EFFECT OF ZINC OXIDE NANOPARTICLES ON FEED EFFICACY OF MULBERRY SILKWORM, *BOMBYX MORI* (L.) (LEPIDOPTERA: BOMBYCIDAE)

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ABSTRACT

The silk industry has developed as a popular cottage industry providing self-employment to more than ten million rural persons in the unorganized sector. Efforts are being made to evolve effective new technologies, that labor-saving and eco-friendly. The silkworm, *Bombyx mori* L. is a monophagous lepidopteran insect that has been domesticated for more than five thousand years. Fresh and healthy leaves of the MR2 variety of mulberry leaves were used in the present study. These MR2 varieties promote the growth of silkworms. Zinc oxide nanoparticles could increase some biological characteristics of silkworm *B. mori*, but this enhancement could economically improve the sericulture goals. During our study period, after 96hrs, the weight of the mulberry silkworm was gradually increased from lower concentrations to higher concentrations [(0.5%, 1.0%, 1.5%, and 2.0%)]. Compared to the control, the higher concentrations (2.0%) showed more growth rate than other concentrations (1.5% and 1.0%). The single cocoon and shell weight were increased depending upon their concentrations compared to the control, after the exposure time of 24, 48, 72, and 96hrs. In the present study, the treatment of Zinc oxide nanoparticles at the concentrations of 1.5% and 2.0% respectively beneficial effects on the growth of the silkworm larval, cocoon, and pupal parameters and also increases the quantity of silk by enhancing the feed efficacy. This supplementation could be prescribed to the farmers to get more quantity of silk.

Keywords: Zinc oxide nanoparticles, *Bombyx mori*, supplementary feed, economic parameters, growth parameters.

INTRODUCTION

Since morin is present, the only food and nutrition available to *Bombyx mori*, the silkworm, is the leaf of the mulberry (*Morus* species). Mulberry leaves fed to silkworms as a dietary supplement have been the subject of extensive research recently. Vitamins including ascorbic acid, thiamin, niacin, folic acid, multivitamins, and vitamin C are included in these supplements. The growth and development of *B. mori* L., the silkworm, as well as other species, are enhanced by proper nutrition. Larval nutrition is essential for the production of silk, and mulberry leaves' nutritional value is highly successful in raising high-quality cocoons. the improved development and growth of silkworm larvae fed on nutrient-rich leaves, as well as the production of high-quality cocoons. Because silkworms are monophagous and can finish their life cycle on mulberry leaves, they get all the nutrients they need from these leaves. In general, the vitamins found in mulberry leaves meet the minimal requirements of silkworms; however, the specific amount of vitamins found in mulberry leaves varies depending on the field conditions, mulberry species, and fertilizer use. For appropriate growth, survival, and the development of its silk glands, *B. mori* needs a certain set of necessary carbohydrates, amino acids, proteins, and vitamins. It was discovered that vitamins and mineral salts were crucial for the nutrition of silkworms. Numerous researchers have looked into how vitamin supplementation affects *B.mori* growth (Etebari and Fazilati, 2003; Etebari *et al.*, 2004; Faruki, 1998). The larval instars of the Silkworm, *B. mori*, have no other food source except mulberry leaves. This is a typical example of a monophagous insect. Since silkworms produce a great deal of silk for human use, scientists have been working to identify the variables that can be changed to the silkworms' advantage. In India, sericulture has long been a land-based industry with significant job potential and financial advantages for rural households. The second-biggest producer of mulberry silk is India. The earth's richest supply of organic chemicals is plants, and it has been noted that certain insects' lives and behaviors are influenced by phytochemicals. In tests conducted to supplement food for the growth of silkworm *B. mori*, a variety of extracts from medicinal plants were found to affect the silkworm's body weight, silk gland weight, and silk thread length (Murugan *et al.,* 1998). Programs for breeding and managing silkworms must take into account the physiological and nutritional needs of hybrids in ecological circumstances to make them need-based. Therefore, the growth and economic factors

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of the multivoltine, cross-breed silkworm, *B. mori* (L) (Race: PMX csr2), have also been the subject of this study.

