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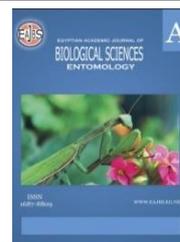
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Improving the Silkworm, *Bombyx mori* L. Cocoon Yield by Supplying the Larval Stage Diet with A Vitamin Mixture

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ABSTRACT

A mixture of vitamins in the cocoon yield of silkworm, *Bombyx mori* L. (Chinese hybrid-9f7x) was studied. Vitamins concentrations were 2, 4, 6 and 8 mg/ml. Results showed that; the concentration was 8mg/ml. of the mixture of vitamins was the best treatment. The weights of fifth instar larvae were 2.125 g when compared to 2.000 g in the control, the weights of pupae recorded 0.800g compared to 0.711g in the control, mortality percentages of the fifth instar were 6.25% when compared to 7.50% in control, durations of the fifth instar larvae were 9.15 day comparing to 9.65 days in control, percentages of cocooning were 93.69% comparing to 90.05% in the control, the productivity of silk was 2.38 cg/day comparing to 1.89 cg/day in control, weights of cocoon were 1.186 g, comparing to 1.031 g in the control, weights of cocoon shell were 0.218 g when compared to 0.183 g in the control and ratio of cocoon shell were 18.38% compared to 17.74% in the control.

INTRODUCTION

The main final sericulture product is natural silk fibre. The silk cocoon production is the most important source for sericulture farmers' and companies' income. The vitamins present in the mulberry leaves fulfil the minimum needs of the silkworm, but their quantities vary in mulberry leaves with variations in the climatic conditions, seasons, mulberry varieties, and fertilization (Etebari, 2002). Providing mulberry leaves with certain nutritive materials such as vitamins and other nutritive compounds has proved to be useful for improving crop yield (Rajegowda, 2002). The vitamin is referred to as an accessory indispensable food factor required by an organism in small quantities to maintain normal growth and regulation of metabolism. Lack of any vitamins in the diet of young animals causes vitamin deficiency disease and reduces animal growth. These symptoms can be cured or prevented by supplementation of the vitamin-rich food. (Kumara and Kumar, 2016). Vitamins are one of the major organic compounds that are essential for normal metabolic activities. (Udayan and Kumar, 2022). The present study aimed to establish the effect of a mixture of vitamins on the cocoon yield of the silkworm, *B. mori* L.

MATERIALS AND METHODS

Insect:

The egg of *Bombyx mori* (Chinese hybrid -9f7x) was obtained from the Seric. Res. Dept., Plant Protec. Res. Inst, Agric. Res. Center. Dokki, Giza.

Materials:

Vitamins mixture consists of A, E, C, B1, B6, D3, K3, folic acid, niacin, biotin and pantothenic acid (8000IU,50IU,3IU,2 mg,4mg, 3000IU,3IU, 1mg, 40mg, 0,01mg and 10mg respectively). This mixture was manufactured by medical professionals for veterinary products and fodders additions.

Treatments:

Four concentrations (2, 4, 6 and 8 mg/ml distilled water.) of vitamins mixture were prepared. After that washed and dried mulberry leaves were treated with each of the prepared concentrations and left to dry under laboratory conditions. At the beginning of the fifth larval instar, larvae were divided into four groups (in addition to the control), and each group consisted of 20 larvae. Larvae were provided with treated leaves, in addition to provide one with untreated leaves as control. All treatments were replicated three times and kept under laboratory conditions ($28\pm 2^{\circ}\text{C}$, $75\% \pm 5\text{RH}$). Treatments were examined daily to supply them with food and record the larval mortality and pupation.

Tested Parameters:

Weights, mortality percentages and durations of 5th instar larvae; weights of pupae, percentages of cocooning, weights of cocoon, weights of cocoon shell, ratio of cocoon shell and productivity of silk were determined for all treatments and control.

