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Influence of turmeric *(Curcuma longa)* tea on the growth and cocoon characters of a Philippine silkworm (*Bombyx mori*) hybrid

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Abstract

Turmeric (*Curcuma longa*) tea in various concentrations was tested on a promising Philippine silkworm (*Bombyx mori*) hybrid, DMMMSU 346, and was reared during dry, wet, and cool seasons to determine its influence on the growth and cocoon characters. The effects of the different concentrations of turmeric tea and rearing seasons were measured in terms of larval growth parameters; and cocoon and post-cocoon characteristics. Disease incidences at the larval stage as well as silk reliability were also evaluated. The study was carried out using a two-factor experiment in a Completely Randomized Design (CRD). Results showed that both turmeric tea concentration and rearing season significantly influenced the length and weight of silkworms, cocoon shell weight, filament length, and filament size. Disease incidences during the larval stage as well as resulting silk reliability during the post-cocoon assessment were significantly affected by the rearing season. Further, turmeric tea concentration significantly affected cocoon shell percentage. Adding turmeric tea to the mulberry diet of silkworms at a certain concentration and rearing season can improve the larval growth, cocoon, and post-cocoon traits.

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Introduction

Sericulture involves a large-scale breeding of silkworms to produce the finest clothing material, silk. It is deeply rooted in the culture and tradition of Indian society and has been considered as an economically-viable and labor-intensive agro-industry in rural areas. Silk is referred to as the "*Queen of Textile*" and is renowned for its natural color, purity, and unusual luster. It is a natural fabric, animal-oriented, and produced from silkworms (Bhat, 2014). Moreover, it represents a livelihood opportunity for millions of people due to its strong orientation towards work, low capital intensity and the remunerative nature of its production. The nature of this industry with rural-based agricultural and non-agricultural activities and the enormous potential for job creation has attracted much attention for it to be recognized as one of the most suitable industries for socio-economic development (Thangavelu, 2002).

The global silk market is driven by increasing demand for silk from the developing textile industry. In addition, the extensive use of silk for the manufacture of wedding dresses, scarves, saris, scarf suits, ties, pillows, wall hangings, curtains, etc. is expected to encourage market growth. Emerging technological advances in sericulture and spider silk are expected to create lucrative opportunities for market growth over the next few years. However, the high cost of raw silk could hinder market growth for the next several years. In addition, the silk industry is labor-intensive.

Asia is the main producer of silk in the world and produces over 95 percent of the total global output, with China in the top seat. India is the second largest producer of silk with 18,475 MT (2006-2007) and the largest consumer of silk as well. It has a strong tradition and culture-bound domestic market of silk (Bukhari & Kour, 2019).

Knowledge of the silkworm's nutritional requirements is very important in terms of cocoon and silk production. Mulberry leaves are the only food for silkworms. The consumption, digestion and utilization of mulberry leaves will have a greater impact on the growth and development of silkworms and in turn will reflect the number of cocoons and silk produced (Mala *et al.*, 2017). Hence, the success of cocoon production greatly depends on the quality of mulberry leaf as feed for silkworms (Dacayanan *et al.*, 2023). The quality of mulberry leaf has a contribution of about 38% (Matsumara *et al.*, 1958; Chundang *et al.*, 2020). Studies show that some plant extracts stimulate and improve the nutritional intake, growth, and even disease resistance of silkworms ultimately improving the cocoon traits (Gobena & Bhaskar, 2015). Many attempts have been made either to fortify the leaves with nutrients, antibiotics, juvenile hormones, plant products with JH-mimic principles, and anti-juvenile hormones. Sprinkling the mulberry leaves with sugars, hormones, food additives, and protein-rich flours has also been done to improve silkworm breed, the cocoon, and the quality of the silk produced (Mala *et al.*, 2017). At the DMMMSU-Sericulture and Development Institute, Philippines, traditional rearing of silkworms on mulberry leaf alone has been practiced and seemed insufficient to achieve increased cocoon and silk production (Almojuela *et al.*, 2022). Among several options, the use of turmeric (*Curcuma longa*) tea as an additive to the mulberry leaves can help improve the nutritional value, thereby improving the silkworms growth, and the quality of cocoons.

