Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 12, Issue, 04, pp.11647-11652, April, 2021

RESEARCH ARTICLE

EFFECTS OF THE FORMS OF PRESENTATION OF THE CONCENTRATED FEED ON THE DIGESTIBILITY AND THE GROWTH OF *ACHATINA ACHATINA* (LINNÉ, 1758) IN ABOVE-GROUND FARMING (CÔTE D'IVOIRE)

KOUATO[1,*] Fulgence, KOUAKOU[1] Fokouo Kessia Irène, AMANI[1] N'dri Saint-Clair, OTCHOUMOU[2] Atcho

[1]Unité de formation et de Recherche des Sciences Biologiques, Département de Biologie Animale, Université Péléforo Gon Coulibaly de Korhogo BP 1328 Korhogo, Côte d'Ivoire
[2]Unité de formation et de Recherche des Sciences de la Nature, Université Nangui Abrogoua, Laboratoire de Biologie et Cytologie Animale, 02 BP 801 Abidjan 02, Côte d'Ivoire

ARTICLE INFO

Article History:
Received 14th January, 2021
Received in revised form
20th February, 2021
Accepted 19th March, 2021
Published online 26th April, 2021

Key words:
Achatina Achatina,
Growth, Digestibility, Food Form.

ABSTRACT

The study of the effects of the presentation forms of the concentrated food on the digestibility and growth of *Achatina Achatina* (Linné, 1758) was carried out from November 2008 to May 2009 at the experimental farm of the Nangui Abrogoua University in Côted'Ivoire. 4 forms of presentation of the concentrated feed (granulated, platelet, crushed and flour) were tested on the apparent digestibility and growth performance of *A. Achatina*. This study found that concentrated food presentation forms influence food intake, food waste and weight growth. The granulated and platelet forms of the concentrated feed were consumed better (0.64 g/d/g of snail and 0.58 g/d/g of snail) and wasted less (0.12 g/d/g of snail and 0.17 g/d/g of snail) than the crushed and flour forms (0.48 g/d/g of snail and 0.43 g/d/g of snail for consumption food; 0.32 g/d/g of snail and 0.41 g/d/g of snail for food waste).The forms that induce better weight growth in decreasing order are: granulated (0.43 g/d), platelets (0.4 g/d), crushed (0.31g/d) and flour (0.28 g/d) j). However, the study did not reveal any influence of the form of presentation of the concentrated feed on shell growth and apparent digestibility in dry matter. Gains of 61 days, 45 days and 14 days of breeding were obtained respectively with the granulated, platelet and crushed form compared to the flour. The granulated and platelet forms are best suited for anyone who would like to engage in breeding this species on a concentrated feed.

Citation: ***KOUATO, Fulgence, KOUAKOU1 Fokouo Kessia Irène, AMANI N'dri Saint-Clair, OTCHOUMOU Atcho,*** **2021.** "Effects of the forms of presentation of the concentrated feed on the digestibility and the growth of *achatina achatina* (linné, 1758) in above-ground farming (côte d'ivoire)", *Asian Journal of Science and Technology*, 12, (04), 11647-11652.

INTRODUCTION

Raising giant African snails is one of the solutions to the protein deficit in the diet of African populations. The control of this breeding is subordinated to that of a concentrated feed which guarantees the biological performances of the animal. Does the form of presentation of this food have an impact on the zootechnical parameters? For about thirty years, research work has been carried out with a view to developing an ideal feed that can guarantee the success and economic profitability of purchasing. It is in this context that the inventory and palatability of forages consumed by snails were carried out through several trials (Cobbinah & Osei-Nkrumah, 1988; Otchoumou *et al*., 1989-1990; 2003a; 2003b; 2004a; 2004b; 2005; Otchoumou *et al*., 2005).

Corresponding author:** ***KOUATO,
Unité de formation et de Recherche des Sciences Biologiques, Département de Biologie Animale, Université Péléforo Gon Coulibaly de Korhogo BP 1328 Korhogo, Côte d'Ivoire.