Statistical Analyses:

To find out the variance between experimental groups and control, data were analyzed by one-way analysis of variance through SPSS (Berkowitz and Allaway 1998). Means were separated by (L.S.D at 0.05%).

RESULTS AND DISCUSSION

Weights of the Fifth Instar Larvae and Pupae:

The weight means of the fifth instar larvae increased gradually with the increase of vitamin mixture. The weight means ranged from 2.000 to 2.125 g for control and the highest concentration (8 mg/ml) of a mixture of vitamins, respectively. Concerning pupae weight, the means of weights of pupae ranged between 0.711 g for control and 0.800 g for 8 mg/ml concentration of vitamins mixture (Table I).

Mortality Percentages of the Fifth Instar:

Data in Table (I), showed that the percentage of larval mortality ranged from 6.25 to 7.50%. The lowest mortality occurred at the highest concentration of vitamin mixture (8 mg/ml distilled water), while the highest percentage of mortality was obtained at control treatment.

The results of the present study are similar to the previous results obtained by many researchers who found improvements in the weights of *B. mori* larvae and pupae by treating mulberry leaves with folic acid (Nirwan & Kaliwat, 1996). Saha & Khan (1996) and Cui *et al.*, (2003) revealed that the treatment of mulberry leaves with vitamins and minerals influenced *B. mori* growth and development. Improvement of the larval characteristics by adding different concentrations of vitamins ascorbic acid, folic acid, thiamin and vitamin B complex (Etebari and Matindoost, 2004). Ganesh *et al.*, (2012) reported that the number of nutrients in different varieties of mulberry has a significant effect on the growth and development of larvae and cocoon production,

Table 1: Experimental groups treated with concentrations of a mixture of vitamins on weights of fifth instar larva, weights of pupa and mortality percentages of fifth instar larva of *Bombyx mori* L.

Concentrations (mg/ml.)	The 5 th larval instar Weight (g)	Weight of pupa (g)	% Mortality of the 5 th larval instar
2	2.010±0.0519c	0.731±0.0223b	6.75±0.0649b
4	2.076±0.1320b	0.748±0.0362ab	6.50±0.1856bc
6	2.092±0.0284b	0.760±0.0158ab	6.50±0.0480bc
8	2.125±0.0237a	0.800±0.0064a	6.25±0.1292c
control	2.000±0.1193c	0.711±0.0204b	7.50±0.1422a
F value	**	*	*
LSD at 0.05%	0.020	0.068	0.489

Duration of Fifth Larval Instar, Percentages of Cocooning, and Silk Productivity:

Data in Table (2), showed that the duration means of the 5th larval instar, percentages of cocooning and silk productivity vary with different vitamin mixture concentrations. The treatment with an 8mg/ml vitamin mixture concentration shortened the duration of the 5th larval instar (9.15 days) compared with all other treatments. In contrast, the percentages of cocooning increased gradually by increasing of vitamin mixture concentration. The highest percentage of cocooning was 93.69% at 8mg/ml concentration, while that of the control treatment was 90.05%. Concerning silk productivity, it was found that treating mulberry leaves with 8mg/ml of vitamin mixture increased the productivity of silk compared with that of the control treatment. The means of silk productivity were 2.38 and 1.89 cg/ day for 8mg/ml vitamin concentration and control treatments, respectively.

In the present study, it has been observed that data similar to Etebari and Matindoost, (2004) who revealed that the larval characteristics can be improved by supplying the larvae diet with some vitamins such as ascorbic acid, folic acid, thiamin, vitamin B complex, Ganesh *et al.* (2012) reported that the variation of nutrient components in mulberry varieties influences on the growth and development of larvae and cocoon production.

Table (2): Experimental groups treated with concentrations of a mixture of vitamins on durations of fifth instar larvae, percentages of cocooning and productivity of silk of *Bombyx mori* L.

