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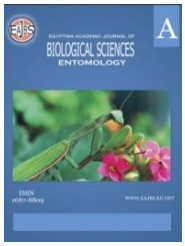

A new Vision for Improving the Biological Properties of The Mulberry Silkworm, *Bombyx Mori* Using the Powder of Three Different Types of Ground Snails and Plant Extracts

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ABSTRACT

These experiments were carried out as an attempt to develop methods used in raising mulberry silkworms. 2 and 3% of three different types of plant extracts *Nigella sativa*, *Allium sativum*, and *Moringa oleifera*, as well as 50 and 100 grams of three different types of ground snail's powder *Eobania vermiculata*, *Helicella vestalis*, and *Monacha cardusiana* were added to the mulberry silkworm *Bombyx mori* diet and tested for their influence on some of its biological characteristics. The results showed the following, 3% *N. sativa* in the worm's diet had the best effectiveness on all the tested traits. Also, 100 grams of different snail's powder showed an effective effect on all the tested biological characteristics of *B. mori*. When 3% of *N. sativa* was mixed with 100 g powder of the three different snails into food, this led to excellent results in measurements of all tested traits, especially in the case of the terrestrial snail *E. vermiculata*. An analysis was made of the most important nutrients that are found in the bodies of the tested ground snails, and the results showed that their bodies contain high levels of proteins, carbohydrates, and sugars as well as some important minerals Especially *E. vermiculata* and *H. vestalis*.

INTRODUCTION

Terrestrial snails are invertebrate animals that belong to the mollusks tribe which ranks second after arthropods in terms of the number of organisms. Animals of the mollusk tribe live in a wide variety of environments. Some see that the ground snails are dangerous pests that must be combated as they spread over many plants feeding on them and leave mucous material causing the transmission of some plant diseases (Mohamed 2010). On the other hand, some of these objects are considered intermediate hosts to transfer some types of worms to humans and other animals (Lu *et al*., 2018). Some others see that these animals over the years are considered a treasure of nature, where they are used in many fields that are very beneficial to humanity (Virabhadra 1969). Some of them are used for nutrition on a large scale as its bodies contain a high percentage of organic and inorganic substances important for bodybuilding (Sogbesan *et al*., 2006, Engmann *et al*., 2013, Nahid *et al*., 2013, Diarra *et al*., 2015; Bugdayci *et al*., 2019 and Das 2020). It is also used in the medical field and in the pharmaceutical industry and it gave great results in treating some diseases, including cancer (Paulo *et al*., 2015, Barminas *et al*., 2017, Ibtissem *et al*., 2017 and Matusiewicz *et al*.,2018), whereas the bodies of these animals

and the mucous material that they secrete contain many antibiotics that have a strong effect on many types of bacteria, fungi, viruses… etc. (Eukene *et al*., 2014, Ulagesan and Kim 2018, Nantarat *et al*., 2019). It is also used to grind its bodies in various industries (Orodu *et al*., 2014, Udeozor and Evbuomwan 2014, Ambali *et al*., 2015, Gumus and Okpeku 2015 and Mohamed 2016).

The mulberry silkworm, *Bombyx mori* is among the most important insects that God blessed us because of its great benefits to humanity (Shahd 2018), as natural silk is extracted from them. These delicate insects need many important nutritional elements in order to increase their production of silk, as well as the antibiotics that protect them from some of the diseases that these delicate insects are exposed to during their breeding. Therefore, some additives must be used with the worm's food, such as some plant extracts (Padma and Ramani 2015; Barge and Pardeshi 2018 Mahmoud *et al*., 2019; Manjula *et al* .,2020 and Manjunath *et al*., 2020), or some other foodstuffs (Rahmathulla *et al* 2007; Thulasi and Sivaprasad 2015; Masthan *et al* 2017 and Kumar and Prashanth 2018) and various antibiotics (Mahdi *et al*., 2017 and Jagtap and Khyade 2019); Silver ions are also used by (Thangapandiyan and Dharanipriya 2019). These additives affect some morphological, biological, and physiological characteristics of the worm, which ultimately affects the quantity and quality of silk production.

The main objective of the research is to use new, different and unconventional materials in the breeding of mulberry silkworms, provided that these materials are available, inexpensive, and easy to obtain and use, and at the same time help improve the biological properties of the mulberry silkworms, which ultimately increases the quantity and quality of silk production. To achieve this goal, ground snail powder was used either alone or added with other substances such as plant extracts to the worms' food.