MATERIALS AND METHODS

Preparing plant extract

On the college campus, fresh *Calotropis procera* leaves were gathered. After three water washes to get rid of any dust, the leaves were dried in the shade to get rid of any remaining moisture. To create the extract for the reduction of zinc ions (Zn^{2+}) to zinc oxide nanoparticles (ZnO), 50 g of freshly washed, finely chopped leaves were combined with 100 ml of sterile distilled water in a 250 ml glass beaker. After that, the mixture was brought to a boil for ten minutes, or until the watery aqueous solution turned pale yellow. After cooling the extract to room temperature, filter paper was used to filter it. To be employed in upcoming research, the extract was refrigerated.

Green zinc nanoparticle synthesis

Using a stirrer-heater, 50ml of C. procera leaf extract was heated to 60–80ºC to create the synthesized nanoparticle. When the temperature hit 60ºC, 5 grams of zinc oxide were added to the mixture. After that, this combination is cooked until it reduces to a paste with a bright yellow color. After that, this paste was gathered in a clay crucible and baked for a day at 100 degrees Celsius in a hot air furnace. For characterization reasons, a powder with a light yellow tint was obtained and properly collected and stored. For characterization, the material was crushed in a mortar and pestle to obtain a finer texture.

Raising Silkworms

The Department of Sericulture, Government of Tamil Nadu, Nannagaram, Tenkasi, generated disease-free laying (DFL) of the multivoltine silkworm, *Bombyx mori* (L.) Race (PMX csR2), for this study. After being prepared for incubation in Block Boxing, the hatched larvae were moved to the rearing tray together with the

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proper amount of mulberry leaves (MR2 variety). The third stage of the larvae was harvested from Sadakathullah Appa College (Autonomous), Tirunelveli, India's supported COP Sericulture Pilot Silkworm Rearing Center. Under lab settings, the collected larvae were kept in the rearing rake.

In this investigation, mulberry leaves of the MR2 variety that were fresh and in good condition were utilized. Every day in the early hours of the day, the leaves were collected from the mulberry farm and kept in a cool place with damp gunny cloth to preserve their freshness until needed. Three days before to rearing, the rearing room was sprayed with a two percent formalin solution to sterilize it. Rearing supplies like trays and boxes are cleaned with a disinfectant solution. During the experiment, hands were cleaned with Dettol solution both before and after handling the worms. Benzoic acid, paraformaldehyde, and lime powder were ground to create a bed-disinfected powder. Every day after cleaning the bed, it was lightly dusted on the worms. In the lab, leaf extracts from *Calotropis procera* were used to create zinc nanoparticles. To obtain the necessary concentrations, the necessary amounts of zinc nanoparticles were obtained and diluted with distilled water. The larvae were placed in six trays in equal numbers of forty each, and they were given mulberry leaves that had been soaked in 0.5%, 1.0%, 1.5%, and 2.0%. It was watched for 24, 48, 72, and 96 hours. In 500 milliliters of distilled water, the zinc nanoparticle solution is diluted separately with 0.5%, 1.0%, 1.5%, and 2.0%. Before giving the mulberry leaves to the larvae in their corresponding trays, they were kept soaked in the solution. Larvae in the control group are kept at the same number and fed mulberry leaves that have been soaked in water.

RESULTS

Zinc oxide nanoparticles enhance the growth of third instar larvae of mulberry silkworm *B.mori* with an increase of concentrations. The maximum growth was observed in the 0.5%, 1.0%, and 1.5% when compared to control at 24 hrs of exposure time (Figure 1). After 48 hours, the weight of the silkworm was gradually increased from lower concentrations to higher concentrations (0.5%, 1.0%, 1.5%, and 2.0%). Compared to the control, the higher concentration (2.0%) showed a higher growth rate than other concentrations. The maximum growth rate was observed in the 0.5%, 1.0%, and 1.5% when compared to control at 48 hrs of exposure time (Figure

2). After 72 hours, the weight of the mulberry silkworm was gradually increased from lower concentrations to higher concentrations (0.5%, 1.0%, 1.5%, and 2.0%). Compared to the control, the higher concentration (2.0%) showed a higher growth rate than other concentrations. Zinc oxide nanoparticles have enhanced the growth of silkworm larvae *B.mori* with an increase in concentrations. The 0.5%, 1.0%, and 1.5% showed maximum growth when compared to control at 72 hrs of exposure time (Figure 3). After 96hrs, the weight of the mulberry silkworm was gradually increased from lower concentrations to higher concentrations (0.5%, 1.0%, 1.5%, and 2.0%). Compared to the control, the higher concentration (2.0%) showed a higher growth rate than other concentrations. The maximum growth rate was observed in the 0.5%, 1.0%, and 1.5% when compared to control at 96 hrs of exposure time (Figure 4). The single cocoon and shell weight were increased depending upon their concentrations compared to the control, after the exposure time of 24, 48, 72, and 96hrs.

