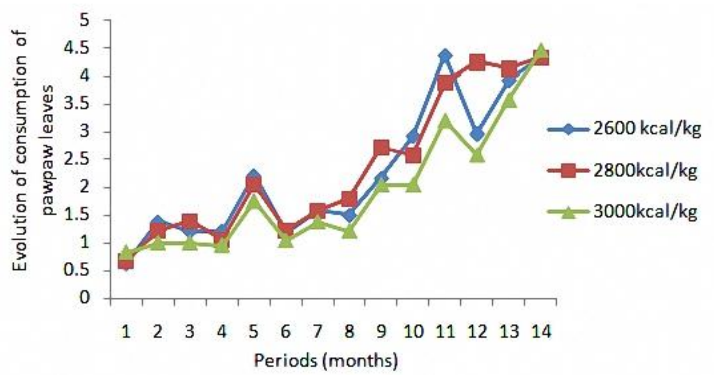

Fig. 1. Effects of the energy level on the monthly consumption of pawpaw leaves.

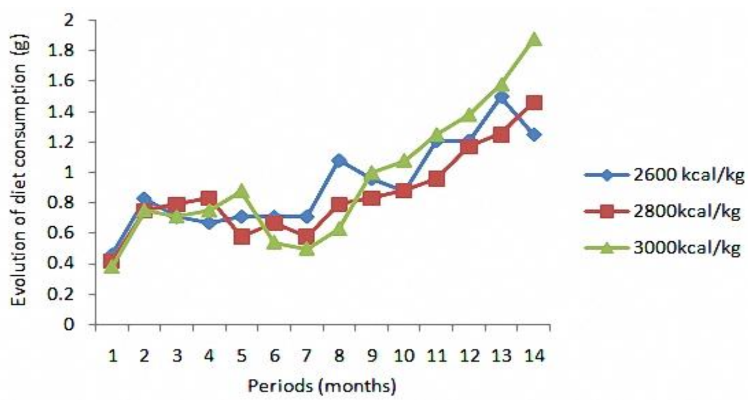

Fig. 2. Effects of energy level on the monthly diet intake.

3.4. Effects of energy level on the evolution of body weight of snails

Fig. 3 illustrates the evolution of body weight with respect to energy level in the diet. It can be seen that the body weight increased regularly from beginning to end of the test whatever the treatment. This increase was significantly higher (P<0.05) in snails receiving 2600 kcal/kg of energy in the diet (Table 1) compared to those receiving 3000 kcal/kg. A positive and strong correlation (P<0.01) was found between energy level and weight (r^2 = 0.039), food consumption and weight (r^2 = 0.235), consumption of pawpaw leaves and the weight (r^2 = 0.457).

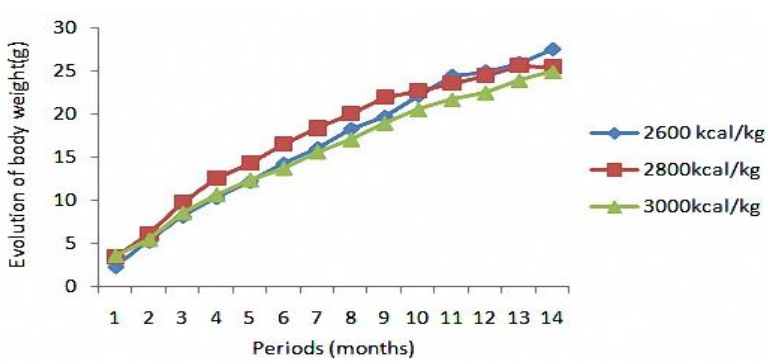

Fig. 3. Effects of the energy level on the evolution of body weight of snails.

3.5. Effects of energy level on the evolution of shell length in *Achatina achatina*

It can be seen from Fig. 4 that the shell length increased regularly regardless of the treatments. A positive and strong correlation (P<0.01) was established between weight and shell length (r^2 = 0.952). At the end of the test, the significantly higher shell lengths (P<0.05) were recorded in snails receiving 2800 kcal/kg of energy in the diet compared to those of other treatments.

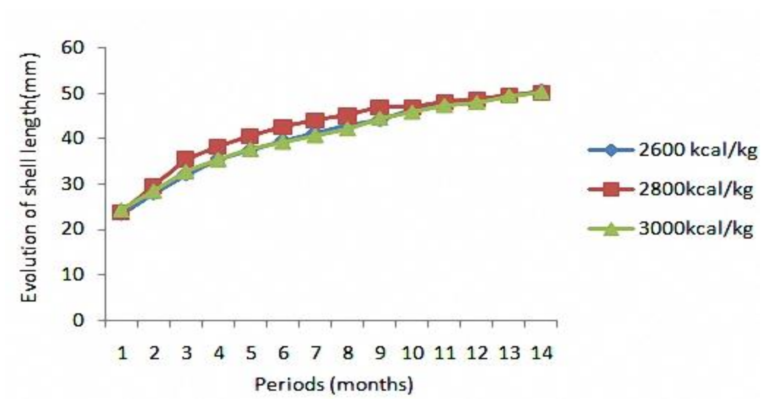

Fig. 4. Effects of the energy level on the shell length of snails.