MATERIALS AND METHODS

Insect Source and Rearing:

Silkworm hybrid eggs (G2XV2XKKXHI) were obtained from the Sericulture Research Department, Plant Protection Research Institute, Agricultural Research Center, Egypt, and maintained at (28 ± 2Cº, 70 ± 5 % RH) according to the technique of Krishnaswami (1978). Mulberry leaves were collected twice daily, then washed and left to dry under room conditions. The mulberry leaves were offered 4 times/day on plastic trays (42 x 30 x 10 Cm) with 100 larvae/ tray. The rearing room was disinfected one week prior the onset of experiment using 3 % formalin. Daily the larval bed cleaning for removing the remained dried food and feces. Chicken egg carton plates were used as mountages for cocoon spinning (Zannoon and Omera, 1994).

Experimental Design and Larval Treatment:

Seeds of black seed *Nigella sativa*, fruits of garlic *Allium sativum*, and leaves of moringa *Moringa oleifera* plants were collected, washed with distilled water, and dried. The dried plant's parts were powdered with electric mixer. Further 50 g powdered thus obtained was subjected to extraction through the soxhlet apparatus with 500 ml acetone solvent for 24 hrs. After 24 hrs the plant extract was filtered and the filtrate was evaporated completely. All these treatments were used at 2 and 3 % concentrations with water. Fresh mulberry leaves were sprayed with each concentration and then dried in air for 10 minutes. Treated leaves of various concentrations were fed to 4^{th} instar larvae. The silkworm larvae fed mulberry leaves sprayed with water as control. Three replicates of 100 larvae were used for each concentration.

Developmental Measurements:

Different biological traits were measured such as larval mortality (%), larval weight, pupation rate, pupal weight, fresh cocoon weight, fecundity (total number of laid eggs/female), hatchability (%), weight and length of silk gland, and growth index.

The percentage of mortality was calculated according to the formulation of Megalla (1984):
Mortality percentage = No. of dead larvae x100 / Total No. of larvae

The pupation rate and hatchability percentage of eggs were estimated according to the formulation of Lea (1996).

Pupation ratio (%) =Number of health pupae x100 / Corrected basic number of examined
Hatchability percentage = Number of hatched larvae x100 / Number of fertilized eggs

Growth Index:

Twenty-five 5th instar larvae of one, three, five, and seven days old were weighed (in g) and the following formula was used for calculation of the growth Index:

$$\text{Growth Index} = \frac{\text{Final weight of the larvae (g) - Initial weight of the larvae (g)}}{\text{Initial weight of the larvae (g)}}$$

Preparing the Ground Snails Powder:

Three different types of ground snails *E. vermiculata; H. vestalis* and *M. cardusiana* were collected from different plants (vegetables, fruits, ornamental plants, and even weeds), then transported them in bags of cloth to the laboratory of zoology in the Plant Protection Department of the Faculty of Agriculture, Benha University. Snail individuals have been cleaned by running water and placed in plastic and wooden tanks containing wet clay soil and feeding constantly on lettuce and cucumber plants. Mature snails were being chosen. At first, the snails were full dried by sun rays for one week, then cleaned carefully and well washed, after that dried with an electric dryer less than 70 C^{o} for 72 hours. Dry snails were first grinded in a hand grinder, then transferred to an electric mixer to increase grinding, then placed in a Wise Mix Ball Mill device to turn it into a very soft powder in the Department of Physics, Faculty of Science, Benha University. After that, the powder was sterilized for 20 minutes less than 121 C^{o} with 1.5 bars and transferred to the refrigerator in plastic bags for safekeeping until use (Mohamed 2016 and Ghazy *et al*., 2017). A portion of the ground snail's powder was taken to the central laboratory at the Faculty of Agriculture, Benha University so that an analysis of the most important elements.

Introduce Snail Powder to The Larvae:

The powder of the three types of snails prepared previously was introduced with food for the fourth age larvae of the mulberry silkworm *B. mori* once daily by spreading it on the surface of clean mulberry leaves. The experiment was divided into three groups, and each group was devoted to one type of ground snail tested. Within each group, two treatments of 50 and 100 g of powder were used. Under each treatment, three replicates were used next to the control, and each of the repeats contained 100 individuals from the fourth age larvae.