Considering the unsatisfactory results of the diet based on green fodder, it appeared necessary to direct research towards a concentrated diet which could be able to improve growth but also and above all to reduce the age of sexual maturity: thus shortening the cycle of development and reproduction of purchasing (Otchoumou *et al*., 2003a; 2003b). So different authors have proposed concentrated foods in the form of flour (Daguzan, 1985; Zongo *et al*., 1990; Ategbo & Zongo, 2000; Codjia & Noumonvi, 2002; Otchoumou, 2005). The flour form of the concentrated feed is very wasteful. In fact, by crawling in turn in the flour and on a wet litter, the cornflowers cause severe food losses (Daouda, 1995). In addition, the forms of presentation of the feed have a definite influence on feed intake, the rate of wastage and therefore on the zootechnical performance of the animals. Studies on the form of presentation of the concentrated feed of snails have so far not been carried out to our knowledge, unlike pigs, poultry and rabbits.

This is why the general objective of this work is essentially the development of a high quality concentrated feed and the mastery of the form of presentation of this feed at *Achatina Achatina* in breeding. This work aims, in the long term, to offer breeders of giant snails a form of presentation of concentrated feed capable of guaranteeing good growth in snails.

MATERIAL AND METHODS

Experimental framework: The study took place in the Achatiniculture Center of the experimental farm of the Nangui Abrogoua University, located in the district of Abidjan, in Côte d'Ivoire. It was carried out in the period from November 2008 to May 2009. It is a rectangular building 8.6 m long by 7.7 m wide. Made up of a single room, this building is made up of four low walls with four rows of trellises on each length. Its roof with an opening in its upper part and the trellises ensure good ventilation of the breeding room. Inside the building, are arranged along the walls and 1m from the ground, two rows of superimposed shelves on which are arranged the breeding enclosures. The relatively average temperature and humidity in the breeding room are 26 ± 1.6 °C and 89.2 ± 1.8%, respectively. The photoperiod averages 12 hours of light and 12 hours of darkness.

Enclosures and breeding substrate: The breeding enclosures are polystyrene tanks with a square base, 50 cm per side with a height of 12.5 cm, or a base area of 0.25 m^2 for a volume of 0.038 m^3. These bins are perforated at the base to allow irrigation water to flow. They are fitted with mosquito-type covers constituting the anti-leakage device and allowing the animals to be ventilated. The bins are placed at random on shelves 1m from the ground. The interior of the breeding tank is covered with a 4 cm thick litter, made of previously heated soil, to eliminate insects and their eggs that can attack snails.

Animals: The snails used in this study belong to a single species: *Achatina Achatina* (Linnaeus, 1758). They were bought on the "Gouro" market in the municipality of Adjamé and come from collections carried out in the forests of the southwest (Soubré) of Côte d'Ivoire. Their age is estimated at 10 months using a shell and weight growth curve of *A. Achatina* Hodasi (1979; 1984).

Food: The feed consists essentially of concentrated feed. This diet was designed on the basis of the work of Conan *etal*. (1989) and Otchoumou (2005). The calculated constituents and characteristics are shown in Table I. This diet is presented to the animals in the form of fine flour, crushed grains, platelets and granules

METHODS

Preparation of concentrated food shapes: The concentrated feed is made from a mixture of cereals (corn, soybeans, wheat), cottonseed meal, and commercial products (dicalcium phosphate, calcium carbonate, trace elements, salt, vitamin). The cereals are ground and then sieved; which makes it possible to obtain two forms of cereals: flour and crushed. The flour forms of cereals and cottonseed meal obtained are mixed with the other constituent products of the concentrated feed at rates chosen on the basis of the work of Conan *et al*. (1989) and Otchoumou *et al*. (2005) (Figure 1A). Here the grains of the cereals have a size less than or equal to 1 mm. The concentrated feed in platelet form is obtained with the concentrated feed flour. This food is hydrated at the rate of 10 cm^3 of water/kg of food. After mixing, the food is spread to a thickness of 0.3 cm on a flat, smooth board. The plates are then cut using a stainless steel square knife with a side of 4 cm and then dried in an oven (Figure 1B). The granulated form is also made with the flour concentrate. This food is hydrated at the rate of 10 cm^3 of water/kg of food. It is then put in a press with a diameter of 5 mm where it emerges in the form of a granule. The food is then oven dried (Figure 1C). Regarding the crushed form, the residue from the first sieving to obtain the flour is further sieved using a sieve with a 3 mm mesh diameter. The grains of the cereals obtained have a size of from 1 mm to 3 mm. The forms obtained are mixed with the other constituent products of the concentrated feed at the same rates as in the concentrated flour feed (Figure 1D).