The turmeric plant has many uses including as medicines, home additive or spice, preservative, and coloring agent in Asian countries as well as part of religious rituals. They are bioactive just like most rhizomes as well as anti-bacterial, i.e. suppress the growth of several bacteria like streptococcus, staphylococcus, and lactobacillus. Experiments showed that turmeric reduces the mortality of silkworms and reduces infection of both viral and bacterial diseases (Singh *et al.*, 2007). Turmeric possesses anti-bacterial and antiseptic properties (Khan *et al.*, 2015). The active ingredients of curcuminoids (including curcumin, demethoxycurcumin and bisdemethoxycurcumin) from Asian medicine and the culinary herb turmeric have anti-tumor effects, but

poor oral absorption in the intestine hinders their wide clinical application (Yue *et al.*, 2016). Curcumin has the ability to inhibit the lipid peroxidation and can scavenge the harmful free radicals (Kanani *et al.*, 2017). One of the alternative ways to improve larval nutrition is the enrichment of mulberry leaves with additional nutrients such as vitamins (Rajabi *et al.*, 2007). In addition, supplementing the silkworm diet with protein ingredients having high nutritional value and great digestibility may improve development (Oliveira *et al.*, 2014).

Climatic factors also influence the growth and development of silkworm larvae and the economic characteristics of their cocoons (Sarkar, 2018). Seasonal variations greatly affect the genotypic expression in the form of phenotypic output of silkworms such as cocoon weight, shell weight, and cocoon shell ratio. The variation of environmental conditions from day-to-day and season-to-season emphasizes the need for temperature and relative humidity management for sustainable cocoon production (Rahmathulla, 2012). Based on the findings of Hazel (1995), as cited by Hussain *et al.* (2011), many of the features of silkworms are not only controlled by genes but are also influenced by environmental factors such as temperature and relative humidity. High temperature affects almost all biological processes including the rate of biochemical and physiological reactions.

Growth and development of the larvae and the ultimate economic characters, such as cocoon yield, shell weight, and silk percentage are greatly influenced by the nutritional level of the leaf which varies among mulberry varieties. Therefore, mulberry feeding trials with different levels of turmeric tea and at different seasons are conducted to select and recommend the suitable levels of turmeric tea and specific season for silkworm rearing and cocoon production.

The study evaluated the effects of turmeric *(Curcuma longa)* tea and rearing season on silkworm growth and their cocoon characters. Specifically, the study determined and compared the performance of a Philippine silkworm hybrid, DMMMSU 346 when fed with mulberries sprayed with varying concentrations of different amounts of turmeric *(Curcuma longa)* tea; evaluated the effects of rearing season on the growth and cocoon characters of DMMMSU 346; and determined the interaction effect of turmeric *(Curcuma longa)* tea supplementation and rearing season on the performance of DMMMSU 346.

Materials and methods

Research Design

The study is a two-factor factorial experiment laid out in Complete Randomized Design (CRD) with three replications. The first factor (Factor A) was the rearing season with three levels, while the second factor (Factor B) referred to the different concentrations of turmeric tea with five levels, equivalent to a total of 15 treatment combinations. The specific factor levels were as follows:

Factor A – Rearing Season	Factor B – Levels of turmeric tea
A1 – Dry Season (April)	B0 – No application
A2 – Wet Season (July)	B1 – 5 grams of turmeric tea per liter of water
A3 - Cool Season (September)	B2 – 10 grams of turmeric tea per liter of water
	B3 – 15 grams of turmeric tea per liter of water
	B4 – 20 grams of turmeric tea per liter of water

Experimental Site and Materials

The experiment was conducted at the Sericulture Research and Development Institute with three (3) trials in the months of April, July, and September. The turmeric tea formulations were tested on the Philippine silkworm hybrid, DMMMSU 346 specifically during the 4th and 5th larval instars.

Preparation of Turmeric tea concentrations

The turmeric roots were washed thoroughly making sure that leaves or any long roots are removed. The drying process started by slicing the rhizomes into small pieces, which basically increased the surface area for drying. The sliced turmeric rhizomes were air-dried for one (1) week and then oven-dried for 30 minutes to make the sliced turmeric crunchy and easy to grind. The dried turmeric rhizomes were ground and pulverized to produce the turmeric powder. To prepare the turmeric tea solution, varying amounts of

turmeric powder as indicated in each treatment were mixed with one liter of water. Weight-volume percent was the method used in expressing the concentration solution; the mass of solute divided by the volume of solution, and multiplied by 100%.