RESULTS AND DISCUSSION

Impact of Different Three Plants Extracts on Some *B. Mori* Characteristics:

The outlined results in Table 1 illustrate the effect of testing two concentrations 2 and 3 % of three different plant extracts *N. sativa, A. sativum,* and *M. oleifera* on Mortality rate, fifth larval weight, silk gland weight, silk gland length, pupation rate, pupal weight, fresh cocoon weight, number of laid eggs and total hatching rate of *B. mori*. It was evident from the results that the lowest percentage of death 3.88% was recorded for 3% of *N. sativa* extract, while this percentage reached 7.49% when the larvae were treated with 2% of *M. oleifera*. On the other hand, 2 and 3% concentrations of any of the tested plants had the highest impact on the fifth larval weight and pupal weight compared to the control, noting that 3% *N. sativa* had the most effective with (3.96 and 1.43 g) respectively. When the silk gland was weighed, the highest results 1.01 and 1.34 g were recorded for two different concentrations 2 and 3 % of *N. sativa* extract only especially 3%, compared to control and other plant extracts, which gave less result than control. The results also proved that, the better measurements absolutely of

silk gland length (28.74, 29.32, and 28.04 cm), pupation rate (82.53, 85.31, and 81.35%), fresh cocoon weight (1.73, 1.77 and 1.72 g) and the number of lied eggs (420.83, 425.73 and 411.20 eggs) were caused by 2 and 3% of *N. sativa*, followed by 3% *A. sativum*, while the least influence on these traits was recorded by 2% *M. oleifera*. Finally, the highest egg hatching rate was recorded when the worm was treated with 3% *N. sativa*, followed by 3% *A. sativum* with 66.83 and 61.11% respectively.

The previous results confirmed that, *N. sativa* plant extract with 3% concentration in the worm's diet had the best effectiveness on all the tested traits.

Table 1: Effect of three different types of plant extracts on some biological properties of *B. mori*

Plant extract	Cons %	Some tested biological properties of the silk worm, *B. mori*								
		Mortality %	Fifth larval weight (g)	Silk gland weight (g)	Silk gland length (cm)	Pupation %	pupal weight (g)	Fresh cocoon weight (g)	Av. No of eggs	Hatchability %
N. sativa	2%	5.41± 0.19^{b}	3.45± 0.08^{b}	1.01± 0.09^{b}	28.74± 0.34^{ab}	82.53± 1.06^{ab}	1.41± 0.01^{a}	1.73± 0.03^{ab}	420.83± 4.05^{a}	58.66± 1.26^{bc}
	3%	3.88± 0.64^{c}	3.96± 0.01^{a}	1.34± 0.03^{a}	29.32± 0.05^{a}	85.31± 0.48^{a}	1.43± 0.02^{a}	1.77± 0.05^{a}	425.73± 4.16^{a}	66.83± 0.07^{a}
A. sativum	2%	6.61± 0.37^{ab}	3.34± 0.12^{bc}	0.52± 0.02^{d}	27.09± 0.54^{c}	74.48± 2.91^{cd}	1.16± 0.02^{d}	1.60± 0.02^{cd}	372.00± 5.24^{b}	56.08± 2.12^{c}
	3%	5.82± 0.45^{b}	3.49± 0.03^{b}	0.64± 0.01^{d}	28.04± 0.04^{b}	81.35± 0.65^{abc}	1.32± 0.02^{b}	1.72± 0.02^{ab}	411.20± 3.00^{a}	61.11± 0.32^{b}
M. oleifera	2%	7.49± 0.65^{a}	3.05± 0.26^{c}	0.51± 0.01^{d}	25.56± 0.23^{d}	62.54± 5.02^{e}	1.13± 0.01^{d}	1.56± 0.03^{d}	318.90± 12.36^{c}	48.52± 1.55^{d}
	3%	5.36± 0.47^{b}	3.32± 0.02^{bc}	0.57± 0.01^{d}	26.48± 0.08^{c}	77.56± 0.34^{bcd}	1.25± 0.02^{c}	1.68± 0.01^{abc}	330.17± 0.94^{c}	59.20± 0.14^{bc}
control		1.23± 0.20^{d}	2.55± 0.06^{d}	0.77± 0.01^{c}	26.40± 0.08^{c}	71.59± 0.91^{d}	1.06± 0.02^{e}	1.66± 0.04^{bc}	362.30± 4.01^{b}	59.87± 0.82^{b}
LSD at 0.05 for		1.39	0.35	0.12	0.79	6.92	0.06	0.09	17.76	3.49