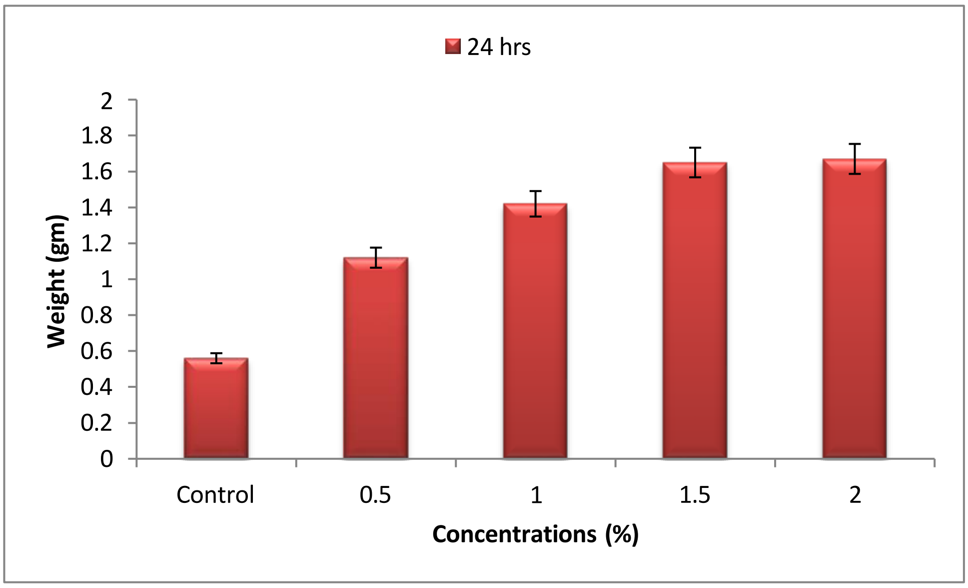

Figure 1. Different concentrations (0.5%, 1.0%, 1.5%, and 2.0%) of selected Zinc oxide nanoparticles treated against mulberry silkworm *Bombyx mori* (L.) after 24 hrs of exposure time

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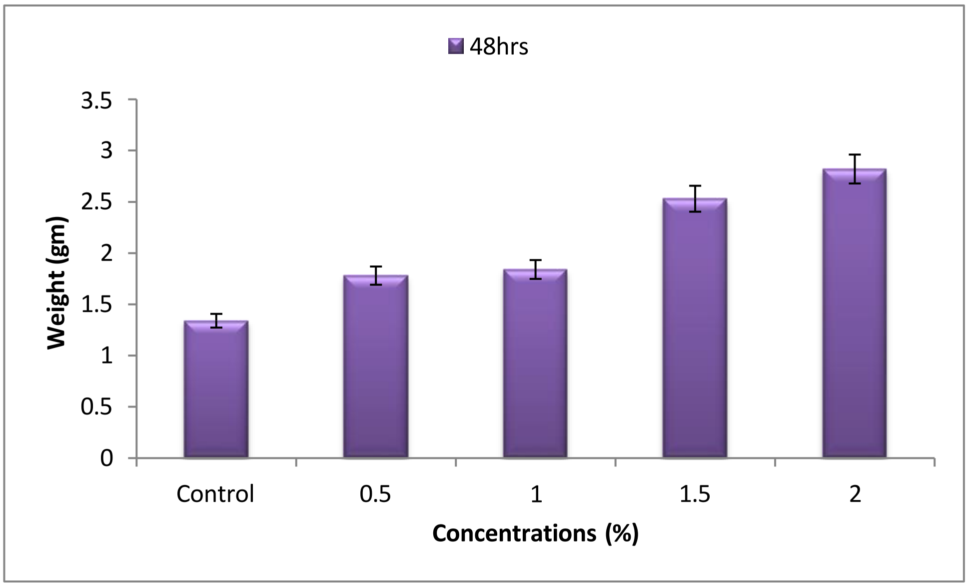

