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Effect of Diet and Photoperiod on Helix Aspersa Growth in the Stage Juvenile / *Efecto de Dieta y Fotoperíodo del Hélix Aspersa Crecimiento en la Etapa Juvenil*

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Resumen:

En este trabajo se estudia en una primera etapa el efecto del consumo de 3 tipos de dieta en el crecimiento del caracol Hélix aspersa durante su juventud, incorporando nuevos insumos y técnicas de cultivo para desarrollar un gran volumen de producción y el rápido crecimiento de las especies, con las características de calidad a menor costo. El diseño experimental comprendió de 2 dietas completas artificiales y dieta natural de lechuga (Lactuca sativa) en su juventud. 600 caracoles distribuidos en 15 grupos de 40 ejemplares desde el nacimiento hasta 42 días de edad fueron estudiados bajo condiciones controladas. Los resultados muestran que la dieta de suero de leche en polvo (II) muestra un aumento de la tasa de crecimiento (482,48 mg), una variabilidad normal de 12,5 % en la distribución del peso, además de una menor tasa de mortalidad. La dieta de lechuga fresca muestra tasas de crecimiento bajas (401.56mg). En la segunda etapa, el efecto del fotoperiodo sobre el caracol reproductivo fue sometido a 2 evaluaciones de régimen de luz. Cada tratamiento se asignó al azar para 7 grupos de 40 caracoles en cultivo, con ambiente controlado, donde se controlan la temperatura, la humedad relativa, el fotoperíodo y el consumo de alimentos.

Palabras clave: Caracol de tierra, dieta, fotoperiodo, agricultura intensiva.

Abstract:

In this paper, it is studied in a first stage the effect of the consumption of 3 types of diets on the growth of the snail *Helix aspersa* during his youth in order to incorporate new inputs and cultivation techniques to develop high-volume production and rapid growth of the species, with the quality features at lower cost. The experimental design comprised 2 complex artificial diets and natural diet of lettuce (*Lactuca sativa*) in his youth. 600 fry distributed in 15 groups of 40 specimens from birth to 42 days of age were studied under controlled conditions. The results show that diet with whey powder (II) shows an increase in growth (482.48 mg), variability 12.5% normal weight distribution, in addition to lower mortality rate. The diet of fresh lettuce shows low growth rates (401.56mg). In the second stage, the effect of photoperiod on reproductive snail subjected to 2 was evaluated light regimes. Each treatment is assigned randomly to 7 groups of 40 snails arranged in automated factory farming, which control temperature, relative humidity, photoperiod and feed consumption.

Keywords: Land snail, diet, photoperiod, intensive farming.

1. Introduction

Land snails farming has emerged as an excellent business opportunity for Latin American countries like Colombia, Peru, Venezuela, Ecuador and Brazil. In Mexico the snail is an unexploited activity, there is evidence of small heliculture farms in the southeastern region of the country, yet more than 65% of these do not have the infrastructure and sufficient resources to meet international quality standards (Cuellar, *2013*). Among the causes we can cite a lack of knowledge on the physiology, reproduction and genetics of the species, suitable methods for cultivation and breeding, in addition to the little exchange of information between breeders.

Given this scenario, a thorough review of our region that allows to know the culture systems, feed type and environmental conditions for production and operation, likewise strengthen the regulatory and legal framework for export as well as the benefits proposed economic, social and ecological. Considering that results of the reproductive parameters of the snail *Helix aspersa* change depending to geographical race of the specimens, the present research is developed, considering that each geographical area should be considered as a heliciculture unit different and the characterization contributes to improving the exploitation (Olivares, 2005).