3.6. Effects of the energy level on the evolution of the shell diameter in *Achatina achatina*

Fig. 5 illustrates the evolution of the shell diameter with respect to energy level in the snail diet. It was noticed that the diameter of the shell increased regularly whatever the treatment. At the end of the test, the shell diameter was significantly higher (P<0.05) in animals receiving 2800 kcal/kg of energy in the diet compared to those of other treatments. A positive and strong correlation (P<0.01) was found between weight and shell diameter (r^2 = 0.860).

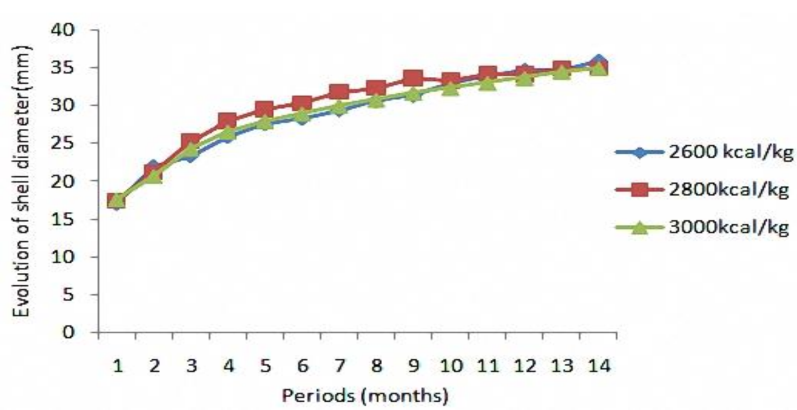

Fig. 5. Effects of energy level on the monthly evolution of shell diameter.

The results of the study on the effect of the energy level on the growth performances of snails showed that: the consumption of the pawpaw leaves was significantly lower (p<0.05) in animals receiving 3000 kcal/kg of energy in the diet. This would be justified by the high consumption of diet in this treatment.

The snails would have received the necessary energy from the diet, the consequence of which is the reduction in the consumption of the pawpaw leaves. Indeed, (Fantino, 2011) revealed that the consumption of feed rich in lipids and proteins causes the secretion of substances (cholecystokinin) which stimulate the contraction of pancreatic enzymes and slow gastric evacuation in the stomach of animals. The consumption of food by snails in this treatment would reduce the consumption of pawpaw leaves by an action on the brainstem and the hypothalamus mediated by the vagus nerve. Similar results were obtained by (Aumaitre et al., 1964), who evaluated the effect of energy and protein ration rates on feed efficiency and growth in piglets and demonstrated that low-energy diets provoked greater ingestion of proteins.

The results also revealed an increase in food consumption in animals receiving 3000 kcal/kg of energy. Our results corroborate those of (Levasseur et al., 1998), who evaluated the influence of the energy source and the energy concentration of the feed on feeding behavior, zootechnical performances and carcass qualities of pork and showed that food consumption increased with respect to energy concentration. However, they are different from those of (Ani et al., 2013) who worked on the effect of the protein and energy level on the growth performances of *Achatina achatina* and observed that food consumption decreases with increase in energy level. Indeed, high consumption of food in this treatment could be linked to palatability.

The results of the study also revealed that significantly lower weight, weight gain, gain in length and shell diameter were recorded in animals receiving 3000 kcal/kg of energy in the diet. This would be related to the low consumption of pawpaw leaves in this treatment. Increased consumption of food in this treatment would limit the consumption of pawpaw leaves. In both natural and captive environments, growing snails consume more tender, water-rich plants (Otchoumou et al., 2004). This hypothesis was supported by the work done by (Adeola et al., 2010), studying the effect of concentrate and vegetables on protein composition and the sensory properties of African giant snails and noted that snails are vegetarian and consume more foods that are tender and rich in water for hydration.

4. Conclusion

At the end of the study on the effect of energy level on the growth performance of *Achatina achatina*, we can conclude that the diet containing 2600 kcal/kg of energy served for 56 weeks improved food consumption, weight gain, average daily weight gain, length and shell diameter in snails. Thus, the energy level of 2600 kcal/kg can be retained in the feeding of growing snails.

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