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter

These results are consistent with Walaa *et al* 2020, which proved that using 3% of the petroleum ether extract of the black seed *N. sativa* plant had the highest effect on the pupation and fertility rates when treating silkworms artificially infected with the *Bacillus bacterium*, while higher concentrations of basil plant extract *O. basilicum* increased the total protein in haemolymph of *B. mori* silkworm. Also, Mahmoud *et al*., 2019 were able to improve some of the biological characteristics and technological features of *B. mori* silkworms by using extracts of *N. sativa* and *O. basilicum* in raising silkworms, which positively affected the quantity and quality of the final cocoon crop.

Impact of Different Three Land Snail's Powder on Some *B. Mori* Characteristics:

The results in Table 2 present a comparison of the effect of adding two different levels of powder 50 and 100 g from three different types of land snails (*E. vermiculata*, *H. vestalis* and *M. cardusiana*) to the mulberry silkworm *B. mori* diet on some important biological characteristics of it. The results proved that when calculating the death rates compared to the control, it became clear that no death rates appeared when using 100 g of *E. vermiculata* powder, while it was the highest with 50 g of *M. cardusiana*. From the results, it is also clear that the highest weights of the fifth larval age, as well as silk gland, were recorded when 100 g powder of *E. vermiculata* and *H. vestalis* were used with *B. mori* food, followed by 100 g of *M. cardusiana* with (3.98, 3.92 and 3.46 g) and (1.47, 1.45 and 1.40 g) respectively, while the lowest value of these weights 2.14 and 0.67 g was recorded with 50 g of *M. cardusiana*. As for the length of silk gland, the total ratio of pupation, and the weight of the formed pupa, their values were the highest due to the addition of 100 g *E. vermiculata* and *H. vestalis*, followed by 50 g from *E. vermiculata* with (30.12, 29.52 and 28.09 cm), (98.27, 96.53 and 94.44 %) and (1.64, 1.56 and 1.52 g) respectively, but these values reached their lowest level

26.31 cm, 76.68 % and 1.36 g with 50 g from *M. cardusiana*. When the newly formed cocoons were weighed, *E. vermiculata* had the best results ever 1.94 and 2.03 g with its two different levels 50 and 100 g powder respectively, while the minimum value 1.75 g was calculated at the level of 50 g for *M. cardusiana* compared to the other two snails. On the other hand, the results shown in the table confirmed that the largest number of laid eggs 524.93, and the highest percentage of hatchability 84.58 % were recorded when *B. mori* was fed with mulberry leaves treated with 100 grams of *E. vermiculata* powder.

Table 2: Comparison of the effect of three different types of land snail's powder on some biological properties of *B. mori*.

Snail species	Powder (g)	Some tested biological properties of the silk worm *B. mori*								
		Mortality %	Fifth larval weight (g)	Silk gland weight (g)	Silk gland length (cm)	Pupation %	pupal weight (g)	Fresh cocoon weight (g)	Av. No of eggs	Hatchability %
E. vermiculata	50	2.07± 0.24 ^{d}	2.68± 0.23^{c}	1.25± 0.04^{b}	28.09± 0.64^{b}	94.44± 0.42^{bc}	1.52± 0.05^{abc}	1.94± 0.01^{ab}	455.70± 17.74^{b}	72.53± 1.34^{b}
	100	0.00± 0^{e}	3.98± 0.01^{a}	1.47± 0.06^{a}	30.12± 0.35^{a}	98.27± 0.51	1.64± 0.07^{a}	2.03± 0.06^{a}	524.93± 14.38^{a}	84.58± 1.91^{a}
H. vestalis	50	5.21± 0.53^{b}	2.27± 0.10^{cd}	1.05± 0.12^{c}	27.31± 0.41^{bc}	92.79± 1.42^{cd}	1.42± 0.05^{bcd}	1.88± 0.03^{bc}	449.60± 16.74^{b}	71.40± 1.18^{b}
	100	4.04± 0.04^{c}	3.92± 0.22^{a}	1.45± 0.03^{a}	29.52± 0.40^{a}	96.53± 0.48^{ab}	1.56± 0.03^{b}	1.91± 0.03^{ab}	497.37± 7.68^{a}	81.43± 1.18^{a}
M. cardusiana	50	7.12± 0.54^{a}	2.14± 0.08^{d}	0.67± 0.02^{d}	26.31± 0.44^{c}	76.68± 2.23^{f}	1.36± 0.06^{cd}	1.75± 0.04^{cd}	363.83± 10.53^{c}	70.04± 3.75^{b}
	100	4.78± 0.20^{bc}	3.46± 0.04^{b}	1.40± 0.03^{ab}	26.62± 0.11^{c}	89.15± 0.75^{e}	1.41± 0.04^{bcd}	1.84± 0.07^{bcd}	384.33± 17.40^{c}	70.39± 1.47^{b}
Control		0.00± 0^{e}	2.65± 0.03^{c}	0.91± 0.06^{c}	26.26± 0.06^{c}	90.23± 0.75 ^{de}	1.32± 0.03^{d}	1.71± 0.05^{d}	392.27± 2.43^{c}	69.41± 0.57^{b}
LSD at 0.05 for		0.94	0.40	0.18	1.19	3.40	0.15	0.14	37.02	5.71