The photoperiod is the principal factor in the reproduction of the snail *Helix aspersa*, due that it induces the activity or the stagnation of the snails depending on the light intensity administered (Aupinel, 1996). It is proven the positive effect of long photoperiod (more of 15h light) on the growth and the reproduction, as well as the inhibitory effect of less light, demonstrating that a "long day" photoperiod stimulates a better growth with relation to a "short day" photoperiod (Aupinel, 1996). For the present study is evaluated the effect of a photoperiod of 14h light and 10h darkness versus a photoperiod of 18h light and 6h darkness in order to determine with accuracy the ideal period for the geographical race of the specimens.

Another relevant factor is the control of microclimate in the systems of intensive breeding. On this point the prototypes and technologies used in large-scale systems there do not contemplate energy saving systems, automatic sprinkler systems, photoperiod and mortality control of the species. This work proposes to evaluate the performance of a system of intensive breeding, specifically controlling temperature, relative humidity and photoperiod in the experimental design, seeking to implement automated systems proposed to support the quality characteristics of the species, besides reducing mortality levels, increasing the productivity and profitability of the helicículture farms.

2. Materials and Methods

2.1 Experimental design

The research was conducted in the town of Valle de Santiago, Guanajuato, with coordinates 20° 23'34"N 101° 11'29"O, maximum altitude of 1720 meters, with annual averages of 18.9°C, 724.2 mm of precipitation, 85% relative humidity.

2.2 Information sources

Measurements of relative humidity and ambient temperature were obtained in situ with a brand thermometer PCE, PCE-EM 883 model, placed at a distance of 0.07 m from the ground at intervals of two hours in crops and areas surrounding Valle de Santiago for the period march 2013 to October 2014.

2.3 Experimental snails

The experimental design consisted of 600 collecting gastropods *Helix aspersa* species, divided into 15 groups of 40 specimens of a first strain of 1500 juveniles (Daguzan, 1982). The average body weight initial are 13.81 ± 0.053 mg. Specimens that were below the average value were rejected for the rest of the evidence. A second selection criterion was the circular marks the shell (Lorvelec, 1991). Finally it was verified that the specimens were free of fungus Verticillium and Fusarium genera.

2.4 Intensive rearing systems (SCI)

The specimens were placed a Intensive Rearing Systems (SCI) 45 x 45 x 60 cm manufactured with food grade polymer (Figure 1) characterized in providing high rigidity, heat resistance up to 99ºC, capable of inhibiting the growth of fungi and bacteria. The SCI incorporates effective control system based on low-energy sensors for monitoring temperature and humidity, plus a mechanical feed system and anti-leak system. The inside edges are rounded to prevent the accumulation of excreta and waste. The design incorporates simple connections for installation; as well as easy cleaning and quick maintenance.

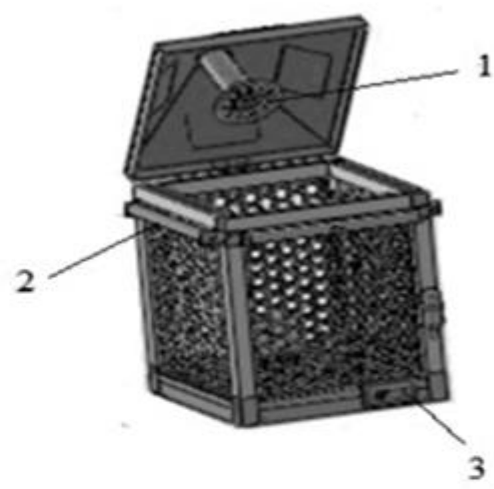


Figure 1. Intensive rearing systems (SCI). The scheme show the automatic irrigator (1), automatic shutter (2) and control system (3).

2.5 Conditioning

The specimens were kept in conditions 14/10 photoperiod (light/dark). They were fed *ad libitum* lettuce (every 24 hours) arranged in disposable plastic containers until they reached an average weight of (13.0 ± 0.5 mg) and used in bioassays in 42 days. Hydration of the species was made with sponges soaked in water and contained in plastic containers of 5 x 10 x 2 cm to prevent drowning of the species. SCI were cleaned daily to avoid involvement excrement slime and other debris.

