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Effect of two diets on the growth of the *Helix aspersa* Müller during the juvenile stage.

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Abstract.

We have been studied the effect of two diets one the growth of the *Helix aspersa* Müller during the juvenile stage under laboratory conditions. Diet I consists of commercial layer's mash. We used ten lots of forty animals of 0.34 + 0.05 g, assigning five to each diet and keep them during the 6 first weeks of life in the laboratory conditions described by Perea *et al.* (2003) and García *et al.* (2004).

The results show that the diet with forage (II) presents low growth rates (81 mg), high variability (24.56%) and asymmetrical distribution of individual (the hypothesis of normality is rejected). On the other hand the diet with commercial feed (I) shows high growth (955 mg), low variability (13.50%) and a normal distribution of the weight.

The diet II with forage does not show a relationship between the weight and the age. In the case of the diet with commercial feed is possible consider a regression model between the weight and the age with a coefficient of determination of 90% and a level of signification of $P<0.0001$. Also we find significant differences ($P<0.001$) in the conversion index, being higher in the diet I, with a lower mortality.

Introduction.

Heliciculture have various alternative systems of production, with different handling and feed options. Extensive systems are characterized by a low technification level and these support feed on green vegetables. In the other side we find intensive systems with a high level of technification and compound feed are used for feeding. Several authors consider that feeding snails with green vegetables do no provide adequate growth rate to commercial snail breeding (Daguzan, 1981). However these systems are very common in the Mediterranean area.

Feeding with compound feed or green vegetable sets the technological frontier for the production systems. So it is important to know the real distance between both alternatives in order to take decisions in heliciculture.

According to this, the aim of this work is to compare feed conversion index and growth in juvenile snails fed with compound feed or green vegetable, under laboratorial conditions. On the other hand, we construct a growth model for both diets to quantify the relationship between weight and age.

Material and Methods.

Animals and rearing method.

The snails (*Helix aspersa* Müller) were born at the CIFA (Andalusian Agrarian Research and Training Centre). A sample of 400 animals was taken from a tray with 3000 snails newly-hatchet. All the animals had a medium weight of 0.34 $\pm$ 0.05 g, and those that fell outside this band were rejected. The animals were distributed between rearing boxes, into 10 groups of 40 animals, and we assigned five groups to each treatment.

The experiment was conducted between May and June 2003, during the animals' juvenile stage, from birth to six weeks old, as indicated by Daguzan (1982) and Dupont-Nivet *et al.* (2000).

This study was conducted in the laboratory under semi-controlled conditions. The animals' natural environment was reproduced according to the descriptions provided by Bonnet *et al.* (1990) and Dupon-Nivet *et al.* (2000) and in accordance with the snail's circadian rhythm (Lorvelec, 1991; Blanc, 1993; Perea *et al.*, 2003) with two clearly defined periods: diurnal or resting, and nocturnal or active. García *et al.* (2004) describes in detail the management system and experimental climatic conditions in each period are indicated in Table 1.

The rearing containers were translucent plastic, 14.5 x 14.5 x 7.5 cm, and were cleaned daily to avoid the negative effects of excreta, mucus and density (Herzberg, 1965; Chevallier, 1979; Dan and Bailey, 1982).

Table 1. Environmental conditions.

	Active period			Rest Period		
	Min	Mean	max	Min	Mean	Max
Relative humidity (%)	69	76	87	52	63	76
Temperature (ºC)	12.0	21.3	27.0	24.0	30.4	36.0
Light Photoperiod (h)	14 h light and 10 h dark					

Diets.

Two diets have been designed, corresponding to treatments I and II (Table 2). Diet I is a compound feed as flour and formulated with cereals, following Brittane (1984), Stephanou (1986) and Jess and Marks (1989). It is made adding 20% of calcium carbonate to a basic compound feed for layer mash, according to Bonnet *et al.* (1990), Ireland (1991) and Perea *et al.* (2003). Also this feed is similar to the used by Dupont-Nivet *et al.* (2000) and García *et al.* (2004). By the other side diet II consist of fresh leaves of cabbage and it represent the feed for extensive systems with green vegetables. Feed is offered *ad libitum* at the beginning of the activity period and it is retired when the rest period begins.

