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INFLUENCE OF MICRONUTRIENTS FORTIFIED MULBERRY LEAVES ON LARVAL GROWTH AND COCOON PARAMETERS OF MULBERRY SILKWORM, *Bombyx mori* L

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted to know the effect of micronutrients on the growth and cocoon characters of silkworm, *Bombyx mori* L. The mulberry leaves (*Morus alba*) were fortified with minerals such as, zinc sulphate, copper sulphate and ferrous sulphate at different concentrations (5,10,15,20 and 25 ppm) and fed to the silkworm. Among these five concentrations tested , it was observed that the zinc sulphate at 15 ppm, copper sulphate at 10 ppm and ferrous sulphate at 20 ppm registered higher mature larval weight, effective rate of rearing, cocoon weight, shell weight, shell ratio and filament length than the control and other treatments.

Keywords: *Bombyx mori; micronutrients; growth; ERR; Cocoon characters.*

1. INTRODUCTION

Micronutrients play a major role in several metabolic activities responsible for protein, sugar and enzyme synthesis leading to better quality mulberry leaf production [1]. Silkworms fed with good quality mulberry leaves enriched with micronutrient supplements in optimum quantity, results in successful seed cocoon production. Many studies focusing on the effect of the minerals on silkworm

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were undertaken by various workers in different period of time [2-5]. The minerals administered to silkworms determined an increase in the length and weight of the larvae [6]. Oral supplementation with copper sulphate, potassium chloride increases the economic parameters and larval weight in silkworm [7]. Feeding with calcium, magnesiumand ferrous sulphate to silkworm have been shown to increase the commercial characters and decrease the larval duration [8]. Supplementation of iron chloride resulted in better economic characters of silkworm [9]. Zinc fortified mulberry leaves increases the quality parameters of cocoons [10,11]. Micronutrients in combination significantly influenced the cocoon characteristics [12-14]. Therefore, the quality of leaves largely determines the performance of silkworm during their development and spinning of quality cocoons. In view of above, the present study was undertaken to study the effect of micronutrients, such as zinc, copper and ferrous sulphates on mulberry silkworm, *Bombyx mori* L. for larval and cocoon parameters (Fig. 1).

Fig. 1. Micronutrients

2. MATERIALS AND METHODS

The experiment was conducted at department of Zoology, Muslim Arts College, Thiruvithancode. The mulberry variety used in the study was MR_2 cultivated under irrigated conditions with wider spacing. The commercial multi x bivoltine hybrid $PMxCSR_2$ was used for the study. The larvae were fed individual leaves three times a day and the required concentrations (viz.,5,10,15, 20 and 25 ppm) such as zinc, copper and ferrous sulphateswere prepared by serial dilution.

2.1 Methods of Application

Weighed quantities of fresh mulberry leaves were sprayed with an aqueous solution of the respective minerals. The leaves treated with mineral solutions were shade dried for 30 minutes and fed on alternate days during third, fourth and fifth instars. One larval batch fed with distilled water sprayed mulberry leaves (Fig. 2).

The mature larvae were mounted. The cocoons were harvested six days after spinning separately 3 replication wise and the following observations were recorded.

Control Zinc Sulphate treated worms

Copper Sulphate treated worms Ferrous sulphate treated worms

Fig. 2. Supplementation of micronutrients with silk worms

2.2 Total Body Weight

The total body weight of fifth instar silkworms of both control and experimental groups were recorded. Mean silkworm larval weight (mg) was calculated.

2.3 Effective Rate of Rearing (ERR%)

ERR was computed on the basis of larval count at the 5^{th} instar stage. It was calculated by using the following formula.

$$ERR = \frac{\text{Total number of cocoons harvested}}{\text{Total number of larvae in the 5th instar}} x100$$

2.4 Weight of Cocoon

10 cocoons were taken and the weights recorded and the single cocoon weight was calculated in mg (Fig. 3).