2.6 Experimental development

Once acclimated, snails were sown in 15 SCI at 40 snails per replicate (5 replicates per treatment). The weight of the seeded organisms ranged from 13.0 ± 0.5 mg. Biometrics shell was performed with vernier and body weight by means of an electronic scale (up to 0.0001 g) 7.14, 21, 28, 35 and 42 days. During the experimental development, snails were fed every 24 hours with daily records of dry matter intake during the day and night in order to avoid a health risk due to the high density of snails around feeders from starvation (Perea, et al. 2006).

The specimens at 21 ± 2°C, relative humidity of 95 ± 2% and 2 photoperiod of 18/6 (light/dark) and 14/10 (light / dark) remained. Those agencies were provided purified water (10 ml) daily. The temperature and humidity in the intensive breeding system is automatically controlled with a water spray system. Excrement, mucus and organic waste were removed every two days (Herzberg, 1965) and (Dan and Bailey, 1982). Fish mortalities were replaced in order to maintain the density. However, the latter were not considered in the calculations of growth and survival.

The conditions under which the experiment was conducted, are shown in Table 1.

	Days													
	0		7		14		21		28		35		42	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Outside Temperature (ºC)	12	29	13	31	13	28	14	31	15	31	14	29	12	31
Inside Temperature (ºC)	21	24	20	23	20	23	21	24	20	23	20	23	20	22
Relative humidity (%)	93	96	94	97	94	98	93	96	95	97	94	98	94	97
Photoperiod I (h)	14h light and 10h darkness													
Photoperiod II (h)	18h light and 6h darkness													

Table 1. Environmental conditions in the experimental units (42 days)

2.7 Diet

To develop the most potential crop snail *Helix aspersa*, a bioassay in order to determine the most suitable for breeding diet of these organisms was performed. The experimental design comprised three artificial diets, one with Fresh Lettuce (Lactuca sativa), control diet considered to be the major source of food for the species and 2 balanced food formulas considered potential long-term replacement of lettuce (Table 2).

Diet II

Ingredient	%
Cornmeal	35
Toasted soy flour	26
Soya wholemeal toast	4
Soybean oil	2
Barley flour	17
Whey poder	5
Wheat bran	6.5
Calcium carbonate	2
Monocalcium phosphate	1
Sodium chloride	1
Vitamin-mineral supplement	0.5

Diet I

Ingredient	%
Lettuce (*Lactuca sativa)*	100

Diet III

Ingredient	%
Barley flour	52
Wheat bran	10
Soybean meal	14
Calcium carbonate	17
Dicalcium phosphate	3
Vitamin-mineral supplement	4

Table 2. Diet compositions evaluated in the experiment.

For 42 days the increase in weight of each specimen levels was recorded. The summary of the records shown in Table 3.