Application of the turmeric tea concentrations

At 4th instar, 50 DMMMSU 346 silkworm larvae for each of the treatments were randomly selected for each replication. The different concentrations of turmeric solutions were sprayed uniformly on fresh mulberry leaves two hours before feeding 4th instar silkworm larvae To ensure uniform volume, 20 ml turmeric tea concentrations was sprayed for every 100 g of mulberry leaves fed to silkworms. Feeding of silkworms with the turmeric tea-enriched mulberry leaves continued up to the 5th instar until the silkworms are fully-matured and ready to spin cocoons.

Data Analysis

The data for each silkworm growth and cocoon growth parameter were recorded, tabulated, computed and statistically analyzed using two-way Analysis of Variance (ANOVA) through Factorial Complete Randomized Design. Significant differences among treatment means were further subjected to Tukey's Honest Significant Difference (HSD) Test, at 5% level of significance. For the overall performance of silkworms under the different treatments, the silkworm breeds were ranked using the Evaluation Index (EI) Method by Mano *et al.* (1993).

Results and discussion

Silkworm Growth Parameters

Larval length, weight and disease incidence

The results indicated that the length of silkworms was not significantly affected by the different concentrations of turmeric tea applied in the silkworm's mulberry diet, and the rearing seasons. Comparably, the average mean lengths of the silkworms ranged from 4.86 to 6.04 cm, with 15 g/li turmeric tea concentration having the highest larval length at 6.04 cm (Table 1). Similarly, the highest larval weight was seen on silkworms fed with 15 g/li concentration (2.71 g), reared during the cool season (Table 2). Likewise, silkworms fed with 15g /li concentration, reared during the cool season also obtained the lowest mean disease incidence at 3.33% (Table 3).

Table 1. Average silkworm larvae length (cm) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	$4.940^{c}{}_{a}$	$5.143^{bc}{}_{b}$	$5.407^{ab}{}_{b}$	$5.700^{a}{}_{b}$	$5.353^{b}{}_{b}$	5.309
Wet Season (July)	$4.860^{c}{}_{a}$	$5.747^{ab}{}_{a}$	$5.617^{ab}{}_{b}$	$5.877^{a}{}_{ab}$	$5.547^{b}{}_{b}$	5.530
Cool Season (September)	$5.057^{b}{}_{a}$	$5.877^{a}{}_{a}$	$5.917^{a}{}_{a}$	$6.043^{a}{}_{a}$	$5.943^{a}{}_{a}$	5.767
Mean	4.952	5.589	5.647	5.873	5.614	5.535

Note: Means followed by the same superscript letter for each row are not significantly different at α=5% (HSD); Means followed by the same subscript letter for each column are not significantly different at α=5% (HSD).

Table 2. Average silkworm larvae weight (g) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	$1.843^{c}{}_{a}$	$2.010^{bc}{}_{c}$	$2.163^{b}{}_{c}$	$2.497^{a}{}_{b}$	$2.237^{ab}{}_{b}$	2.150
Wet Season (July)	$1.857^{b}{}_{a}$	$2.540^{a}{}_{b}$	$2.583^{a}{}_{b}$	$2.720^{a}{}_{b}$	$2.650^{a}{}_{a}$	2.470
Cool Season (September)	$1.850^{b}{}_{a}$	$2.947^{a}{}_{a}$	$2.863^{a}{}_{a}$	$3.053^{a}{}_{a}$	$2.853^{a}{}_{a}$	2.713
Mean	1.850	2.499	2.536	2.757	2.580	2.444

Note: Means followed by the same superscript letter for each row are not significantly different at α= 5% (HSD); Means followed by the same subscript letter for each column are not significantly different at α= 5% (HSD).