2.5 Weight of Shell

10 shells were taken and the weight were recorded and single shell weight was calculated in mg.

2.6 Shell Ratio

Shell ratio was calculated using the following formula and expressed in percentage.

$$\text{Shell ratio} = \frac{\text{Weight of shell}}{\text{Weight of cocoon}} \times 100$$

2.7 Filament Length

The total filament length was measured in meters. Filament length = Length of raw silk m x 1.125 circumference / No. of reeling cocoons (Fig. 4).

The data were statistically analysed by mean and standard deviations.

Fig. 3. Cocoons

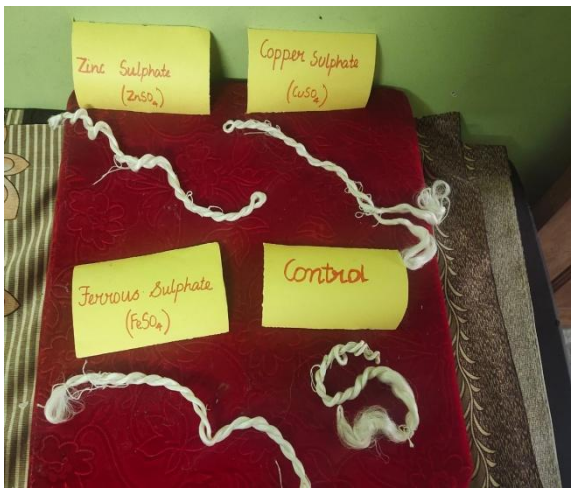

Fig. 4. Raw silk

3. RESULTS

The present investigation revealed that fortification of mulberry leaves with zinc sulphate at different concentrations had a positive impact on the growth and economic parameters of silkworm (Table 1). Application of zinc sulphate at 15 ppm significantly increased the larval weight 1015.2±6.80 mg to 1042.4±9.12 mg which was found to be superior over all treatments. The enhancement of larval weight is 2.66 per cent over control. This was followed by 20 ppm, 10 ppm, 25 ppm and 5 ppm. The 5 ppm concentration registered lower larval weight of 1015.2±6.18mg, which was on par with the control. Effective rate of rearing is the key indicator for successful silkworm rearing. In the present study, highest ERR of 89.16 percent was recorded in 15 ppm.

Present study showed that enrichment of mulberry leaves with varied concentrations of zinc sulphateelucidated considerable positive effect on the cocoon parameters. Highest cocoon weight(1200±68.16mg) and filament length (780±16.36m) were registered in the larvae fed with 15 ppm treated mulberry leaves. This treatment was followed by 20 ppm,10 ppm,5 ppm and 25 ppm. The least cocoon weight of 1022±94.72 mg was observed in the control.

Table 2 shows the effect of copper sulphate fortified mulberry leaves on larval and cocoon parameters. 10 ppm copper sulphate enhanced the larval weight (1041.6±5.91 mg) followed by 20 ppm, 25 ppm, 15 ppm and 5 ppm. In control, the larval weight was noticed as 1015.2±6.80 mg. Highest effective rate of rearing (88.16±1.96 mg) was recorded at 10 ppmwhen compared to control and other treatments. Copper sulphate administration improved the cocoon parameters. Maximum cocoon weight (1190±90.14 mg), shell weight(220±8.42 mg), shell ratio (18.48 ±0.26%) and filament length (762±16.36m) were recorded at 10 ppm.

Table 3 shows the larval and cocoon parameters of silkworm,*B.mori* influenced by ferrous sulphate. Maximum larval weight (1038.6±4.26mg) was observed at 20 ppm when compared to control (1015.2±6.80mg) and other treatments. ERR also enhanced with ferrous sulphate(88.00±6.82%)with 20 ppm. In control group ERR was 78±2.60% .Regarding cocoon characters, at 20 ppm ferrous sulphate maximum cocoon weight (1198±84.72 mg), shell weight (220±1.92 mg), shell ratio (18.36±0.62%) and filament length (750±36.18m) were recorded, which was followed by 15 ppm, 25 ppm,10 ppm, 5 ppm and control.