Breeding management: A total of 240 young-adult snails (estimated 10 months of age) were used in this study which lasted 6 months. After two weeks of acclimatization to life in captivity, the animals were evenly divided into 12 batches of 20 snails each at the rate of 3 repetitions for each form of the concentrated feed. Another batch of snails placed under the same experimental conditions made it possible to replace dead snails and maintain the starting density. The animals were reared at a density of 80 snails/m^2. They were regularly watered with a watering can and cleaned. The average ambient temperature of the barn is 25.5 ± 2.2 ° C and the relative humidity of the air is 91.7%. Regular watering of the entire room is done twice a week to create a humid microclimate conducive to snail activity.

Every two weeks, each animal in the lots is weighed individually using an EKS-branded precision 0.01 g electronic scale and the shell length is measured using a brand-name mechanical caliper. Vernier Caliper precision 1 mm. Food is weighed and served every three days. At the end of the three days, the refusals are collected and weighed. The feces are also collected every morning and weighed. A sample of the food distributed, the refusals and the faeces are put in an oven at 70 °C for 24 hours to allow the calculation of the dry matter content. Every two weeks, fecal dry matter, distributed feed and refusals are assessed. These values will then be used to calculate the food intake and the apparent digestive utilization coefficient (CUDa) of the dry matter

Expression of results: The food intake and the apparent digestibility coefficient in dry matter of the different forms of concentrated food were calculated by calculation using the following formulas:

Food intake(Ia)

$Ia\ (g/d/g\ of\ snail) = (K_1 \times AD - K_2 \times RA) / P_M$ with $K\ (\%) = (dry\ weight / fresh\ weight) \times 100$

K = percentage of dry matter
K_1= percentage of dry matter of the feed distributed
K_2 = percentage of dry matter of food refusal
AD = mass of food distributed in one day
RA= mass of food refusal in one day
P_M = Average live weight of snails

Apparent digestive utilization coefficient (CUDa) of dry matter

CUDa (MS) = (Ia-MSF) x 100 / N
MS= dry matter
Ia = food intake
MSF (g/d/g of snail) = fecal dry matter
N = number of snails

The weight and shell growth, the number of days of rearing and the cumulative mortality rate are calculated according to the following formulas:

Weight growth (Cp)

C_P *(g/d) =* (P_2-P_1) */ D*with P_1= initial average weight; P_2= final average weightand D= duration in days

Shell growth (Cc)

Cc (cm/d) = (L_2-L_1) */ D*with L_1=average initial shell length and L_2=average final shell length

Number of days of breeding (N_D)

N_D *= (gain de poids) /* C_P

Cumulative mortality rate (T_M)

T_M *(%) = (EF x 100) / (EI)* with EF= number of dead snails and EI=initial number of snails

Statistical analyzes: Average values for live weight, shell length, body weight growth, shell growth, and apparent digestive utilization coefficient in dry matter were analyzed statistically. The STATISTICA version 6.0 programs (Leroy and Farnir, 2000) and Microsoft Excel 2003 were used to perform the various statistical processing. Means were compared by analysis of variance according to Turkey's honest meaning difference (HSD) test. The results are presented as the mean plus standard deviation.

RESULTS

Food ingestion: The comparison of dietary intakes by analysis of variances with the Turkey test ($P < 0.05$), shows that there is a significant difference between the mean dietary intake values (Table 2). Purchases fed with granulated feed (0.64 ± 0.05 g/d/g of snail) and platelets (0.58 ± 0.1 g/d/g of snail) had a significantly higher consumption to snails fed in the crushed form (0.48 ± 0.15 g/d/g of snail) and with flour (0.43 ± 0.16 g/d/g of snail).