Concentrations (mg/ml.)	Duration of 5 th larval instar (days)	% of cocooning	Silk productivity (cg/day)
2	9.50±0.0848ab	90.34±0.0067bc	1.88±0.2046b
4	9.30±0.0678ab	90.18±0.0136bc	1.89±0.3678b
6	9.25±0.0499ab	92.17±0.0042ab	2.14±0.1368ab
8	9.15±0.0455b	93.69±0.0035a	2.38±0.2377a
control	9.65±0.0448a	90.05±0.0067c	1.89±0.2546b
F value	*	*	**
LSD at 0.05%	0.467	2.011	0.301

As shown in Table (3), the means of cocoons weight ranged from 1.031g and cocoon for control to 1.186g and cocoon for 8 mg/ml concentration of vitamins mixture. Means of cocoon shell weights ranged from 0.183 to 0.218 g/cocoon for control and 8 mg/ml concentration of vitamins mixture, respectively. The means of the ratio of cocoon shell ranged between 17.56 % for 2 mg/ml and 18.38 % for 8 mg/ml of mixture of

vitamins.

Data in the present study agree with Cui *et al.* (2003) when using vitamin C on feeding habits and growth of the silkworm, *Bombyx mori*. Etebari and Matindoost, (2004) revealed that larval characteristics can be improved by supplementing different concentrations of vitamins such as ascorbic acid, folic acid, thiamin, and vitamin B complex. Saiful (2005) found improvement in the reproduction of *Bombyx mori* when using pyridoxine. Rahmathulla *et al.*, (2007) & Ganesh *et al.* (2012) reported that the number of nutrients in different varieties of mulberry has a significant influence on the growth and development of larvae and cocoon production when using treated leaves with folic acid.

Table 3: Experimental groups treated with concentrations of a mixture of vitamins on cocoon indices of *Bombyx mori* L.

Concentrations (mg/ml.)	Weight of cocoon (g)	Weight of cocoon shell (g)	Ratio of cocoon shell (%)
2	1.036±0.0252b	0.182±0.0067b	17.56±0.2046b
4	1.040±0.0487b	0.188±0.0136ab	18.07±0.3678ab
6	1.085±0.0166b	0.198±0.0042ab	18.24±0.1368a
8	1.186±0.0059a	0.218±0.0035a	18.38±0.2377a
control	1.031±0.0255b	0.183±0.0067b	17.74±0.2546b
F value	**	**	**
LSD at 0.05%	0.087	0.031	0.517

Declarations:

Ethical Approval: Ethical Approval is not applicable.

Funding: This work has received no external funding.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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ARABIC SUMMARY

تحسين محصول شرانق دودة الحرير التوتية باستخدام مخلوط من الفيتامينات

نجاه حامد سليمان

قسم وقاية النبات، كلية الزراعة، جامعة الفيوم، مصر.

خلال فصل الربيع لعام 2022 تمت دراسة تأثير أوراق التوت المعاملة بمخلوط من الفيتامينات بربع تركيزات مختلفة (2-4-6-8 مجم/ملتر) علي محصول شرانق دودة الحرير التوتية . تم اذابة المخلوط الفيتامينات في الماء المقطر ورش اوراق التوت بها. تم تغذية يرقات هجين صيني بواسطة ورق توت هندی بدون أي معاملة خلال الأربع أعمار اليرقية الأولى. بعد الانسلاخ الرابع تم تقسيم اليرقات الي اربع مجموعات بالاضافة للكنترول وكل مجموعة قسمت الي ثلاث مكررات وكذلك الكنترول. تم دراسة تأثير خليط الفيتامينات على كل من وزن اليرقات وكذلك العذاراي ونسب الموت ومدة العمر اليرقي ونسبة التشرنق وانتاجية الحرير واوزان كل من الشرانق وقشورها وكذلك حساب نسبة الحرير. كانت أفضل النتائج هي مجموعة اليرقات التي تغذت على الأوراق التي تم معاملتها بالتركيز 8 مجم/ملتر.