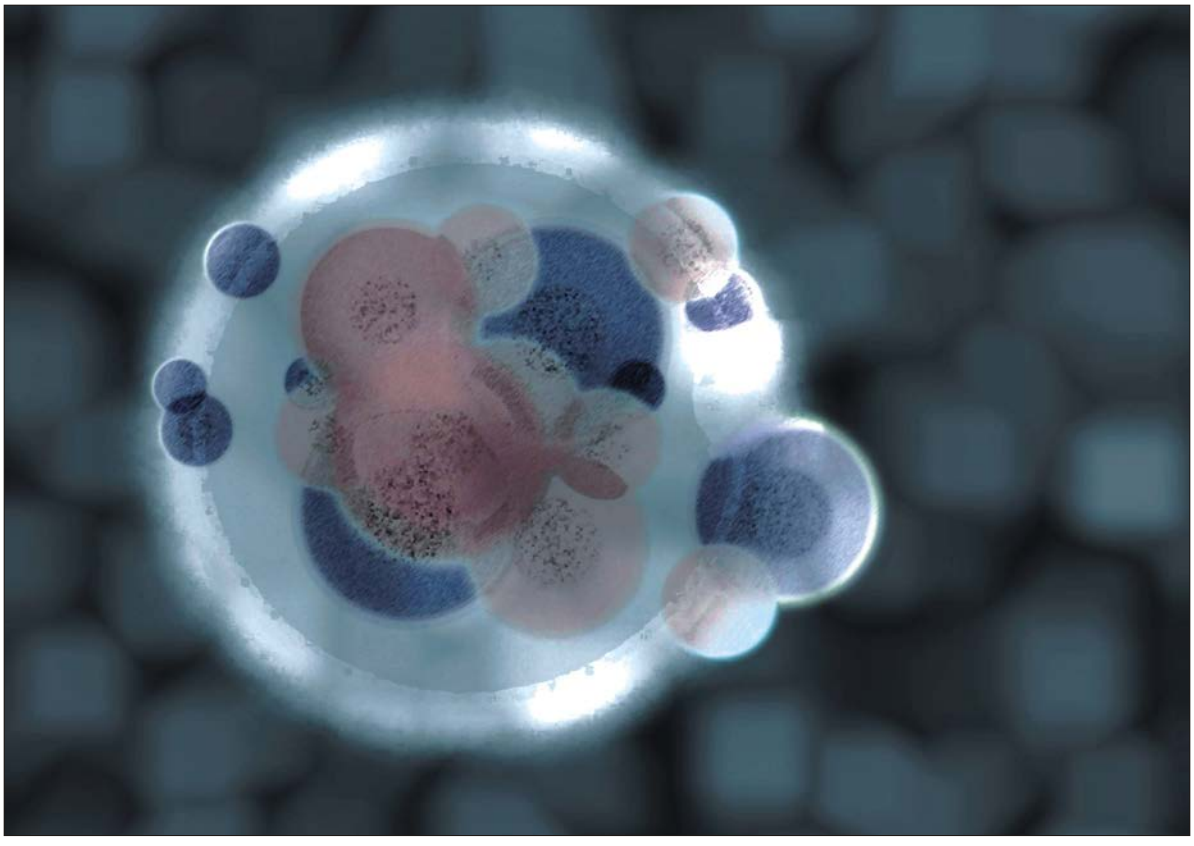

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Fortification of Mulberry Leaves with Medicinal Botanical Plant Extracts Effect on Silkworm, *Bombyx mori* L. (PM×CSR$_2$) (Lepidoptera: Bombycidae) Larval Growth and Cocoon Traits