Figure 2. Different concentrations (0.5%, 1.0%, 1.5%, and 2.0%) of selected Zinc oxide nanoparticles treated against mulberry silkworm *Bombyx mori* (L.) after 48 hrs of exposure time

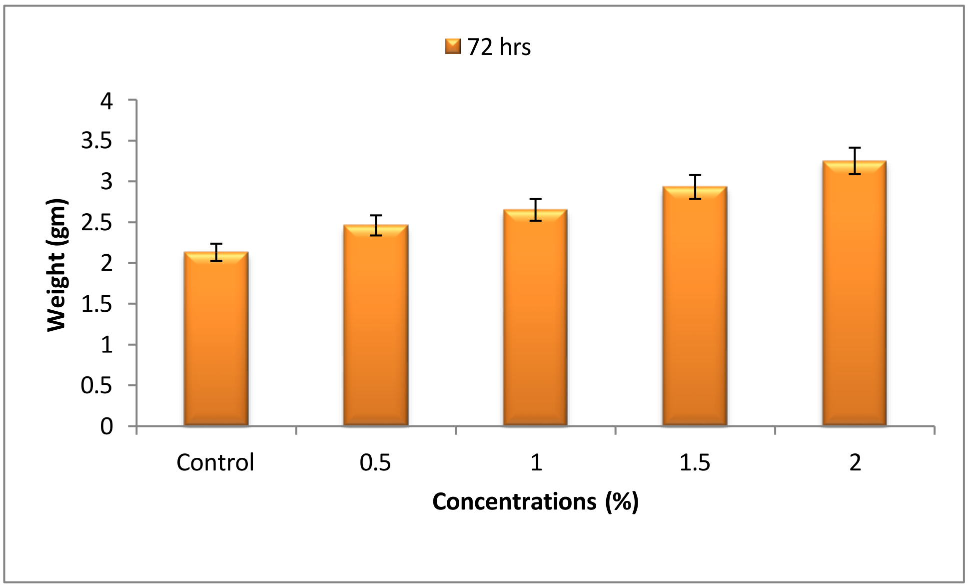

Figure 3. Different concentrations (0.5%, 1.0%, 1.5%, and 2.0%) of selected Zinc oxide nanoparticles treated against mulberry silkworm *Bombyx mori* (L.) after 72 hrs of exposure timorous

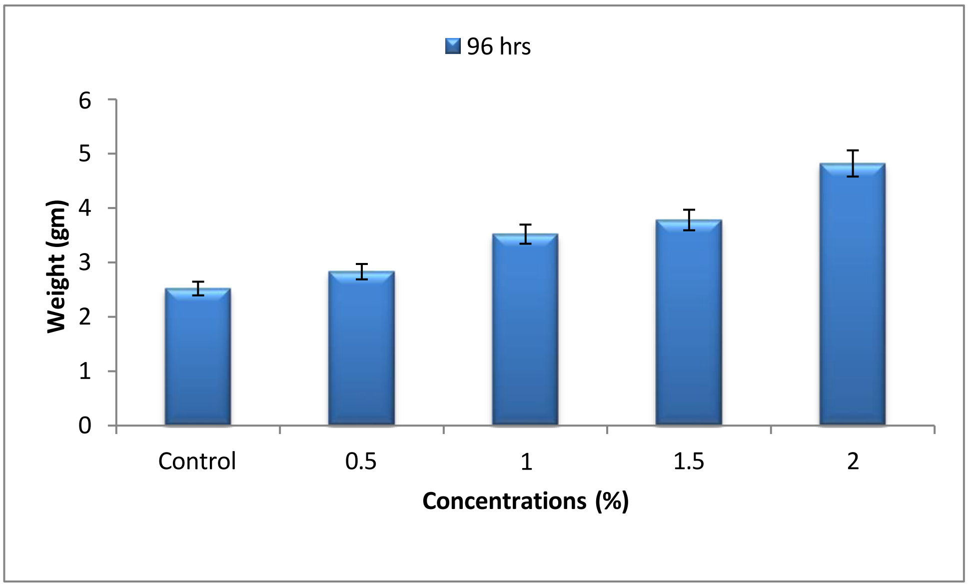

Figure 4. Different concentrations (0.5%, 1.0%, 1.5%, and 2.0%) of selected Zinc oxide nanoparticles treated against mulberry silkworm *Bombyx mori* (L.) after 96 hrs of exposure time