4. DISCUSSION

The role of mineral nutrition, needs to be ascertained as it has a number of roles in reducing the duration of larval and pupal stages. Such studies provide

Table 1. Larval and cocoon parameters of silkworm, *B.mori* influenced by ZincSulphate

Concentration (ppm)	Mature larval weight (mg)	ERR (%)	Cocoon weight (mg)	Shell weight (mg)	Shell ratio (%)	Filament length (m)
5	1015.2±6.18 (0.30)	84.30± 1.40 (7.69)	1150 ±96.12 (12.52)	200± 2.66 (21.21)	17.39± 0.21 (7.74)	701± 22.16 (20.86)
10	1022.0± 6.16 (0.69)	86.02 ±2.61 (10.26)	1170 ±82.62 (14.48)	205 ±8.24 (24.24)	17.52± 0.64 (8.55)	710 ±18.45 (22.41)
15	1042.4 ±9.12 (2.66)	89.16 ±4.22 (14.31)	1200 ±68.16 (17.42)	220± 6.80 (33.33)	18.30 ±0.82 (13.38)	780 ±16.36 (34.48)
20	1040.2±18.16 (2.46)	88.14± 8.16 (12.82)	1180 ±76.82 (15.46)	210± 5.20 (27.27)	17.79±0.83 (10.22)	720 ±20.10 (24.14
25	1020.2± 9.17 (0.49)	80.46± 5.26 (3.15)	1100 ±92.98 (7.63)	195± 2.64 (18.18)	16.53 ±0.86 (2.42)	602± 15.10 (3.79)
Control	1015 ±6.80	78.00± 2.60	1022± 94.72	165± 4.80	16.14 ±0.24	580 ±16.44

Note :Per cent deviation over control values in parentheses

Table 2. Larval and cocoon parameters of silkworm, *B.mori* influenced by copper sulphate

Concentration (ppm)	Mature larval weight (mg)	ERR (%)	Cocoon weight (mg)	Shell weight (mg)	Shell ratio (%)	Filament length (m)
5	1016.4 ±3.11 (0.10)	82.18 ±0.50 (5.08)	1115 ±86.27 (9.10)	195± 1.58 (18.18)	17.49± 0.71 (8.36)	680 ±22.16 (17.24)
10	1041.6 ±5.91 (2.56)	88.16±1.96 (12.13)	1190 ±90.14 (16.44)	220± 8.42 (33.33)	18.48± 0.26 (14.50)	762± 16.36 (31.38)
15	1020.8 ±5.16 (0.49)	84.14±1.62 (7.54)	1148 ±76.14 (12.33)	200 ±9.14 (21.21)	17.42± 0.82 (7.93)	620± 18.45 (6.90)
20	1037.2 ±3.82 (2.17)	87.10±0.88 (11.54)	1170 ±92.70 (14.48)	200± 6.52 (21.21)	17.09 ±0.64 (5.89)	600± 20.10 (3.45)
25	1026.5 ±4.22 (1.08)	80.00±1.22 (3.76)	1060 ±78.16 (3.72)	190± 4.68 (15.15)	17.90 ±0.46 (10.90)	610± 15.10 (5.17)
Control	1015.2 ±6.80	78.00± 2.60	1022 ±94.72	165± 4.80	16.14 ±0.244	580± 16.44

Note:*Per cent deviation over control values in parentheses*

Table 3. Larval and cocoon parameters of silkworm, *B.mori* influenced by ferrous sulphate