Table2. Chemical composition of diets.

Treatment	CP (%)	CF (%)	ADF (%)	CO_3Ca (%)	Ash (%)
I	13.76	3.20	3.60	23.70	33.00
II	1.84	0.45	2.70	-	0.60

Measurements and statistical analyses.

Weight and death rate of each group is daily registered, and the remaining feed is thermally treated until constant weight to determine dry matter. Measures are carried out at the beginning of the rest period, with temperature and relative humidity described in Table 1.

The normality of the distribution of live weight was verified using a Chi-squared Test. The variability of the individual weights was expressed using the variation coefficient. Growth was modelled using simple, linear and non-linear regression analysis. We used a unifactorial analysis of variance (ANOVA), which indicated the existence of significant differences in the weight, mortality rate and feed conversion index according to the treatment and the number of weeks. Furthermore, the existence of homogeneity groups was detected using a multiple range test (LSD).

Results.

Table 3 shows weakly weight and its variation coefficient (CV) from birth to until the sixth week of age. At the beginning of the experiment, animal weight shows a low variability, lower than 12%. Variability grows in the first week of live, around 30% for each treatment, and progressively falls with animal age.

At the beginning of the experience, animal weight was similar (P>0.05) for each treatment. Diets differs since first week until the end of the experience and give two homogeneity levels (P<0.0001). Snails of treatment I present the highest weight with 0.955 g and lower variability (13%), while animals fed with green vegetables (treatment II) shows the lowest weight and highest variability.

Table 3. Weakly weight evolution according to diet.

Treatment	Week						
	0	1	2	3	4	5	6
I	13.4±0.9[(a)] (11.83)	35.11±1.92[(b)] (32.37)	88.42±3.56[(b)] (23.86)	215.63±10.28[(b)] (28.23)	462.69±15,59[(b)] (19.93)	800.22±26.18[(b)] (19.36)	955.80±23.55[(b)] (13.50)
II	18.2±0.6[(a)] (7.16)	25.83±1.32[(a)] (30.23)	34.29±1.83[(a)] (31.59)	41.23±1.69[(a)] (24.30)	46.74±1,89[(a)] (23.94)	71.8±3.77[(a)] (31.03)	81.40±0.46[(a)] (24.56)

[1]Mean ± ES (CV); Different letters indicate significant differences (p<0.0001).

Table 4 shows weekly evolution of death rate and feed conversion index. The study of mortality shows the highest level for snails fed with green vegetables (treatment II) since second week to final the experience. On the other hand, feed conversion index is significantly higher for animals fed with compound feed (treatment I) in all weeks.

Table 4. Death rate and feed conversion index.

Variable	Treatment	Week						
		1	2	3	4	5	6	mean
Death rate (aa)	I	0.371	0.085[a]	0.028[a]	0.028[a]	0.000[a]	0.000[a]	0.085[a]
	II	0.428	0.228[b]	0.457[b]	0.828[b]	0.142[b]	0.233[b]	0.380[b]
Feed conversion index (g weight/g consumption DM)	I	1.275[b]	1.066[b]	1.069[b]	0.842[b]	0.839[b]	0.839[b]	0.936[b]
	II	0.473[a]	0.480[a]	0.144[a]	0.340[a]	0.664[a]	0.664[a]	0.583[a]

Different letters indicate significant differences; a, b: P<0.0001

Growth models.

Table 5 shows Chi-square test to contrast normality distribution of final weight in each treatment. Final weight of animals fed with compound feed fits with a normal distribution, with high homogeneity and low data dispersion. While hypothesis of normality is rejected for animals fed with green vegetables.