Food refusals: The comparison of food refusals by the analysis of variances in the Turkey test ($P < 0.05$) indicates that the flour (0.41 ± 0.10 g/d/g of snail) and crushed (0.32 ± 0.13 g/d/g of snail) have a greater amount of refusal compared to platelets (0.17 ± 0.10 g/d/g of snail) and granules (0.12 ± 0.15 g/d/g of snail) throughout the period of the experiment (Table 2).

Apparent digestive utilization coefficient: Statistical analysis indicates that there is no significant difference ($p < 0.05$) between the coefficients of apparent digestive uses in dry matter of the lots fed with flour feed (87.5% ± 1.27), crushed (87.33% ± 1.19), platelets (88.74% ± 1.24) and granulated (88.46% ± 0.78), (Table 2).

Weight and shell growth

Weight growth : Snails subjected to the various forms of concentrated feed had an initial average live weight of 39.43g for the granulated feed; 39.42g for the wafer food; 39.53g for the crushed food; 39.41g for the flour food. These animals acquired a final mean live weight of 117 g; 109g; 95.71g and 91.03g. The average weight growths of snails fed in the granulated (0.43 g/d) and platelet (0.4 g/d) form are better than the crushed (0.31 g/d) and flour (0.28 g) forms (Table 3). Analysis of the weight growth curves over time shows that they look the same. Two phases are distinguished (figure 2). From the start of the experiment to the 4th week, the weight increases are strong and characterized by a strong slope. From this period (4th week) the weight growth becomes relatively average for animals subjected to different forms of concentrated feed. However, since the 2nd week, the initially confused curves stand out progressively with higher weight growth values for animals fed on pellets and platelets and low for those fed on crushed foods and flour. Animals fed the concentrated feed in the granulated and wafer form give the best weight performance at *Achatina Achatina*.

The comparison of the weight growth by the analysis of variances with the HSD test of Turkey ($p < 0.05$), does not indicate any weight difference between the different batches of snails from the start of fattening up to the 8th week. On the other hand, from the 10th week of the experiment, the weight of the snails fed with flour (73.95 ± 20.16g) becomes significantly lower ($P < 0.05$) than those fed with pellets (83.73 ± 16.90g). At the 12th week of the experiment, the weight of the snails fed with pellets (87.78 ± 16.96g) became significantly higher ($P < 0.05$) than those fed in the crushed form (77.84 ± 19.74g) and this until the end of the experiments. The tests reveal a significant difference from the 14th week between the weight of the batches fed with platelets (88.18 ± 14.01g) and those fed with flour (78.36 ± 15.71g).At the 20th week, the batches fed with platelets (99.19 ± 14.39g) become significantly superior to those fed with the crushed form (89.27 ± 23.94g) and this until the end of the experiment. At the end of the experiment, the animals fed the platelets and granules weighed significantly more than those fed the flour (91.03 g) and the crushed form (95.71 g).The flour, crushed, platelet and granulated form of the concentrated feed respectively induced a total weight gain of 51.62g; 56.18; 69.6 and 78.01g. The difference in weight between the snails fed with granules, platelets, crushed foods compared to flour is 26.39 g in favor of the granulated food, 17.98 g in favor of the platelet food and 4.56 g in favor crushed. These differences in weight between these food forms and flour can be estimated at 61 days, 45 days and 14 days of rearing of snails fed on flour more than those fed on granulated, platelet and crushed

Shell growth: The average shell growth rates are 0.2 cm/d for the batches subjected to the granules, 0.2 cm/d for those consuming the platelets, 0.19 cm / d for those consuming the crushed pieces and 0,16 cm/d for the flour-fed snails (Table 4). Analysis of the curves of shell growth as a function of time (Figure 3) shows that snails fed the different forms of the concentrated feed exhibit the same growth pattern.