Concentration (ppm)	Mature larval weight (mg)	ERR (%)	Cocoon weight (mg)	Shell weight (mg)	Shell ratio (%)	Filament length (m)
5	1017.2 ±3.15 (0.11)	83.18 ±1.26 (6.42)	1040 ±71.10 (1.76)	1.80± 1.46 (9.09)	17.31 ±0.72 (7.25)	708± 32.14 (22.07)
10	1024.9± 2.18 (0.89)	84.00± 1.64 (7.00)	1120 ±68.22 (9.59)	196 ± 2.62 (18.79)	17.50± 0.51 (8.43)	710 ±42.83 (22.41)
15	1027.4 ±5.82 (1.18)	86.16± 0.80 (10.30)	1180± 92.18 (15.46)	198± 1.84 (20.00)	16.77± 0.43 (3.90)	688 ±45.27 (18.62)
20	1038.6 ±4.26 (2.27)	88.00 ±6.82 (12.00)	1198± 84.72 (17.22)	220± 1.92 (33.33)	18.36± 0.62 (13.75)	750± 36.18 (29.31)
25	1022.2± 6.16 (0.69)	82.42± 2.15 (5.13)	1160± 66.24 (13.50)	195± 21.41 (18.18)	16.81± 0.23 (4.15)	690± 52.16 (18.97)
Control	1015.2 ±6.80	78.00± 2.60	1022± 94.72	165± 4.80	16.14± 0.24	580± 16.44

Note:*Per cent deviation over control values in parentheses*

evidences for practical application of micronutrients for qualitative and quantitative improvements in silk production. The positive impact of mineral nutrition on the silkworm economic traits has been well documented with reference to nutritional role of several minerals such as potassium iodide, cobalt chloride [15], copper sulphate, ferroussulphate and magnesium sulphates [8] and carbonates .In the present study , zinc sulphate , copper sulphate and ferrous sulphate were used to enrich the mulberry leaves and fed to silkworm larvae, which enhances the larval weight, effective rate of rearing and economic traits such as cocoon weight, shell weight, shell ratio and filament length.

The present observations were in correlation with the findings of Chamundeswari and Krishnan [16] who reported that supplementation of zinc chloride to silkworm at varied concentrations of 30, 60 and 120 mg/ml to fourth and fifth instar resulted in increased larval weight.

Kumar et al. [17] evaluated zinc, spirulina and their mixed effect on 5^{th}instar *B. mori* larvae and observed the commercial characters. All the treated groups other than control groups determined a significant increase of the larval weight, cocoon weight, and filament length parameters indicating the positive effects of the added nutrients in the mulberry leaves during the larval development. Choudhuri et al. [18] studied the effect of nano micronutrients to mulberry silkworm on larval and cocoon traits. They reported that nanoZnO + nanoCu each at 500 ppm resulted in significant superiority for yield and quality parameters of mulberry and subsequently when fed to silkworm, they exhibited improved performance in respect of full grown larval weight, total larval duration, effective rearing rate, and cocoon parameters. According to Nazer et al. [19] treatment of $ZnSo_4$(0.5%), $FeSo_4$(1%) and $MnSo_4$ imposed the yield parameters of silkworm, such as, larval weight, ERR, single cocoon weight, single shell weight and shell ratio.In the present study, 15 ppm zinc sulphate, 10 ppm copper sulphate, 20 ppm ferrous sulphate increased the larval and economic parameters. As per Murugesh et al. [20] administration of mineralsviz, zinc sulphate, magnesium sulphate and potassium chloride at 100 ppm, 200 ppm and 100 ppm respectively during third, fourth and fifth instars of silkworm, *B.mori* significantly improved the biological traits of larvae as well as economic traits of cocoons. Jayappa et al. [21] explained that combinations of micronutrients (Boron + Zinc, Born+Copper, Zinc+ Copper and Boron + Zinc + Copper) fortified on two mulberry varieties showed enhanced seed cocoon traits like cocoon weight and shell weight.

5. CONCLUSION

This study demonstrated that application of micronutrients such as, zinc sulphate (15 ppm) , copper sulphate (10 ppm), and ferrous sulphate (20 ppm) on mulberry leaves, when fed to silkworm, *B.mori* enhanced the larval weight , effective rate of rearing and cocoon characters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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