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Influence of dietary supplementation of *Sida acuta* plant extract on the mulberry silkworm, *Bombyx mori* L.

Suryabhan B Barge, Anilkumar B Pardeshi*
Department of Zoology, Deogiri College, Aurangabad, Maharashtra, India

Abstract
The dietary supplementation of *Sida acuta* plant extract were tested against III, IV and Vth instar larvae of silkworm for improving the performance of growth and cocoon characteristic of silkworm, *Bombyx mori* L. The various concentration of methanol extract of *Sida acuta* plant extracts (0.5, 1.0, 1.5, 2.0 and 2.5%) were administered to III, IV and Vth instars silkworm with mulberry. The larval weight, cocoon characteristic were influenced by various concentration of plant extract. The intensity of influence was depending on the time and dose exposure. The plant extract at 2.0% concentration resulted higher larval growth and increased cocoon weight. The mean larval weights, relative growth rate of final instar larva of *Bombyx mori* were increased. The average pupa weight, shell weight, shell ratio and silk filament length were also increased with this supplementation of plant extract over the control. In the present study the plant extract of *Sida acuta* have growth promoting effect in silkworm which helps to improve the performance of silk in *Bombyx mori*.

Keywords: plant extract, *Bombyx mori*, economic performance

Introduction
The silkworm *Bombyx mori* L. is a phytophagous insect and a typical monophagous feeder on mulberry leaves. Sericulture is an agro based popular cottage industry and plays a vital role in the improvement of rural economy of India. It is well known for its low investment and quick and high returns which makes it an ideal industry fitting well in to the socio-economic frame of India. India is the second largest silk producer in the world after China. Germany is the largest consumer of Indian silk. Increase larval growth and cocoon quality and quantity would result better economics for this industry and meet the production needs. In recent years, many attempts have been made to improve the quality and quantity of silk through enhancing the leaves with nutrients, spraying with antibiotics, vitamins, hormones and hormone analogues, plant products or using extracts of plants. Plants are the richest source of organic chemicals on earth and phytochemicals have been reported to influence the life and performance of different insects [1]. Various extracts of medicinal plants have been tested by supplementation in the silkworm *Bombyx mori* and were seen to influence the body weight, silk gland weight and the silk thread length in *Bombyx mori* [2]. The nutritional supplementation of *Amaranthus hybridus*, *Xanthium indicum* and *Alternanthera sessilis* plant extracts were studied on economic performance of mulberry silkworm, *Bombyx mori* L. [3, 4, 5]. It was also observed that the dietary supplementation of the leaf, flower and pod extracts of *Moringa oleifera*[6]. Better response were influenced by commercial herbal tonic 'logen' and 'Alloe' on the economic performance of the larvae, *Bombyx mori* [7, 8].

The *Sida acuta* is the common wireweed flowering plant and widely distributed in the sub-tropical regions and belong to family Malvaceae. The plant is traditionally used as crude herbal drugs by ethnic tribes in India and as ingredients of Ayurvedic medicines, extracts of this plant are used to treat similar ailments (e.g., kidney disorders, arthritis, pains, diabetes etc.). Previous data showed that aqueous acetone extracts of *Sida acuta* contents saponosides, coumarins, steroids, phenolic compounds and alkaloids. In addition, their extracts have showed good antioxidant and anti-inflammatory activities [9].

There has been no attempt so far to study the effect of *Sida acuta* plant extract on the silkworm *B. mori*. The aim of this contribution is to evaluate influence of various concentration of methanol plant extract on the growth and economic performance of silkworm, *Bombyx mori*.

Materials and Methods
Animal Collection
The silkworm breed selected for the experiment was Indian bivoltine hybrid (CSR_2 X CSR_4) disease free laying of the silkworm, *Bombyx mori* were obtained from District Sericulture Office, Aurangabad. After hatching larvae were isolated from stock culture and feeding them with appropriate quantity of fresh mulberry leaves. The III, IV and Vth instar larvae were utilized for the experiment. After third instar, the larvae were acclimatized to the laboratory condition and divided in to six experimental groups including control. During this period larvae were fed four times a day and maintain necessary disinfection condition.

Plant Collection
The plant, *Sida acuta* was identified and authenticated by the department of Botany, Deogiri College, Aurangabad. The leaves of plants were collected, washed thoroughly with distilled water and shed dried. The dried leaves were

powdered with the help of mechanical device. Further 50gm. powdered, thus obtained was subjected to extraction through soxhlet apparatus with 500ml methanol solvent for 24 hrs. After 24 hrs, given extract was filtered and filtrate was evaporated completely. Evaporated extract material dissolved in distilled water and diluted to 0.5, 1.0, 1.5, 2.0 and 2.5 % concentration for further experiment. Fresh mulberry leaves were sprayed with each concentration and then dried in air for 10 minutes. Treated leaves of various concentrations were fed to III, IV and V instar larvae, four feeding per day. The silkworm larvae fed mulberry leaves sprayed with distilled water and served as control. The feeding were maintained up to the cocoon stage of the silkworm. Larval weight, cocoon weight, shell weight, papal weight, filament length and cocoon shell ratio were determined for all doses. Results were presented as means ±S.D.