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ABSTRACT
Nutrition plays a pivotal role in sericulture. It improves the growth, development, health, feed consumption and conversion of silkworm thereby improving the commercial traits. Silkworm, *Bombyx mori* L., is a monophagous insect that drives all required nutrients for its growth and development from mulberry leaf. Some plant extracts are feeding stimulants and improve the nutritional intake, growth, disease resistance/tolerance of silkworm ultimately improving the cocoon traits. The present investigation was carried with an objective to determine the impact of fortification of M_5 mulberry leaves with botanicals on growth and commercial traits of *B. mori* (PM×CSR$_2$). Three botanicals (*Parthenium hysterophorus* L., *Phyllanthus niruri* Hook and *Psoralea coryleifolia*) were tested along with two controls. The experiment was laid in CRD replicated three times. Feeding of fortified leaves with the plant extracts led to better larval growth and development which ultimately reflected in the economic traits of PM×CSR$_2$ silkworm hybrid. Fifth instar 5th day larval weight (26.25 and 27.52 g/10), mature larval weight (28.63 and 30.13 g/10), ERR (98.33 and 100.00%), cocoon weight (18.06 and 18.79 g/10), shell weight (3.68 and 3.72 g/10), pupal weight (14.30 and 15.23 g/10), shell ratio (20.38 and 19.80%), filament length (901.03 and 910.95 m) and silk productivity (4.04 and 4.097 cg per day) in two rearing were found significantly maximum for *P. coryleifolia* fortified leaves fed worms followed by *P. niruri* besides reducing larval duration and cocoon filament denier compared to other treatments. Thus, fortification of mulberry leaves with *P. coryleifolia* and *P. niruri* leaf extracts had favorably influenced PM×CSR$_2$ larval growth leading to significantly better economic traits. There is a need to identify the active principle(s), standardize and formulate the botanicals and develop better administration techniques for commercial silkworm rearing.

Key words: Plant extracts, phagostimulant, silkworm (*Bombyx mori*), M_5 mulberry, PM×CSR$_2$, cocoon traits, post cocoon traits

INTRODUCTION

Nutrition plays a pivotal role in sericulture industry by improving the growth and development of silkworms resulting to better cocoon and post cocoon traits of silkworm. Silkworm is a monophagous insect that derives almost all the nutrients required for its growth and development from the mulberry leaf itself (Nasreen *et al*., 1999). Though the silkworm

nutrients are balanced in mulberry leaf, the quantity available is not sufficient for the larval growth due to variation in mulberry plant and its management. Hence, silkworm should be fed with good quality mulberry leaves in optimum quantity for successful cocoon production. Thus, silkworm nutrition is considered as a major area of research in sericulture. Nutrition study on silkworm is an essential prerequisite for its proper commercial exploitation. Nutrition of silkworm is the sole factor which almost individually augumented quality and quantity of silkworm cocoon production and productivity (Laskar and Datta, 2000). Successful cocoon production by mulberry silkworm largely depends on nutritional quality and quantity of mulberry leaves provided to the developing worms. In recent years, many attempts have been made to fortify mulberry leaves with supplementary nutrients, spray or dust on the late instar larvae with antibiotics, juvenoids, botanicals, feed additive flours, etc., so as to improve the growth of silkworms and in-turn the quality and quantity of silk produced.

It has been shown that feeding of mulberry leaves to silkworm, treated with medicinal botanical plant extracts has varied influence on growth, development and reproduction. Aqueous extracts of *Lantana camara*, *Parthenium hysterophorus* and *Tridax procumbens* (Hipparagi *et al*., 2001), *Tribulus terrestris* (Murugesh and Mahalingam, 2005), *P. hysterophorus* (Rajashekaragouda *et al*., 1997), *P. hysterophorus* and *Tridax procumbens* (Mahesha *et al*., 1999b), *Psoralea coryleifolia* and *Phyllanthus niruri* (Shubha, 2005), *Withania somnifera* (Bhaskar *et al*., 2004) and others have improved the growth and development of silkworm, *B. mori* leading to better economic traits. Medicinal Botanical Plant Extracts (MBPE) increase the feeding efficiency of silkworms as they have phagostimulant characteristics and contain sterols of different kinds which are required for insect's normal growth and development. Some of the MBPE enhance bioavailability of nutrients, digestion and allocation of more energy while others have direct growth promoting properties (Hipparagi *et al*., 2001). The MBPE are said to improve growth and development of silkworm, reduce the contamination of silkworm rearing environs by diseases and their further spread. Being non toxic eco-friendly alternative to chemicals for the management of diseases of silkworm, they are easily degradable without posing any threat to the environment apart from non-toxicity to the users. The present study was therefore, undertaken to determine the effect of three botanical plant extracts on growth, development, cocoon and post cocoon traits of *B. mori* ($PM \times CSR_2$).