		Days						
		0	7	14	21	28	35	42
Diet I	U1	13.40 ± 0.90 (11.83)	23.56±15.62 (17.43)	46.06±17.0 (18.36)	101.12±12.45 (20.3)	229.31±12.2 (21.17)	305.67±17.4 (17.9)	515.34±9.45 (21.36)
	U2	14.05 ± 1.90 (20.76)	25.17 ± 4.87 (21.49)	48.67±5.8 (9.12)	91.23±6.34 (13.2)	237.27±9.48 (25.4)	440.03±8.5 (19.7)	536.83±8.60 (20.6)
	U3	14.31 ± 0.30 (4.32)	24.72 ± 1.92 (24.37)	59.35±21.5 (23.45)	94.58± 7.43 (8.75)	171.67±16.3 (14.4)	387. 16± 16.8 (4.73)	436.60±13.5 (26.45)
	U4	13.25 ± 2.90 (32.37)	23.98 ± 9.09 (7.15)	52.43±14.2 (9.34)	114.52± 1.23 (7.32)	197.34±19.26 (34.7)	402.89±13.2 (21.33)	385.48±16.4 (27.1)
	U5	13.86 ± 0.60 (10.12)	22.07 ± 6.74 (19.36)	54.09±31.2 (21.14)	97.2±8.43 (6.47)	218.40± 6.98 (17.5)	437.55±8.4 (20.9)	359.32± 7.8 (26.8)
Diet II	U6	14.09±1..80 (5.75)	25.47 ± 17.9 (5.74)	49.71±26.19 (10.54)	98.57 ± 11.09 (21.8)	253.36± 6.54 (13.87)	347.09±17.3 (16.5)	383.92±18.34 (21.5)
	U7	13.12±2.20 (21.17)	26.85 ± 3.4 (5.78)	52.45 ± 4.6 (8.36)	97.32 ± 3.21 (15.3)	249.45± 2.43 (30.23)	326.05± 6.8 (32.14)	572.62±15.47 (24.1)
	U8	14.28±0. 28 (28.23)	24.70 ± 9.4 (26.45)	63.31±10.23 (15.4)	117.87 ± 4.2 (12.9)	183.12± 8.43 (19.57)	423.42±11.4 (24.3)	549.63 ± 15.5 (17.3)
	U9	13.05 ± 1.46 (24.56)	23.54 ± 5.6 (17.45)	54.98±15.32 (5.18)	122.16 ± 31.1 (23.3)	239.69±7.37 (18.37)	469.36±4.07 (7.45)	478.97 ± 18.4 (24.48)
	U10	13.47 ± 1.7 (14.21)	24.69 ± 31.4 (20.14)	57.06 ± 9.7 (3.22)	121.09 ± 6.3 (9.67)	251.55 ± 23.8 (14.67)	450.37±10.3 (16.5)	498.76 ± 23.1 (19.5)
Diet III	U11	13.37± 1.34 (18.45)	22.67±16.34 (16.2)	43.39 ± 26.1 (17.6)	85.15 ± 9.76 (12.45)	217.18 ± 8.3 (14.3)	386.45±7.56 (16.4)	449.31± 6.34 (25.09)
	U12	13.18 ± 1.84 (7.16)	23.49± 4.78 (5.76)	55.39± 3.09 (7.21)	97.34 ± 4.35 (5.27)	221.69 ± 15.9 (24.13)	285.29±16.3 (31.2)	359.67± 6.12 (8.12)
	U13	14.67 ± 0.32 (37.32)	20.60 ± 34.2 (26.91)	44.67± 3.16 (8.19)	106.89 ± 12.9 (19.38)	174.34± 6.23 (16.3)	410.69±5.34 (24.3)	501.46 ± 13.7 (18.6)
	U14	15.02±0.6 (24.16)	21.34± 4.18 (2.43)	47.04 ± 25.4 (11.07)	105.60±10.43 (8.24)	160.23 ± 3.7 (14.34)	345.09±6.87 (17.56)	476.56 ± 11.3 (24.47)
	U15	14.11± 1.20 (21.19)	23.16±25.02 (12.7)	51.94±11.76 (5.23)	99.76 ± 9.11 (12.9)	165.56 ± 10.2 (21.8)	403.05±7.45 (16.34)	335.93± 6.76 (23.19)

Table 3. Daily weight evolution according to diet (mg).
Average ± standard diversion (coefficient of variation).