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

Finally, the previous results confirmed that the use of ground snail's powder for *E. vermiculata, H. vestalis* and *M. cardusiana* in *B. mori* breeding had a clear effect on improving the qualities of the worm, which ultimately affects the final production of silk, with noting that higher levels of powder 100 g had the greatest effect. Among the things that were most confirmed by the results was that *E. vermiculata* snail was the best type in worm feeding, followed by *H. vestalis*, while *M. cardusiana* was the least in affecting the characteristics of *B. mori* silkworm.

When garden snail *Limicolaria aurora* meat meal was used in *Clarias gariepinus* fish feeding as an important source of protein, this led to great positive results in improving fish characteristics, as weight increased and the efficiency of fish increased in food conversion and make the most of the nutrients, Sogbesan *et al*., 2006. On the other hand, Diarra *et al*., 2015 used meals from ground snails *Achatina fulica* in raising chickens as a substitute for expensive fish meals, and this resulted in good results in laying eggs while reducing the cost of production and breeding. *E. vermiculata* land snail powder was used to improve the properties of *B. mori* by Ghazy *et al*., 2017, and the results were remarkable, as the use of *E. vermiculata* led to the improvement of twelve traits as fifth duration (days), total larvae duration (days), mortality percentage, number of cocoon per liter, cocooning percentage, pupation ratio, fecundity, cocoon weight, cocoon shell weight, pupal weight, cocoon shell ratio, and silk productivity.

Impact of Three Different Snail's Powder and *N. Sativa* Extract on Some *B. Mori* Characteristics:

The observed results in Table 3 illustrate the effect of treating mulberry leaves provided to the mulberry silkworm *B. mori* with a mixture of 3% *N. sativa* plant extract and 100 g powder of the different three land snails *E. vermiculata, H. vestalis,* and *M. cardusiana* under test, on some important characteristics of *B. mori*. It was evident from the results that

the best measurements for all tested traits appeared when the worm individuals were fed on mulberry leaf treated with a mixture of 3% *N. sativa* extract and 100 g of *E. vermiculata* powder, when the weights of the fifth larval age, silk gland, the formed pupa, and the newly formed cocoon reached 4.27, 1.93, 1.84 and 2.14 g respectively, while the length of the silk gland recorded 31.29 cm, on the other hand, the rate of pupation reached the highest 100 %, and the largest number of eggs were laid by the insect 598.63 eggs, due to this treatment, which in turn gave the highest percentage of hatching 92.59 % compared to the control, finally, the larvae individuals gave the highest index of the growth rate 5.00 also, noting that no mortality rates were found during the experience when this treatment was used with the silkworm food. The second place in terms of the effectness on the tested worm traits was the share of the treatment (3% *N. sativa* extract + 100 g of *H. vestalis* powder), when the measurements of most of the studied worm's traits were decreased slightly from the first treatment, noting that this treatment led to a rate of pupation reached 100% as well as the first treatment, with very small individual mortality rates of 1.2 %. The results also confirmed that the treatment (3% *N. sativa* extract + 100 g of *M. cardusiana* powder) had the least effect on the worm's characteristics, although it clearly outperformed the control.