MATERIALS AND METHODS

Study location: The experiment was conducted at the Department of Sericulture, University of Agricultural Sciences (UAS), Gandhi Krishi Vignana Kendra (GKVK), Bangalore during 2006-2007. The GKVK, Bangalore is located at 77°35' E longitude and 12°58' N latitude at an altitude of 930 m above mean sea level.

Mulberry variety: Ten years old M_5 mulberry variety (rain fed) was used as a source of feed.

Disinfection of rearing room for silkworm rearing: Prior to commencement of rearing, the silkworm rearing room and the equipments used for rearing were properly disinfected (Krishnaswami *et al*., 1973).

Silkworm breed and procurement of eggs: Five disease free layings (dfls) of $PM \times CSR_2$ silkworm hybrid were procured from government grainage.

Incubation, brushing of eggs and rearing of worms: The dfls were kept in separate trays of 90×60 cm size by spreading paraffin paper from bottom-top and at optimum conditions of 25±1°C temperature and 75±5% relative humidity. The dfls were subjected to black boxing for 24 h at blue egg stage (9th day of laying). On the 10th day, the eggs were exposed to light at 10:00 o'clock to achieve synchronized and uniform hatching. After hatching, the larvae, up to second moult, were fed with chopped M_5 mulberry leaves. After III instar, 50 worms were randomly selected and subjected to MBPE fortified mulberry leaves as treatments (Table 1).

Collection and preparation of plant extracts: The botanicals were collected from herbal garden, Department of Horticulture (*P. coryleifolia* and *P. niruri*) and botanical garden (*P. hysterophorus*) (Fig. 1a-f), UAS, GKVK,

Table 1: Botanicals used for the preparation of aqueous plant extracts for fortification of mulberry leaves

Common name	Botanical name	Family	Parts used	Biochemical constituents
Congress grass	*Parthenium hysterophorus*	Asteraceae	Leaf	Ellagilannin, phyllanthine-D, karempfero rhamnopyranoside, eridectyol rhamnopyranoside, lignansniranthin, nirtetralin, phyltetralin, phyllonthine and hypophyllanthine
Nelanelli	*Phyllanthus niruri*	Euphorbiaceae	Leaf	Psoralen, isopsoralen, corylifolin, corylifolinin, psoralidin, isopsoralidin, backuchiol, bavachin, isobavachin,7-0-methylbavachin, neobavalsoflavone traincontane, β-sitosterl-d-glucoside, corylidin, bavachalcone, neobavalcone, bakuchalcone, psoralidin-2, 3-oxidediaacetate, stigmasterol, limonene, 4-terpineol and linalool
Babchi	*Psoralea coryleifolia*	Fabaceae	Leaf	Parthenin, hysterin, campesterol and stigmo sterol
Water control	-	-	-	
Absolute control	-	-	-	

Fig. 1(a-f): Botanicals used in the experiments and their extracts

Bangalore. Freshly collected plant leaves were washed with running tap water and rinsed with distilled water. The extracts (Fig. 1a-f) were prepared by crushing in an electrically operated mixer by adding known quantity of distilled water on weight by volume basis (1:10 proportion). The crushed material was filtered through double layered muslin cloth and the filtrate was maintained as the stock solution. From this stock solution 1 mL was pipetted out and diluted in 10 mL of distilled water to get 10% concentration. The stock solution was maintained in refrigerator and every time fresh dilution was prepared and sprayed on bits of mulberry leaves and fed to silkworms.

Mode of application: Mulberry leaves were cut into 10×12 cm size bits and the same were sprayed with plant extracts by using an automizer and shade dried for 5 min and then fed to the silkworms as per the schedule of the treatments. 0.2 mL of the extracts was sprayed on the mulberry leaf bits of 10×12 cm size.

Schedule of application: Plant extracts were imposed and used only starting from III instar onwards. The schedule of application was as follows: III instar (first day first feed), IV instar (first and third day first feed) and V instar (every day first feed).

Design of the experiment: Completely randomized design with five treatments replicated three times. Fifty worms per replications were maintained.