DISCUSSION

Only distilled water added to mulberry leaves caused a modest rise in the weights of the larvae, pupae, and cocoon shells. An increase in absorption efficiency helped to somewhat offset the declining rate of ingestion of less liked foods. Assimilation efficiency did not change noticeably in response to a decrease in food intake. According to reports, the amount of JH present and the length of the feeding time were directly correlated with the weight of the cocoon and pupa (Akai *et al.*, 1985 Chowdhary *et al.*, 1990). Specific gene regulation and expression are influenced both directly and indirectly by dietary or nutritional variables and associated metabolic interactions (Iftikhar and Hussain, 2002). In the realm of nutrigenetics, these interactions and variations could be used as indicators to choose silkworm breeds according to their nutritional efficiency metric.

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According to Javaid (1991), silkworm larvae that were fed mulberry leaves enriched with mineral nutrients had low mortality rates but good food consumption and coefficient of utilization. According to Javed and Gondal's (2002) findings, the larvae treated with 0.2% N + 0.150% ascorbic acid on mulberry leaves exhibited a greater mortality rate but decreased mean values for food consumption, body weight, body length, and cocoon shell ratio. A lower food intake lengthens the larval phase. This research suggests that high conversion efficiency types may shorten the larval life period, requiring less food in total to maintain ideal growth. A highly significant difference in nutritional features was found between leaf varieties, such as MR2 and MR2 treated with silver nanoparticles, according to the study's findings. This study has reported similar outcomes. The mulberry silkworm's weight was progressively raised after 96 hours, going from lower to higher concentrations (0.5%, 1.0%, 1.5%, and 2.0%). The greater concentration (2.0%) exhibited a faster rate of growth in comparison to the control. It is recognized that nutritional components and associated metabolic interactions have both direct and indirect effects on particular gene expression and that the effectiveness of nutrition is nearly neutralized by the rise in intake leading to increased production of the cocoon and shell. Feed conversion efficiency is regarded as a crucial physiological parameter for assessing the superiority of silkworm breeds and directly and indirectly contributes to a significant portion of the cost-benefit ratio of keeping silkworms (Magadum *et al.*, 1996; Gokulamma and Reddy, 2005).

Mulberry leaves' nutritional value is influenced by several agroclimatic variables, and any nutrient shortage in the leaves has an impact on the silkworm's ability to synthesize silk. The quantity and quality of silk produced are directly impacted by nutritional management (Hiware, 2006). The feeding habit is determined

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by the niche, quantity, and quality of food provided, the larvae's age, and their overall health. The majority of the metrics increased in the set that got treatments with aloe herbal formulation and seaweed extract, according to the general performance of *B. mori* as observed in the current study in response to these influences. The evaluation index values for the silkworm larvae's performance throughout this experimental rearing were calculated. Previously, preliminary secondary metabolites of Pakistan seaweeds, namely Spatoglossum asperum (J. Agardh) and *Caulerpa racemosa* (Forsskal) Webber V. Bosse (Qasim *et al*., 1986; Aliya *et al*., 1991; Ahmad *et al.*, 1992) and Indian seaweeds namely, *Kappaphycus sp*. (Rao and Pullaiah, 1982; Lahaye and Kaffer, 1997; Muthuraman and Ranganathan, 2004; Rajasulochana *et al.*, 2009; Varghese *et al.*, 2010; Manilal *et al.*, 2010); *Ulva reticulate Forsskal* (Varghese *et al*., 2010); *Gracilaria fergusonii* J. Agardh (RenukaBai, 2010); *Caulerpa racemosa* (Forsskal) Webber V. Bosse and Grateloupia lithophile Boergesen (Rao and Pullaiah, 1982; Lahaye and Kaffer, 1997; Muthuraman and Ranganathan, 2004; Manilal *et al*., 2010; Srivastava *et al.*, 2010) were studied about the enrichment of protein and growth enhancement.

CONCLUSION

The silkworm *B. Mori*'s biological traits may be improved by zinc oxide nanoparticles, but this improvement may also more profitably advance sericulture objectives. The application of zinc oxide nanoparticles at concentrations of 1.5% and 2.0%, respectively, had positive impacts on the parameters related to the growth of the cocoon, pupal, and silkworm larvae in the current study. It also improved the amount of silk produced by improving feed efficacy. Farmers could be offered this substance to increase the amount of silk they produce.

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