Table 3: The effect of mixing *N. sativa* extract with three land snail's powder on some biological properties of *B. mori*.

snail powder +plant extract	Some biological properties of *B. mori*									
	Mortality %	Fifth larval weight (g)	Silk gland weight (g)	Silk gland length (cm)	Pupation %	pupal weight (g)	Fresh cocoon weight (g)	Av. No of eggs	Hatchability %	Growth index
E. vermiculata* + *N. sativa	0.00± 0^{b}	4.27± 0.06^{a}	1.93± 0.03^{a}	31.29± 0.83^{a}	100.00± 0.00^{a}	1.84± 0.02^{a}	2.14± 0.01^{a}	598.63± 5.86^{a}	92.59± 0.32^{a}	5.00± 0.00^{a}
H. vestalis* + *N. sativa	1.20± 0.28^{a}	4.12± 0.12^{a}	1.86± 0.05^{ab}	30.62± 0.25^{ab}	100.00± 0.00^{a}	1.68± 0.03^{b}	2.01± 0.01^{b}	583.43± 5.23^{b}	90.19± 0.12^{a}	3.91± 0.02^{b}
M. cardusiana* + *N. sativa	1.70± 0.23^{a}	4.09± 0.21^{a}	1.77± 0.05^{b}	29.21± 0.38^{b}	98.26± 0.31^{a}	1.61± 0.01^{c}	1.83± 0.01^{c}	407.40± 2.34^{c}	74.69± 0.77^{b}	3.38± 0.08^{c}
control	0.00± 0^{b}	3.16± 0.12^{b}	1.36± 0.04^{c}	26.32± 0.03^{c}	78.56± 1.23^{b}	1.12± 0.01^{d}	1.59± 0.03^{d}	351.87± 1.59^{d}	63.22± 1.24^{c}	2.14± 0.01^{d}
LSD at 0.05 for	0.59	0.46	0.13	1.54	2.08	0.06	0.06	13.62	2.44	0.13

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

It is evident from the previous results that using a mixture of *N. sativa* extract with any snail's powder meal to feed the mulberry silkworm had a very high effect on improving its properties, but the degree of the effectness differed according to the snail type, where the higher effect of *E. vermiculata*, was immediately followed by *H. vestalis*, and the least influential of them was *M. cardusiana*. This great positive effect of *E. vermiculata* and *H. vestalis* powder on improving the qualities of *B. mori* silkworm may be due to their bodies containing significant proportions of important nutrients, which play a fundamental role in improving the growth rate and thus directly affect the quantity and quality of the final production of silk.

Ghazy *et al*., 2017 proved that *E. vermiculata* snail powder alone or adding it to some materials as (paraformaldehyde, salicylic acid, and benzoic acid) in the rearing of two hybrid varieties of mulberry silkworm *B. mori* called H1X UV X G2 X V2 and L444, led to a significant improvement in many worm's properties, as well as the final qualities of the silk product compared to other treatments in which the land snail was not used.

Chemical Analysis of the Most Important Elements of the Three Types of Land Snails:

Data in Table 4 monitor a comparison to analyze the most important chemical elements in the bodies of three different types of land snails *E. vermiculata*, *H. vestalis*, and *M. cardusiana*, and as shown, the results proved that the body of *E. vermiculata* land snail contained the higher proportions of all elements under study, where the total percentage of protein, carbohydrates, sugars, fats, phosphorous and calcium reached 22.62, 12.88, 7.06,

3.69, 0.61 and 7.82 % respectively, this type was able to give *B. mori* worm total energy reached 175.18 kcal / 100 g. As for *H. vestalis* snail was contained high proportions of the previous elements also, but it came in second place when compared to *E. vermiculata*. The lowest percentages of elements were recorded for *M. cardusiana*. Finally, it becomes clear that land snails generally contain high levels of protein, carbohydrates and sugars, as well as calcium, which have an important and effective role in the growth of *B. mori* body. Snails also contained fats and phosphorous, but in lower proportions than other elements.