Mounting and harvesting: The mature larvae from respective treatments and replications were picked and transferred to the bamboo mountage for cocoon spinning. The cocoons were harvested on 5th day after mounting.

Data collected: The following larval, cocoon and post cocoon traits were recorded:

- **Moulting duration:** For the last two larval moults (III and IV), the moulting period was recorded
- **Larval duration (h):** Fifth instar and total larval duration were recorded
- **Larval weight (g):** Ten larvae were randomly picked from each treatment replication wise and their weight was recorded using electronic balance at the end of each instar for the last three instars (III, IV and V)
- **Effective rate of rearing (ERR) (%):** The ERR was calculated using the formula:

$$\text{ERR (\%)} = \frac{Z}{W} \times 100$$

where, ERR is effective rate of rearing, Z is number of cocoons harvested and W is number of initial population of larvae brushed.

Cocoon, pupal and shell weight (g): Ten cocoons were randomly selected and weighed on an electronic balance from each replication to obtain cocoon, pupal and shell weights.

Cocoon Shell Ratio (CSR) (%): Cocoon shell ratio is the proportion of shell weight to cocoon weight expressed in percentage and computed as follows:

$$\text{CSR (\%)} = \frac{SW(g)}{CW(g)} \times 100$$

where, CSR is cocoon shell ratio, SW is shell weight in grams and CW is cocoon weight in grams.

Silk filament length (m): Three cocoons from each replication were taken and reeled individually on a single cocoon reeler (epprouvette). The total number of revolution was recorded and converted in to meter by using the formula:

$$L = R \times 1.125$$

where, L total length of the filament in meter per cocoon, R is number of revolutions recorded by epprouvette 1.125 is circumference of epprouvette.

The average filament length of three cocoons of each replication was calculated and recorded.

Silk filament weight (g): The reeled silk (three cocoons) was oven dried at 85°C and the average weight was calculated.

Denier: Denier was computed using the formula:

$$\text{Denier} = \frac{SFW}{SFL} \times 9000$$

where, SFW is silk filament weight (g) and SFS is silk filament length (m) and 9000 is a constant value.

Silk Productivity (SP): The SP was computed using the formula:

$$\text{SP (cg/day)} = \frac{SW}{FILD}$$

where, SP is silk productivity in centigram per day, SW is shell weight in centigram, FILD is fifth instar larval duration in days.

Statistical analysis: Data recorded were analyzed statistically for the test of significance using Fisher's method of "Analysis of variance". The level of significance for "F- test" was at 5% (Cochran and Cox, 2000).

RESULTS AND DISCUSSION

Molting, fifth instar and total larval duration: Feeding silkworms with mulberry leaves supplemented with aqueous plant extracts decreased mou0lting (III and IV instars), fifth instar and total larval duration in both rearing (harvest I and II) (Table 2). Shorter moulting duration (21.00 and 22.00, 31.67 and 32.75 h for harvest I and II in III and IV moults, respectively), fifth instar larval duration (9.11 and 9.08 days for harvest I and II, respectively) and total larval duration (27.11 and 28.17 days for harvest I and II, respectively) were recorded on an average from *P. coryleifolia* fortified mulberry leaves fed worms followed by *P. niruri* and *P. hysterophorus*,

Table 2: Effect of plant extracts fortified mulberry leaves on moulting and larval duration of *B. mori* (PM×CSR_2)

Treatments (botanicals)	Moulting duration (h)				5th instar larval duration (days)		Total larval duration (days)	
	III moult		IV moult					
	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II
P. hysterophorus	22.00	23.00	32.83	33.30	9.27	9.33	27.40	28.42
P. niruri	21.50	22.50	32.00	33.00	9.19	9.17	27.21	28.25
P. coryleifolia	21.00	22.00	31.67	32.75	9.11	9.08	27.11	28.17
Water control	23.08	23.33	33.50	33.75	9.61	9.50	28.52	29.58
Absolute control	23.08	22.50	33.67	33.83	9.63	9.58	28.52	29.67
F-test	*	NS	*	NS	*	*	*	0.00
SEM±	0.211	0.49	0.289	0.51	0.046	0.047	0.030	0.042
CD (5%)	0.664	-	0.910	-	0.145	0.155	0.095	0.098
CV (%)	1.650	3.73	1.528	2.6639	0.850	1.83	0.187	0.71