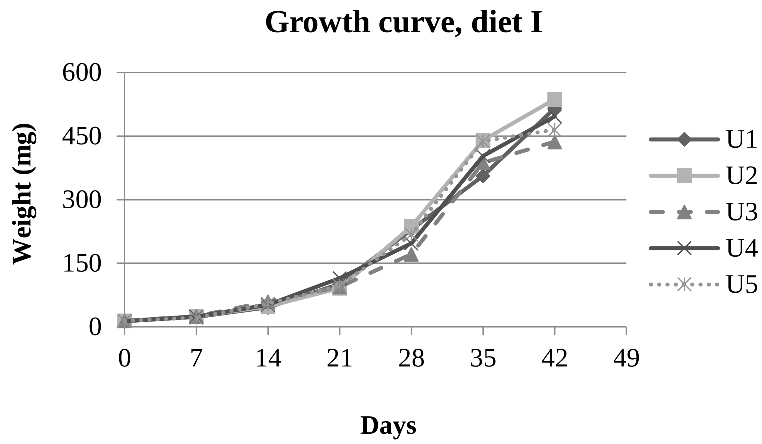


Figure 2. Growth of the terrestrial snails with diet I. The figure shows the intensive increase of weights in 5 experimental units after 28th days, a final average weight of 415.37 ± 10.6 (18.6) is obtained.

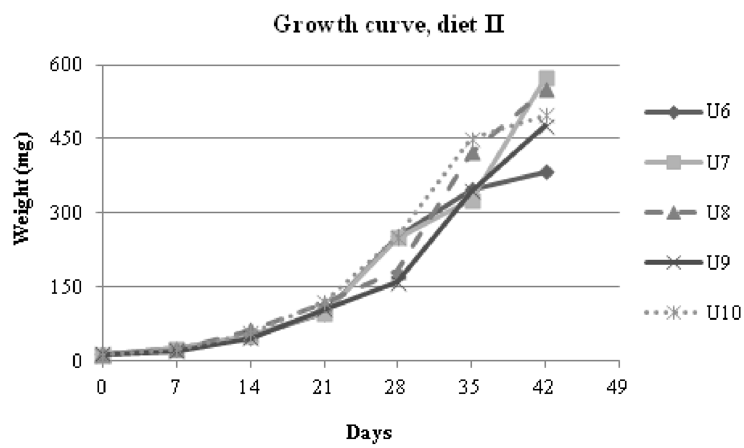


Figure 3. Growth of the terrestrial snails with diet II. The figure shows the final average weight of 496.29 ± 15.7 (20.18), also observes a significant difference between the weight obtained between the unit 6 and 7.

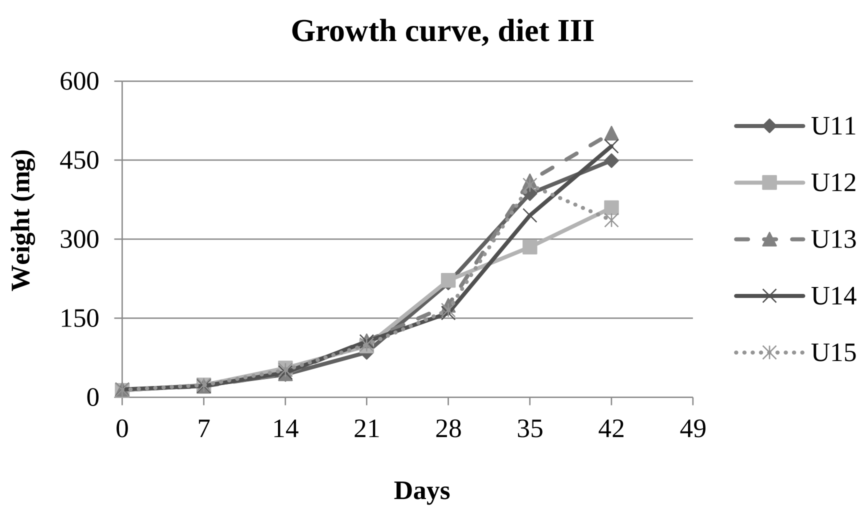
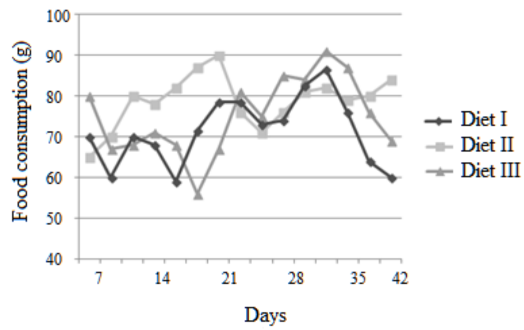
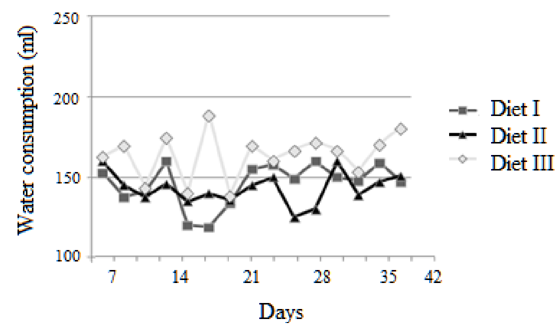