Larval parameters (Silkworm weight): Ten larvae were randomly selected in each group and the larval weight was measured using electronic balance and it was expressed in gm.

Cocoon parameters (Cocoon weight): Five days after spinning 10 cocoons were harvested and weighed. After taking weight of cocoon the pupae were removed outside and weighed.

Cocoon shell weight: After taking weight of pupae the empty cocoon shell were weighed.

Cocoon shell ratio: Shell ratio is calculated by the formula,

$$\text{Cocoon shell ratio (\%)} = \frac{\text{Cocoon shell weight}}{\text{Cocoon weight}} \times 100$$

$$\text{Denier of the filament: } = \frac{\text{Single cocoon filament weight (gm.)}}{\text{Single cocoon filament length (m.)}} \times 9000$$

Results and Discussion

The data on the effect of various concentration of *Sida acuta* plant extract on morphometric study of larval growth and economic performance of silkworm, *Bombyx mori* are presented in Table-I. The dietary supplementation with various concentrations (0.5, 1.0, 1.5, 2.0 %) of plant extract to the silkworm larvae resulted in an increase in larval weight in third, fourth and fifth instar larvae. Cocoon weight, shell ratio, denier filament weight and filament length were found to be increased. The third instar larvae in the control group grow with an initial weight of 0.379gm. It gradually increases with the increasing concentration of plant extract. The recorded weight was gradually increased up to the fifth instar larvae (2.559 gm) at 2.0 % concentration of plant extract while at 2.5 % concentration larval weight was reduced (2.531 gm) due to the plant extract containing bioactive compounds.

The larvae produced cocoon and weight of cocoon from control group (1.325gm) were lesser than experimental groups where larvae fed with various concentration of plant extract. When the concentration of plant extract was increased the cocoon weight also increased simultaneously. The maximum cocoon weight obtained in the present experiment was 1.599gm at the concentration of 2.0% of plant extract fed to silkworm larvae. When the concentration of plant extract was increased the weight of pupae and shell also increased simultaneously.

The pupae weight and shell weight of control group were also smaller than the experimental groups. The weight of pupae and shell were maximum at 2.0% concentration of plant extract are 1.201 and 0.298gm respectively. The shell ratio in control group was 14.415 % while in experimental group, maximum shell ratio was 18.636 % at 2.0 % concentration of plant extract. The silk or filament length of the reel able silk in control was 719m. while maximum length of silk filament was 898m, recorded in experimental group at 2.0% of concentration.

In the present study the treatment of plant *Sida acuta* extract at the concentration of 0.5 %, 1.0 %, 1.5 % and 2.0 % may have beneficial effect on the growth of the silkworm *Bombyx mori* and also increased the larval weight, cocoon weight, pupal weight, shell ratio, denier and filament length by enhancing feed efficacy than control whereas at 2.5 % concentration, the overall performance of silkworm were comparatively reduced. Many researchers showed that the larval and cocoon characters improve by different concentration of plant extract and their natural formulation such as Ascorbic acid, folic acid, thiamin, vitamins, hormones, Alloe tonic etc., [8, 10, 11, 12, 13].

Table 1: The influence of dietary supplementation of *Sida acuta* plant extracts on economic parameters of silkworm, *Bombyx mori*

Group	Treatment	Larval wt. (gm)			Cocoon weight (gm)	Shell weight (gm)	Pupa weight (gm)	Shell ratio (%)	Total silk length (m)	Denier	Filament Weight (gm)
		IIIrd Instar wt.	IVth Instar Wt.	Vth instar Wt.							
1.	Control	0.379 ±0.005	0.533 ±006	2.319 ±0.08	1.325 ±0.07	0.191 ±0.005	1.129 ±0.06	14.415 ±1.16	719 ±46	1.614 ±0.8	0.129 ±0.005
2.	0.5%	0.416 ±0.005	0.551 ±0.005	2.336 ±0.08	1.352 ±0.08	0.199 ±0.004	1.141 ±0.07	14.718 ±1.25	791 ±47	1.672 ±0.9	0.147 ±0.004
3.	1.0%	0.435 ±0.006	0.572 ±0.006	2.401 ±0.09	1.394 ±0.08	0.219 ±0.006	1.196 ±0.07	15.710 ±1.32	815 ±42	1.866 ±0.10	0.169 ±0.006
4.	1.5%	0.489 ±0.006	0.599 ±0.005	2.419 ±0.010	1.401 ±0.10	0.236 ±0.004	1.243 ±0.08	16.845 ±1.26	852 ±36	1.859 ±0.10	0.176 ±0.007
5.	2.0%	0.509 ±0.007	0.609 ±0.006	2.559 ±0.11	1.599 ±0.09	0.298 ±0.005	1.201 ±0.09	18.636 ±1.34	898 ±39	1.944 ±0.11	0.194 ±0.005
6.	2.5%	0.530 ±0.006	0.650 ±0.007	2.531 ±0.11	1.589 ±0.09	0.279 ±0.006	1.291 ±0.08	17.558 ±1.30	878 ±45	1.855 ±0.11	0.181 ±0.006