Table 3: Effect of plant extracts fortified mulberry leaves on silkworm, *B. mori* (PM×CSR_2), larval weight (III, IV and V instar) and ERR

Treatments	Larval weight (g/10)								ERR (%)	
	III instar		IV instar		V instar (5th day)		Mature			
	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II
P. hysterophorus	0.98	0.98	4.77	4.70	25.52	26.13	27.67	28.08	96.33	98.00
P. niruri	0.99	0.99	4.93	4.94	25.77	26.94	27.87	28.40	97.33	100.00
P. coryleifolia	1.02	1.01	5.03	5.11	26.25	27.52	28.63	30.13	98.33	100.00
Water control	0.96	0.96	4.66	4.68	24.30	25.42	26.51	27.45	94.67	96.00
Absolute control	0.95	0.94	4.65	4.64	23.86	24.43	25.91	26.69	94.00	95.33
F-test	*	*	*	*	*	*	*	*	*	0.00
SEM± (at 5%)	0.009	0.02	0.035	0.06	0.160	0.36	0.090	0.41	0.394	1.08
CD (5%)	0.027	0.051	0.110	0.190	0.505	1.13	0.285	1.30	1.243	3.39
CV (%)	1.515	2.15	1.259	2.15	1.104	2.38	0.573	2.55	0.711	1.90

ERR: Effective rate of rearing

in that order when compared to the controls. The significant reduction in moulting, fifth instar and total larval duration in plant extracts extra-foliated mulberry leaves fed worms may be because of the growth promoting properties of the botanicals, more consumption of food by the worms due to phagostimulating action of the botanicals facilitating faster growth and the plant extracts may possess phytoecdysonal property, where an increased titer of phytoecdysone in the blood of insects facilitates the moulting process leading to faster growth and reduced time of moulting and developmental period. The findings of Chandrakala *et al.* (2001) and Krishnaprasad *et al.* (2001) whom have used different botanical plant extracts and reduced moulting, fifth instar and total larval duration are in close conformity with the present findings.

Larval and cocoon traits: Larval weight (III, IV, V at 5th day) and mature) was significantly higher in *P. coryleifolia* (1.02 and 1.01, 5.03 and 5.11, 26.25 and 27.52, 28.63 and 30.13 g/10 worms for harvest I and II, respectively) followed by *P. niruri* administered batch (0.99 and 0.99, 4.93 and 4.94, 25.77 and 26.94 and 27.87 and 28.40 g/10 worms) when compared to the controls (Table 3). The significant increase in larval weight when *P. coryleifolia* and *P. niruri* are used might be attributed to the enhancement of bio-availability of nutrients for digestion and conversion by these plant extracts resulting in robust growth of the silkworm. In addition, the plant extracts positively influenced healthy and vigorous growth of silkworms by stimulating the worms to feed more compared to the control batches. Increase in larval weight as a result of supplementation of mulberry leaves with aqueous extracts and/or with dust formulation of medicinal botanical plants has been reported by many researchers (Murugesh, 2002; Rajashekaragouda *et al*., 1997; Shubha, 2005; Mahesha *et al*., 1999a; Nair *et al*., 1998; Dubey and Srivastava, 2005; Laskar and Datta, 2000; Nagesh and Srivastava, 2001; Patil *et al*., 2001, 2005; Sujatha and Rao, 2003).

Supplementation of mulberry leaves with plant extracts and feeding to silkworm significantly (at 5% α) increased the Effective Rate of Rearing (ERR) (Table 3), cocoon weight, pupal weight, shell weight and cocoon shell ratio (Table 4). The *P. coryleifolia* extra-foliated mulberry leaves fed silkworms registered maximum ERR (98.33 and 100.00%), cocoon weight (18.06 and 18.79 g/10 worms), pupal weight (14.30 and 15.23 g/10 worms), shell weight (3.68 and 3.72 g/10 worms) and cocoon shell ratio (20.38 and 19.80%) for the first and second rearing respectively. *Psoralea coryleifolia* was followed by *P. niruri* and *P. hysterophorus* in decreasing order to favorably influence silkworm traits. Minimum cocoon traits were recorded from the controls. The significant improvement in cocoon traits could be due to improved appetite of silkworms becoming stronger and tolerant to diseases, biochemical constituents of the plant