Table 5. Chi-square test to final weight for each treatment.

Treatment	Mean (g)	Standar desviation	p-value	Ho[1]
I	0.9558	0.1290	0.0785	Acepted
II	0.0814	0.0241	0.0000	Rejected

[1] Ho: it is rejected for p<0.05

Table 6 and figures 1 and 2 show growth models to each feeding system. Growth with compound feed (treatment I) fits to an exponential model with a determination coefficient of 90% and a level of signification of p<0.0001). Also it shows a low data dispersion and a small range of intervals and confidence limits. By the other side growth with green vegetables (treatment II) does not show a good adjust to any model and it shows groups of individuals growing with different speed. Figure 2 shows with a line those which retard or inhibit their growth respect the population.

Table 6. Relationship between weight (Y in g) and age (X in weeks).

Treatment	Model	Coefficient		R^2	p-value	Standar
		a	b	(%)		error
I	Y=exp(a+bX)	-3.9180	0.7132	89.69	0.0000	0.3537
II	Y=exp(a+bX)/(1+exp(a+bX))	-3.9642	0.2480	43.43	0.0000	0.4930

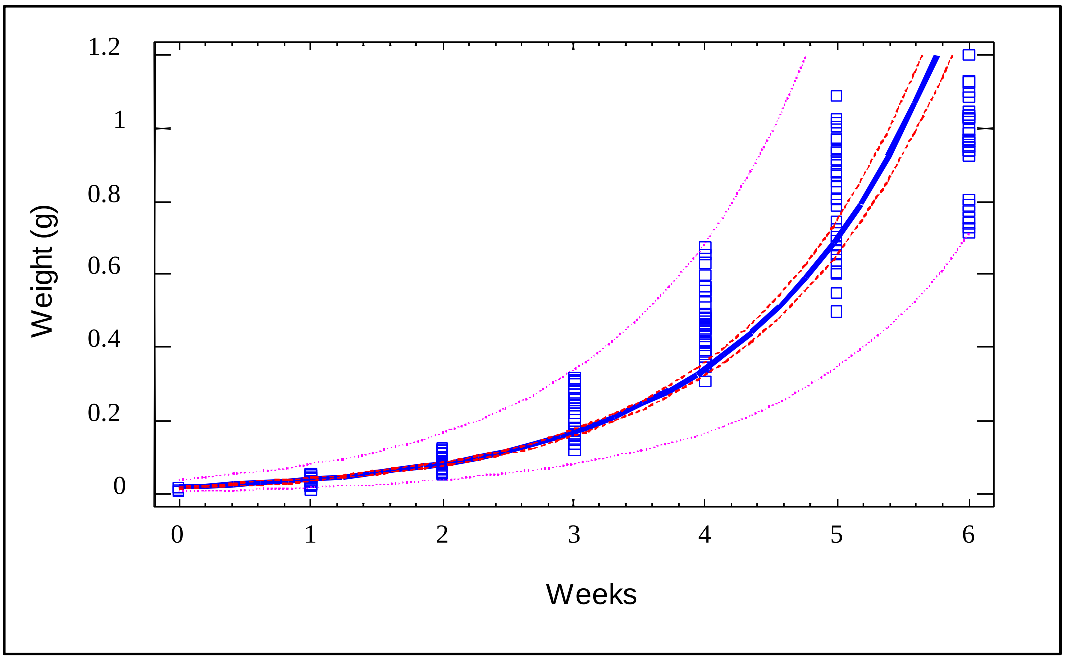

Figure 1. Growth curve for treatment I (compound feed).