Figure 4. Growth of the terrestrial snails with diet III. It was obtained a final average weight of 424.58 ±7.81 (19.27). The U5 presents significant decrease in the last 7 days of the experiment.



(a)



(b)

Figure 5. Consumption of food and water. The graph a shows (a) preference of the diet with whey of milk in powder. The graph (b) reports major consumption of water in the experimental units that fed on the diet III.

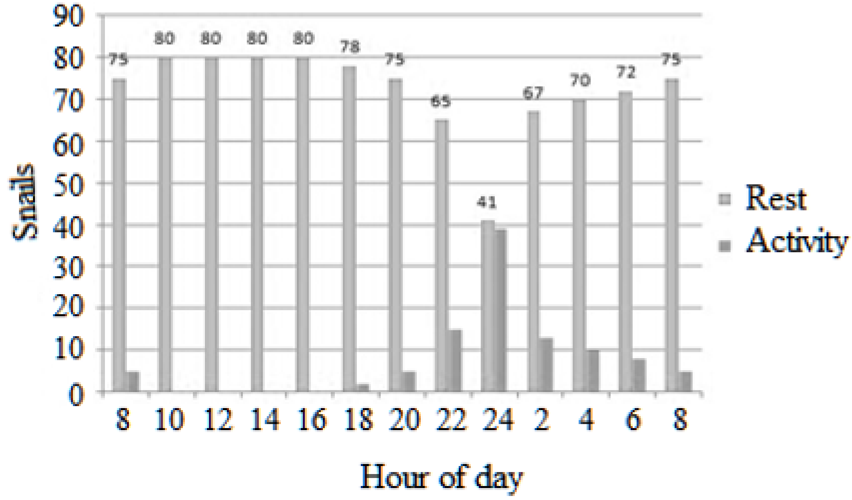
2.8 Death rate

The Table 4 shows the evolution of the mortality. The study demonstrates high level of deaths in the population fed on fresh lettuce from 7 days of birth.