Table 1. Constituents and characteristics calculated per 100g of dry matter

Constituents (g)									
Corn	Cottonseed cake	Soybean seeds	Soft wheat remoulding	Dicalcium phosphate	vitamins	Calcium carbonate	Salt	Trace elements	total
9.7	15.7	15.7	14.7	4	0.5	39.2	0.4	0.1	100
Characteristics (in% of dry matter)									
Gross energy cal/g	Total Nitrogenous Matter	Total Calcium	Total phosphorus	butterfat	Starch	Sugar Free	Crude Cellulose	ash	Crude protein
2727	17.14	16.1	1.19	4.61	12.24	3.04	4.67	43.35	-

Table 2. Digestibility parameters

	Food form			
Parameters	Flour	Crushed	platelet	Granulated
Food ingestion (g/d/g of snail)	0.43 ± 0.16^{b}	0.48 ± 0.15^{b}	0.58 ± 0.1^{a}	0.64 ± 0.05^{a}
Refused (g/d/g of snail)	$0.41 \pm 0{,}10^{b}$	0.32 ± 0.13^{b}	$0.17 \pm .11^{a}$	0.12 ± 0.10^{a}
CUDa(MS) (%)	87.5 ± 1.27^{a}	87.33 ± 1.19^{a}	88.74 ± 1.24^{a}	88.46 ± 0.78^{a}

Table 3. Parameters of weight growth of *Achatina Achatina* depending on the form of the concentrated feed

Variables	Food form			
	Flour	crushed	platelet	granulated
P_0	39.41 ± 0.44^{a}	39.53 ± 6.73^{a}	39.42 ± 3.8^{a}	39.43 ± 3.12^{a}
P_{10}	73.95 ± 20.1^{b}	75.55 ± 18.8^{ab}	80.31 ± 14.63^{ab}	83.73 ± 16.90^{a}
P_{12}	76.46 ± 23^{b}	77.84 ± 19.74^{b}	84.55 ± 16.8^{ab}	87.78 ± 16.9^{a}
P_{14}	78.36 ± 15.71^{b}	80.86 ± 19.06^{bc}	88.18 ± 14.01^{ac}	92.17 ± 1^{a}
P_{16}	81.09 ± 16.89^{b}	84.54 ± 17.7^{bc}	91.85 ± 14^{ac}	96.45 ± 18.8^{a}
P_{18}	82.18 ± 18.16^{b}	86.33 ± 19.3^{cb}	94 ± 19.12^{ac}	99.17 ± 18.09^{a}
P_{20}	85.19 ± 22.22^{b}	89.27 ± 23.9^{b}	99.19 ± 14.39^{a}	104 ± 19.55^{a}
P_{24}	91.03 ± 21.7^{b}	95.71 ± 23.22^{b}	109.02 ± 18.32^{a}	117.44 ± 24^{a}
Weight gain Total (g)	51.62	56.18	69.6	78.01
Cp (g/d)	0.28 ± 0.25^{b}	0.31 ± 0.24^{b}	0.4 ± 0.24^{a}	0.43 ± 0.26^{a}

NB: the mean values of the same row indexed by the same letter are not statistically different in the turkey HSD test ($P < 0.05$).
Pi = live weight at the i^{th} week. Cp = weight growth

Table 4.Parameters of shell growth and mortality of *Achatina Achatina* depending on the form of the concentrated feed

variables	Food form			
	Flour	crushed	plateletgranulated	
LC_0	6.46 ± 0.44^{a}	6.54 ± 0.46^{a}	6.54 ± 0.51^{a}	6.57 ± 0.47^{a}
LC_8	7.93 ± 0.73^{a}	8.06 ± 0.67^{a}	8.09 ± 0.64^{a}	8.09 ± 0.82^{a}
LC_{16}	8.27 ± 0.79^{a}	8.38 ± 0.8^{a}	8.42 ± 0.75^{a}	8.48 ± 0.79^{a}
LC_{24}	8.8 ± 0.62^{a}	8.82 ± 0.7^{a}	8.96 ± 0.66^{a}	9 ± 0.68^{a}
Shell length gain (cm)	2.34	2.29	2.42	2.43
Cc (cm/d)	0.16 ± 0.16^{a}	0.19 ± 0.16^{a}	0.2 ± 0.17^{a}	0.2 ± 0.16
Number of deaths	17	16	5	3
Mortality rate (%)	28.33	26.6	8.33	5