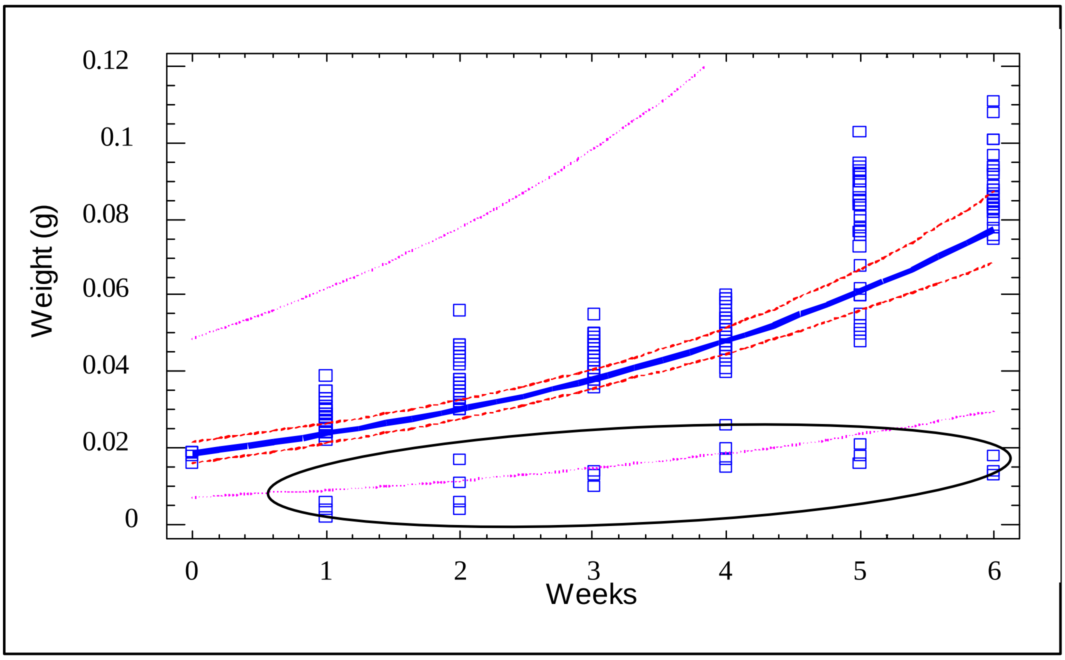

Figure 2. Growth curve for treatment I (green vegetables).

Discussion.

The management system used in this experiment provide an favourable environment to edible snail development (Perea *et al*., 2003). The factors that affect growth (food, density, management, environmental conditions, etc) can act either independently or in a synergic way; consequently, all these causes converge to provide a favourable or unfavourable medium for the development of the snail. When the snail finds unfavourable conditions it can inhibit its growth for a long period of time until these conditions change. So Sanz Sampelayo *et al.* (1990) obtained slow and asymmetric growths with a management system based on constant environmental conditions and feeding with compound feed; while García *et al.* (2004) using the management system of this experiment obtained fast and homogeneous growth with a normal distribution of final weight. So these favourable conditions permit to use the obtained growth as a good indicator for each feeding system.

In this study, feeding with green vegetables provide a slow and heterogeneous growth, with a final weight eleven times lower than compound feed (Table 3). Feed conversion index is very unfavourable during all the weeks, which shows an inadequate cover of nutritional needs. Also there is a 25% of animals with delayed or inhibit growth (Figure 2). This delay phenomenon has been described by Sanz Sampelayo *et al.* (1990), Lazaridou-Dimitriadou and Daguzan (1981), Fontanillas and García-Cuenca (2002) and

Cuellar (2003). It is called dwarfism and it is attributed to genetic variability. According to results, the observed delay can not be attributed to genetic factors and it only can be explain as a phenomenon related to feeding.

On the other hand, the results obtained with compound feed (treatment I) show a high growth, low variability and a normal distribution for weight. Also, death rate and feed conversion index are more favourable. Low data dispersion allows to predict weight as a function of age, obtaining a good adjust to an exponential model with a significant level of 90%. These results show that feeding with compound feed is the best option during juvenile stage for *Helix aspersa* Müller.

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