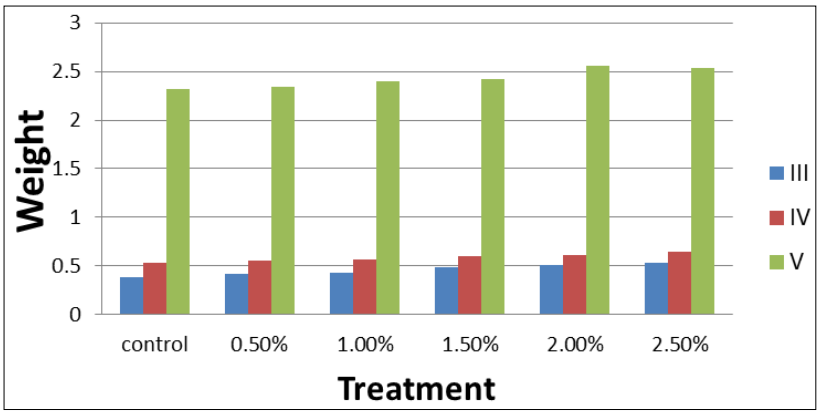

Fig 1: Influence of *Sida acuta* extract on larval weight of *Bombyx mori*

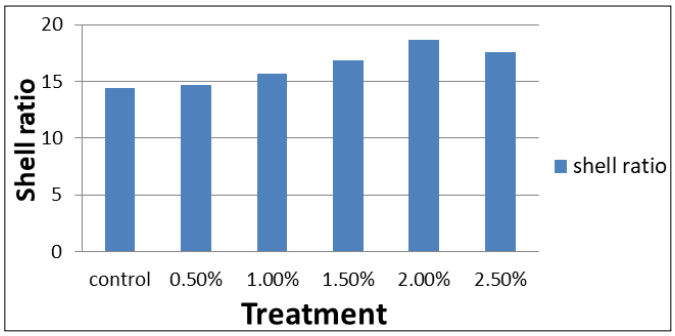

Fig 2: Influence of *Sida acuta* extract on shell ratio

A strong correlation was found to exist between growth of silkworm and silk production after leaf treatment of plant extracts, *T. terrestris*, *B. diffusa* and *P. niruri* and showed growth promoting effects due to presence of active compound which may enhance the bioabailability of nutrients for digestibility [2]. Nutrition plays an important role in improving the growth and development of *B. mori* [14]. Alagumalai *et al.*, [15] observed fortification of mulberry leaves with the flour of black gram and red gram to improve the larval growth and cocoon characteristics in *B. mori*. Similarly, the growth of silkworm larvae improved significantly upon feeding them with mulberry leaves supplemented with different nutrients[16]. Rajasekaragouda *et al.*, [1] noticed that the growth promoting effect of plant extract, *Tribulus terrestis* and *Psoralea coryllifolia*. Pardeshi and Bajad [3, 4] observed the growth promoting effect of nutritional supplementation of *A. hybridus* and *X. indicum* on larval growth and economic performance of silk in *Bombyx mori*. Barge and Pardeshi [5] found the *A. sessilis* plant extract enhanced the growth and cocoon characteristics of silkworm, *Bombyx mori.* In the present study, the weight of silkworm larvae, cocoon weight, shell ratio and filament length were increased with dietary supplementation of plant extract, *Sida acuta.* It might be due to bioactive compounds which have growth promoting and nutritive nature of this plant. Murugan *et al.*, [2] noticed a strong correlation between the growth of silkworm and the silk production in the silkworm after the treatment of plant extracts. Saravanan *et al.*, [17]. observed the supplementation of *Vigna unguiculata* aqueous extract with mulberry leaves at different concentration enhanced the quality and quantity of silk in *Bombyx mori*.

Conclusion

The study results concluded that, the treatment of *B. mori* larvae with moderate concentration of plant extract caused beneficial effect on economic parameters, whereas the higher concentration of plant extract caused adverse effect.

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