Table 4: Effect of plant extracts fortified mulberry leaves on cocoon traits of silkworm, *B. mori* (PM×CSR$_2$)

	Cocoon weight (g/10)		Pupal weight (g/10)		Shell weight (g/10)		Cocoon shell ratio (%)	
Treatments	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II
P. hysterophorus	16.91	17.36	13.59	14.03	3.25	3.27	19.22	18.84
P. niruri	17.11	17.88	13.59	14.33	3.43	3.44	20.05	19.24
P. coryleifolia	18.06	18.79	14.30	15.23	3.68	3.72	20.38	19.80
Water control	15.55	16.41	13.11	13.30	2.67	3.03	17.17	18.46
Absolute control	15.53	16.19	12.97	13.30	2.63	2.81	16.93	17.36
F-test	*	*	*	*	*	*	*	NS
SEM±	0.235	0.33	0.218	0.31	0.030	0.14	0.347	0.79
CD (5%)	0.740	1.02	0.686	0.97	0.095	0.44	1.093	-
CV (%)	2.445	3.25	2.793	3.81	1.673	7.66	3.191	7.27

Table 5: Effect of plant extracts fortified mulberry leaves on post cocoon traits of silkworm, *B. mori* (PM×CSR$_2$)

	Silk filament length (m)		Silk filament weight (g)		Denier		Silk productivity (cg per days)	
Treatments	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II	Harvest I	Harvest II
P. hysterophorus	875.96	882.77	0.240	0.240	2.469	2.447	3.506	3.505
P. niruri	882.59	885.33	0.239	0.240	2.437	2.427	3.732	3.751
P. coryleifolia	901.03	910.95	0.237	0.233	2.367	2.307	4.040	4.097
Water control	810.97	868.02	0.231	0.243	2.564	2.533	2.778	3.189
Absolute control	754.51	854.81	0.221	0.250	2.630	2.632	2.731	2.933
F-test	*	*	*	*	*	*	*	0
SEM±	9.007	7.47	0.003	0.0049	0.013	0.0452	0.040	0.1724
CD (@ 5%)	28.379	23.52	0.010	0.0156	0.040	0.1423	0.127	0.5433
CV (%)	1.846	1.47	2.254	3.5484	0.885	3.1706	2.076	8.5420

extracts, increased nutritional efficiency of feed which is utilized by worms, influence of the nutrients in the feed supplied which is probably attributed to the stimulatory effect of the botanicals on protein synthesis in the silk gland during larval period. These results are in line with the findings of Rajashekaragouda *et al*. (1997), Hipparagi *et al*. (2001), Murugesh (2002), Mahesha *et al.* (1999b), Bhaskar *et al.* (2004), Shubha (2005), Gayathri *et al*. (2006), Krishnaprasad *et al*. (2000), Laskar and Datta (2000), Santoshkumar *et al*. (2000), Sridevi (2003), Sujatha and Rao (2003), Sridevi *et al*. (2004), Datta and Gupta (2002), Ranganatha *et al*. (2004), Jeyapaul *et al*. (2003), Murugesh and Mahalingam (2005) and Dubey and Srivastava (2005) who reported better ERR, cocoon weight, pupal weight, shell weight and cocoon shell ratio from different medicinal botanical plants extra-foliated mulberry leaves fed silkworms.