Table 4: Comparison analysis of the most important elements of three different types of land snails**.**

Snail type	Land snails elements %						
	Proteins %	Carbohydrates %	Sugars %	Fats %	Phosphorous (P) %	Calcium (Ca) %	Energy (kcal/ 100g)
E. vermiculata	22.62±0.27^{a}	12.88±0.33^{a}	7.06±0.01^{a}	3.69±0.05^{a}	0.61±0.02^{a}	7.82±0.15^{a}	175.18±1.79^{a}
H. vestalis	20.61±0.30^{b}	10.14±0.14^{b}	7.03±0.02^{a}	3.48±0.01^{b}	0.58±0.02^{a}	7.59±0.02^{a}	154.35±1.64^{b}
M. cardusiana	16.49±0.29^{c}	8.24±0.04^{c}	6.43±0.08^{b}	2.82±0.01^{c}	0.42±0.01^{b}	7.13±0.01^{b}	124.26±1.00^{c}
LSD at 0.05	0.99	0.71	0.16	0.11	0.06	0.31	5.24

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

Fagbuaro *et al*. (2006) confirmed that ground snails *Archachatina marginata* (ovum) Pfeiffer, *Archachatina marginata* (saturalis) Philippi, *Achatina achatina* and *Limicolaria* spp. contain large proportions of protein, as well as calcium, sodium, magnesium, potassium, iron, and phosphorous which have an effective role in the body growth process. This statement was also confirmed by Engmann *et al.* (2013) when they discovered that the land snail *Achatina achatina* body is rich in the most important elements that benefit the body, such as proteins and many other elements, the most important of which are calcium.

Conclusion

The use of plant extracts has an effective effect on the biological properties of mulberry silkworm, but these properties were significantly improved when they were replaced with ground snail powder and added to the worm's food, and when using the two together, especially the black seed plant *N. sativa* extract and ground snail powder *E. vermiculata* or *H. vestalis*, the results were much better. . . Hence, it can be said that the use of ground snails' powder alone or with some plant extracts is very beneficial in improving the biological properties of mulberry silkworms as they are easy to obtain and inexpensive as well as easy to use and give excellent results which ultimately affects the quantity and quality of the resulting silk.

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ARABIC SUMMARY

رؤية جديدة لتحسين الخواص البيولوجية لدودة الحرير التوتية ***Bombyx mori*** بأستخدام مسحوق ثلاثة أنواع مختلفة من القواقع الأرضية والمستخلصات النباتية

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تمت هذه الدراسة لتوضيح تأثيرأضافة جرعات مختلفة (50 و100 جرام) من بودرة ثلاثة أنواع من القواقع الأرضية ***Eobania vermiculata , Helicella vestalis , Monacha cardusiana*** وكذلك تركيزات مختلفة (2 , 3 ٪) من بعض المستخلصات النباتية ***Nigella sativa , Allium sativum , Moringa oleifera*** ألى غذاء دودة الحرير التوتية على تحسين بعض الصفات البيولوجية (نسبة الوفيات, وزن العمر اليرقى الخامس, وزن غدة الحرير, طول غدة الحرير, نسبة التعذر, وزن العذراء, وزن الشرانق, عدد البيض الكلى, نسبة الفقس, معدل النمو) الخاصة بدودة الحريرالتوتية ***Bombyx mori***. أظهرت النتائج أن تركيز 3٪ من مستخلص ***N. sativa*** في غذاء الدودة كان له التأثير الأفضل على جميع الصفات المختبرة مقارنة بالمستخلصات النباتية الأخرى. كما أكدت النتائج أن 100جرام من مسحوق القواقع الأرضية الثلاثة أدى ألى تحسين الصفات البيولوجية المختبرة لدودة الحرير التوتية بشكل كبير, بل وتفوقت على نتائج المستخلصات النباتية الثلاثة المختبرة. ولكن النتائج الأفضل تم تسجيلها لصالح القوقع الأرضى ***E. vermiculata*** يليه النوع ***H. vestalis***, وعندما تم خلط 3٪ من مستخلص ***N. sativa*** مع 100 جم من القواقع الأرضية الثلاثة المختلفة في الغذاء ، أدى ذلك إلى نتائج ممتازة في قياسات جميع الصفات المختبرة ، خاصة في حالة القوقع الأرضي ***E. vermiculata***. تم إجراء تحليل كيميائى لأهم العناصر الغذائية الموجودة في أجسام القواقع الأرضية المطحونة المختبرة، وأوضحت النتائج أن أجسامهم تحتوي على مستويات عالية من البروتينات والكربوهيدرات والسكريات وكذلك بعض المعادن الهامة خاصة النوعين ***E. vermiculata*** و ***H. vestalis***