Figure 1. Presentation of the different forms of concentrated food (Kouato, 2008)

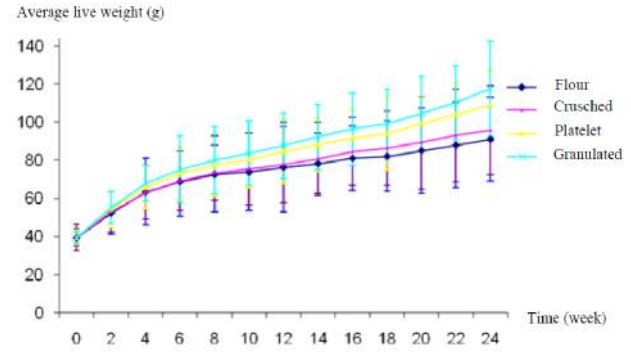

Figure 2. Weight growth of *A. Achatina* subjected to different forms of concentrated feed

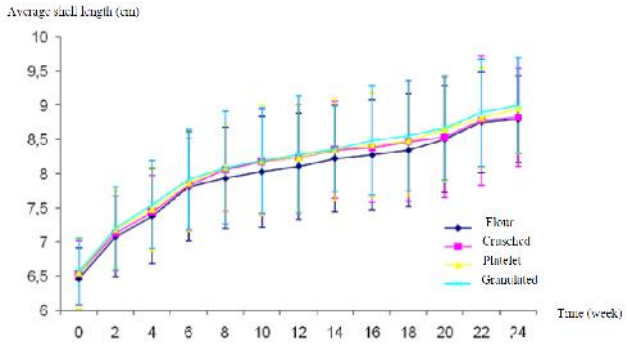

Figure 3. Shell growth of *A. Achatina* subjected to different forms of concentrated feed

The shell growth curves make it possible to distinguish two phases. From the start of the experiment to the 6th week, shell growth is strong and characterized by a steep slope. From this period (6th week) shell growth becomes relatively average for animals subjected to different forms of concentrated feed. Comparison of shell growth by analysis of variance with Turkey's HSD test (P <0.05), indicates that the average shell lengths of snails fed on the different forms of the concentrated feed remained the same from the beginning to the end of the experiments. These animals therefore exhibit the same average shell growth.

Mortality rate: During this study, the cumulative mortality rate from week 1 to week 24 varied depending on the form of the concentrated feed (Table 4). It was recorded 17;16; 5 and 3 cases of mortality, which corresponds to a rate of 28.33%; 26.6%; 8.33% and 5% respectively for animals fed in the flour, crushed, platelet and granulated form. The cumulative mortality rate recorded is higher in animals fed the flour and crushed form than in those fed the granules and platelets. The mean values of the same row indexed by the same letters are not statistically different (p> 0.05).

LC_i = average shell length at the ith week.

DISCUSSION

The results indicate that there is a difference in weight between snails fed flour and crushed foods and those fed platelets and granules. At the end of the experiment, the average live weight of the snails fed with granules (117.44 g) and platelets (109.02 g) are higher than those fed with crushed (95.71g) and flour (91.03g).

This result shows that the forms of the concentrated food influence weight growth. This difference in weight between the forms of the concentrated food is thought to be due to the difference in food intake observed between these different forms of the concentrated food. In fact, snails fed on granules (0.64 g/d/g of snail), platelets (0.58 g/d/g of snail) had a higher food intake (P <0.05) than those fed with crushed (0.48g/d/g of snail) and flour (0.43g/d/g of snail). These results are in agreement with that of Ireland (1991) who showed that there is a strong positive correlation between body weight and food intake of *Achatina Achatina*. This suggests that a large intake of food results in high body weight growth. This phenomenon has been reported by Otchoumou *et al*. (2005). The snail's chewing apparatus (the radula) is covered with a horny blade with many teeth that crush food. The snail will therefore tend to prefer foods that can be crushed. This could explain the high consumption of the granulated and platelet form which are compact forms. Regarding shell length, the results of this study indicate that there is no significant difference (P <0.05) between snails fed with the different forms of concentrated food despite a difference in intake. This result therefore indicates that shell growth is not influenced only by food intake. Indeed, calcium is an important nutrient involved in the making of the shell of snails (Bonnet *et al*., 1990). This result could be justified by the fact that each form of food provided animals with the quantity of calcium necessary for shell growth. In addition, the dietary rate of distributed calcium meets the needs of this species, which is 12.2% (Otchoumou *et al*, 2005).