Post cocoon traits: The longest silk filament was obtained from *P. coryleifolia* (901.03 and 910.95 m for harvest I and II, respectively) followed by *P. niruri* (882.59 and 885.33 m) and *P. hysterophorus* (875.96 and 882.77 m) when compared to the aqueous control (810.97 and 868.02 m) and absolute control (754.51 and 854.81 m) (Table 5). This might be due to more shell content of cocoon in *P. coryleifolia* followed by *P. niruri* and *P. hysterophorus* in that order. Similar results were reported by Murugesh (2002) who noted exogenous administration of leaf extracts of *T. procumbens*, *T. terrestris* and *P. hysterophorus* improved filament length. Further, Rajashekaragouda *et al*. (1997) reported longest silk filament of 873 m due to supplementation of 20% *Parthenium* leaf extract. This has been further confirmed by Murugan *et al.* (1999) who found an increased filament length when mulberry leaves fortified with aqueous extracts of botanicals such as *T. procumbens*, *L. camara*, *C. inermae* and *C. sparsiflorus* were fed to silkworm (PM×CSR$_2$). Further they noted improvement in other economic parameters like cocoon weight, silk gland weight and silk gland protein concentration. A significant decrease in filament denier was found in *P. coryleifolia* (2.367 and 2.307 for harvest I and II, respectively) followed by *P. niruri* (2.437 and 2.427) and *P. hysterophorus* (2.469 and 2.447) when compared to the aqueous control (2.564 and 2.533) and absolute control (2.630 and 2.632) indicating an improvement in the quality of the silk filament (Table 5). It might be due to bioavailability of certain nutrients to the worms from the plant extracts which might have enhanced the protein synthesis particularly the fibroin synthesis in the posterior silk gland, which in turn might have influenced the filament denier. This finding was in agreement with the finding of Santhoshkumar (1997) who reported that, dust formulation of *L. camara* and *C. inermae* fortified mulberry leaves resulted in lowest denier when fed to silkworm larvae. Santoshkumar *et al*. (2000) also reported lower denier when silkworm larvae were fed with mulberry leaves fortified with *L. camara* leaf powder besides the improvement in other economic traits. Sridevi *et al*. (2004) opined a significant reduction in filament denier when silkworm larvae were fed with mulberry leaves fortified with *W. somnifera* aqueous leaf extracts besides the improvement in other economic traits. Rajashekaragouda *et al.* (1997) indicated lower filament denier when silkworm larvae were fed with mulberry leaves fortified with 20% *P. hysterophorus* aqueous leaf extracts.

Higher silk productivity was found in *P. coryleifolia* (4.040 and 4.097 cg per day for harvest I and II, respectively) followed by *P. niruri* (3.732 and 3.751 cg per day) and *P. hysterophorus* (3.506 and 3.505 cg per day) when

compared to the aqueous control (2.778 and 3.189 cg per day) and absolute control (2.731 and 2.933 cg per day) (Table 5). The improvement in silk productivity might be due to the useful biochemical constituents present in the plant extracts, better feeding and bioavailability of nutrients to the larvae through mulberry leaf. The results are in line with the findings of Murugesh and Mahalingam (2005) who also observed an increase in silk productivity from 3.16 (control) to 4.10 cg per day when mulberry leaves were fortified with 0.4% *T. terrestris*. As per Murugesh (2002) treating mulberry leaves with *T. procumbens*, *T. terrestris* and *P. hysterophorus* enhanced the silk productivity. Further, Sridevi (2003) also found higher silk productivity in *W. somnifera* (6.68 cg per day) followed by *T. cordifolia* (6.21 cg per day) and *T. arjuna* (6.12 cg per day).

CONCLUSION

The silkworms reared on mulberry leaves sprayed with plant extracts exhibited significant differences with respect to growth, cocoon and post cocoon traits. V instar 5th day larval weight (26.25 and 27.52 g/10), mature larval weight (28.63 and 30.13 g/10), ERR (98.33 and 100.00 %), cocoon weight (18.06 and 18.79 g/10), shell weight (3.68 and 3.72 g/10), pupal weight (14.30 and 15.23 g/10), shell ratio (20.38 and 19.80 %), filament length (901.03 and 910.95 m) and silk productivity (4.04 and 4.097 cg per day) in harvest I and II, respectively were found significantly maximum in *P. coryleifolia* followed by *P. niruri* besides reducing the total larval duration (27.11 and 28.17 days) compared to other treatments. On the other hand, cocoon filament denier was also found minimum for *P. coryleifolia* (2.367 and 2.307) followed by *P. niruri* (2.437 and 2.427) and the same were maximum in the controls. Thus, the plant extracts had favorably influenced the growth, cocoon and post cocoon traits of $PM \times CSR_2$ for the benefit of the silk cocoon producers in order of importance (*P. coryleifolia*>*P. niruri*>*P. hysterophorus*).

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