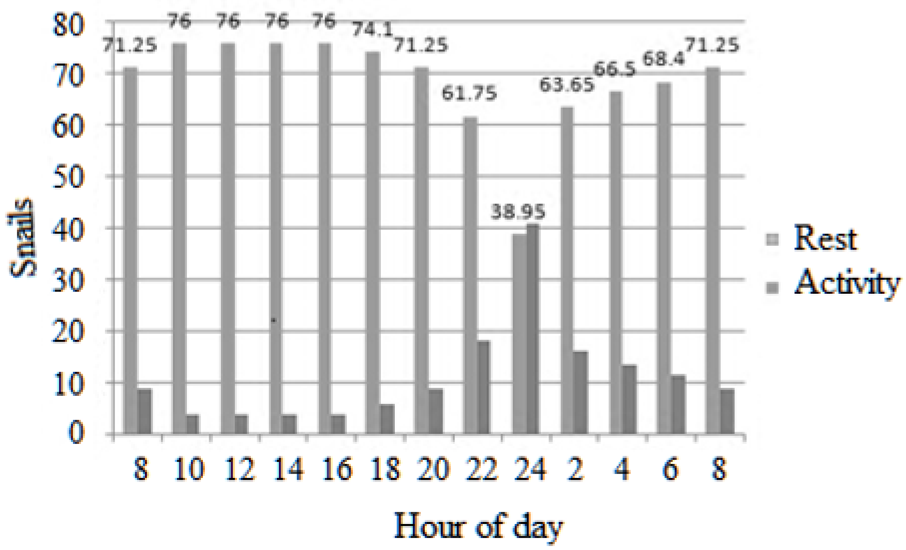
	Diet I					Diet II					Diet III				
Days	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15
0	1	2	1	0	1	1	0	1	0	0	1	0	1	0	0
7	1	1	2	2	2	1	2	1	1	0	1	1	0	0	0
14	2	2	3	1	2	2	1	0	1	0	2	1	2	2	1
21	1	2	2	1	1	0	1	1	0	1	1	1	2	1	2
28	2	1	2	2	1	0	1	2	1	0	1	2	1	0	0
35	2	2	2	1	2	1	2	1	0	1	1	1	1	1	0
42	1	1	3	1	1	1	1	0	0	1	0	1	1	0	1
Total Death	10	11	15	8	10	6	8	6	3	3	7	7	8	4	4
% Death	25	28	38	20	25	15	20	15	7.5	7.5	18	18	20	10	10
Alive	30	29	25	32	30	34	32	34	37	37	33	33	32	36	36
% Alive	75	73	63	80	75	85	80	85	93	93	83	83	80	90	90

Table 4. Evolution of mortality of snails.

2.9 Photoperiod



(a)



(b)

Figure 6. Photoperiod. The graph (a) shows the results of the photoperiod by day long (18h light and 6h darkness), in It is possible to estimate a decrease of activity of the species in the schedule of 10-16h with respect to the short photoperiod of 14h light and 10h darkness (b).

3. Results

The evolution of body weight between 3 and 45 was significantly higher ($p \leq 0.01$) in snails that received diet II (whey powder). The final weights ranged between 415.37 mg in snails with natural diet (fresh lettuce) and 496.29 mg with artificial diets. Weight gain was 482.48 mg for those fed diet II and 401.56 mg for snails diet III (Table 2) snails. Humus supplementation did not significantly alter mortality (Figure 3) and the median survival was 81 665%. At this point it should be noted that the experimental units that were fed with fresh lettuce report higher mortality rate of 73%.

It was noted that irrigation in intensive breeding grounds during the dark phase of the photoperiod helps maintain 95% moisture, reducing water consumption and energy achieving the same or better results.

The photoperiod as the regime of 14/10 h activity favored spice, contributing to the growth of the species, preventing hibernation.

It was concluded that the growth, reproduction and activity of snails Helix aspersa can be stimulated or inhibited by photoperiod, confirming that the knowledge of this phenomenon is essential for helicícola exploitation. Humidity increased to 98 and 99% reported on day 14 and 35, produced soft shells.

Closed culture systems, require a proper control environment, which implement automated systems to generate microclimates, contributes to maintaining the quality characteristics of the species, in addition to reducing mortality levels, increasing productivity and helicícolas profitability of farms. It designed for easy handling and operation by incorporating simple connections for installation; as well as easy cleaning and quick maintenance.

The Automated System for Intensive Cultivation and proposed Terrestrial snail farming is scalable to the needs of production; favoring the batch job or colonies.

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Biographical sketch

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Marco Aurelio Silva Navarro. Full Time Professor in Universidad Politécnica del Bicentenario, He studied his Master in Customs Law Universidad La Salle León; He has realized coordination activities and has been manager in productive processes, distribution and commercialization inside factories with products of high rotation. He has a Master in Teaching Specialist in Education from Instituto Irapuato, currently he is studying the Doctorate in Sciences Specialized in Pedagogy in Instituto de Ciencias y Tecnologías del Estado de Guanajuato. His research lines are Technologies to Evaluate and develop the Human Capital.