This result could also be due to manipulation by using the caliper to measure shell length. Kouassi *et al*. (2015) have shown that the use of the caliper leads to a breakage of the outer edge of the shell which results in reduced shell growth.
The results concerning the amounts of residue indicate a significant difference between the flour, crushed form and the platelet, granulated form. This result indicates that flour and crushed foods are the most wasted food forms. This wastage leads to under consumption which results in low weight growth observed in snails fed with flour and crushed feed. Similar studies in pork have shown reduced wastage and improved feed efficiency through granulation (Quemere *et al*., 1979; Fekete *et al*., 1983).

The study of apparent dry matter digestibility shows that there is no difference between the concentrated feed forms. This result suggests that the poor growth performance recorded by the flour feed is not due to the quality of the feed but rather to the feed intake which is itself influenced by the form of the feed. The high mortality rate recorded in snails fed the flour and the crushed form could be related to the form of the food distributed. In fact, the flour and crushed forms lead to food waste, a consequence of under consumption. It follows an accumulation and decomposition of food refusals in the litter favorable to a proliferation of parasites. The results indicate a reduction in the fattening period of 61 days with the granulated feed compared to the flour. This confirms the economic profitability of the granulated feed. The work of Kpodekon *et al*. (2009) have also shown that the sunflower-based granulated feed gives significantly better performance in rabbits compared to the corresponding flour form, and that the granulated feed has reduced the duration of the meal from 10 to 12 days.

Conclusion

At the end of this study, it appears that the form of the concentrated food has an effect on weight growth. Thus, the granulated and platelet form of the concentrated feed gives *Achatina Achatina* significantly better growth performance compared to the flour and crushed form. Granules and platelets are consumed more and wasted less. They reduce the duration of fattening, do not cause a high mortality rate in buyins unlike flour and crushed feed. Growth performance could be improved with flour and crushed feed if certain measures are taken to minimize food waste.

REFERENCES

Ategbo J. M. & Zongo D. 2000. Effet de la teneur en eau du substrat d'élevage sur la croissance et la survie d'*Achatina achatina* (Linné). *Agronomie africaine*, 12(2) : 71-79.

Bonnet J. C., Aupinel P., Vrillon J.L. 1990. L'escargot-*Helix aspersa*: Biologie-élevage. INRA Editeur,Paris ISBN: 2-7380-0247-1, 124p.

Cobbinah J. R. & Osei-Nkrumah A. 1988. The effect of food on growth of *Achatina achatina*. *Snail Farming Research*. 2: 20-24.

Codjia J.T.C & NoumonvI R.C.G. 2002. Guide technique d'élevage sur les escargots géants n°2, Bureau pour l'Echange et la Distribution de l'Information sur le mini élevage. http:// www. Bib. fsagx. ac. B / bedin / production / guide/ pdf/ 2.pdf, 8p.

Connan L., Bonnet J. C., Aupinel P.1989. L'escargot « petit-gris ». Progrès en alimentation. *Revue de l'Alimentation animale.* 3 : 24-27.

Daguzan J. 1985. Contribution à l'élevage petit-gris : *Hélis aspersa* (Müller) (Mollusque gastéropode pulmoné stylomatophore). Evolution de la population juvénile de l'éclosion à l'âge de 12 semaines, en bâtiment et en condition d'élevage contrôlées. *Annales zootechniques*. 34(2) : 87-110.

Daouda H. 1995. Le calcium dans l'alimentation de l'escargot géant africain d'Afrique *Achatina achatina* (Linné). *Cahiers Agricultures*. 4: 444-448.

Fekete J., Castaing J., Lavorel O., Leuillet M. 1983. *Journées Recherches Porcine en France*, 15 : 361-374.

Hodasi J.K.M. 1979. Life history studies of *Achatina achatina* (Linné). *Journal of molluscan studies*. 45: 328-339.

Hodasi J. K.M. 1984. Some observations on the edible giant Snails of West Africa. *World Review*.52: 24-28.

Ireland M.P. 1991. The effect of dietary calcium on growth, Shell tickness and tissue calcium distribution in the snail *Achatina fulica*. *Comparative Biochemistry and physiology*. 98 (1) : 111-116.

Kouassi K D., Aman J-B., Kouakou F. 2015: Impact de la fréquence des manipulations sur la croissance de l'escargot géant d'Afrique *Archachatina marginata*. *Livestock Research for Rural Development*. Volume 27, Article #195. Retrieved March 11, 2021, from http://www.lrrd.org/lrrd27/10/koua27195.htm.

Kpodekon T. M., Youssao A. K. I., Koutinhouin B. G., 2009. Comparaison des performances de croissances de lapereaux en engraissement nourris par un aliment à base de tourteau de tournesol, soit sous forme farineuse soit sous forme granulée. *Livestock Research for Rural development*. 21 (12).

Otchoumou A., 2005. Effet de la teneur en calcium d'aliments composés et de la photopériode sur les performances biologiques chez trois espèces d'escargots Achatinidae de Côte d'Ivoire élevés en bâtiment. Thèse d'Etat ès sciences Naturelles, Université d'Abobo-Adjamé (Côte d'Ivoire), 175p.

Otchoumou A., Dosso H., Fantodji A., 2003a. the edible African giant snails: Fertility of *Achatina achatina* (Linné 1758), *Achatina fulica* (Bowdich 1820) and *Archachatina ventricosa* (Gould 1850) in humid forest; influence of animal density and photoperiod on fertility in breeding. *Bolletino Malacologico*, 39: 179-184.

Otchoumou A., Dosso H., Fantodji A. 2003b. Elevage comparatif d'escargots juveniles *Achatina achatina* (Linné, 1758), *Achatina fulica* (Bowdich,1820) et *Archachatina ventricosa* (Gould, 1850) : Influence de la densité animale sur la croissance, l'ingestion alimentaire et le taux de mortalité cumulée. *Revue africaine de santé et de productions animales*. 1(2) : 146-151.

Otchoumou A., N'Da K., Dosso H., Kouassi, K. D. 2004a. Inventaire des végétaux sauvages consommés par l'escargot géant africain *Archachatina ventricosa* (Gold 1850) : préférences alimentaires. *Haliotis.* 33 : 13-20.

Otchoumou A., Dupont-Nivet M., Dosso H. 2004b. Les escargots comestibles de Côte d'Ivoire : Effets de quelques plantes, d'aliments concentrés et de la teneur en calcium alimentaire sur la croissance *d'Archachatina ventricosa* (Gould 1850) en élevage hors sol en bâtiment. *Tropicultura*. 22 (3) 127- 133.

Otchoumou A., N'Da K., Kouassi K. D. 2005. L'élevage des escargots géants comestibles d'Afrique : Inventaire de végétaux sauvages consommés par *Achatina achatina* (Linné, 1758) et préférence alimentaire. *Livestock research for rural development*, 17 (3) 028.

Otchoumou A., Zongo D., Dosso H. 1989 - 1990. Contribution à l'étude de l'escargot géant africain *Achatina achatina* (Linné). *Annales d'écologie, Université nationale de Côte d'Ivoire*.21 : 31-58.

Quemere P., BertrandG., Perez J. M., Seve B. 1979. *Journées Recherches Porcine en France*, 11 : 203-216.

Zongo D., CoulibalyM., Diambra O.H., Adjiri E. 1990. Note sur l'élevage de l'escargot géant africain *Achatina achatina*. *Nature et faune*, 6(2) :32-44.

****