Table 3. Disease incidence per rearing season and turmeric tea concentration

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	26.67	41.33	40.00	42.67	43.33	38.67^{a}
Wet Season (July)	24.67	15.33	12.00	16.00	32.67	20.27^{b}
Cool Season (September)	12.67	11.33	10.00	3.33	20.67	11.60^{c}
Mean	21.33^{b}	22.66^{b}	20.67^{b}	20.67^{b}	32.22^{a}	23.51

Note: Means followed by the same letter are not significantly different at α= 5% (LSD)

Cocoon and Post-Cocoon Parameters

Cocoon shell ratio (%)

Silkworms fed with mulberry leaves sprayed with 5 g/li turmeric tea concentration and reared during cool season produced cocoons with significantly heavier shells (Table 4). In terms of cocoon shell ratio (%), the turmeric tea concentrations (5, 10, 15, 20 g/li) were all comparable across all rearing seasons, and with significantly higher cocoon shell ratio than the control (Table 5).

Table 4. Average cocoon shell weight (g) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	$1.177^{b}{}_{c}$	$1.307^{ab}{}_{b}$	$1.290^{ab}{}_{b}$	$1.390^{a}{}_{b}$	$1.397^{a}{}_{a}$	1.312
Wet Season (July)	$1.367^{b}{}_{b}$	$1.570^{a}{}_{a}$	$1.557^{ab}{}_{a}$	$1.487^{ab}{}_{ab}$	$1.367^{b}{}_{a}$	1.470
Cool Season (September)	$1.560^{a}{}_{a}$	$1.693^{a}{}_{a}$	$1.637^{a}{}_{a}$	$1.583^{a}{}_{a}$	$1.517^{a}{}_{a}$	1.598
Mean	1.368	1.523	1.495	1.487	1.427	1.460

Note: Means followed by the same superscript letter for each row are not significantly different at α= 5% (HSD); Means followed by the same subscript letter for each column are not significantly different at α= 5% (HSD).

Table 5. Average cocoon shell ratio (%) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	17.02	18.42	18.93	18.51	18.77	18.33
Wet Season (July)	16.11	19.51	18.42	19.54	18.84	18.48
Cool Season (September)	17.51	19.60	20.06	19.98	17.99	19.03
Mean	16.88^{b}	19.18^{a}	19.14^{a}	19.34^{a}	18.53^{a}	18.61

Note: Means followed by the same letter are not significantly different at α= 5% (HSD)

Filament length and Filament size (denier)

The filament length of cocoons obtained from silkworms reared during the wet season was found to be comparable using any of the given turmeric tea concentrations from zero to 20 g/li (Table 6). There was no significant difference in the average denier size of silk filaments among the different concentrations of turmeric tea used for silkworms reared during the wet and dry seasons. However, feeding silkworms with 5 g/li turmeric tea concentrations produced silk filaments with significantly higher denier size (Table 7).

Table 6. Average filament length (m) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	$765.7^{a}{}_{a}$	$698.3^{ab}{}_{ab}$	$638.3^{bc}{}_{b}$	$592.3^{c}{}_{b}$	$611.0^{bc}{}_{a}$	661.1
Wet Season (July)	$718.3^{a}{}_{a}$	$647.7^{a}{}_{b}$	$725.0^{a}{}_{a}$	$732.7^{a}{}_{a}$	$673.7^{a}{}_{a}$	699.5
Cool Season (September)	$723.0^{ab}{}_{a}$	$777.0^{a}{}_{a}$	$735.3^{ab}{}_{a}$	$622.7^{c}{}_{b}$	$642.3^{bc}{}_{a}$	700.1
Mean	735.7	707.7	699.6	649.2	642.3	686.9

Note: Means followed by the same superscript letter for each row are not significantly different at α= 5% (HSD); Means followed by the same subscript letter for each column are not significantly different at α= 5% (HSD).

Table 7. Average filament size (denier) per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	$2.91^{a}{}_{a}$	$2.52^{a}{}_{b}$	$2.91^{a}{}_{b}$	$2.96^{a}{}_{b}$	$2.72^{a}{}_{b}$	2.80
Wet Season (July)	$2.71^{a}{}_{a}$	$3.00^{a}{}_{b}$	$2.67^{a}{}_{b}$	$2.76^{a}{}_{b}$	$2.66^{a}{}_{b}$	2.76
Cool Season (September)	$3.12^{b}{}_{a}$	$3.74^{a}{}_{a}$	$3.56^{ab}{}_{a}$	$3.44^{ab}{}_{a}$	$3.50^{ab}{}_{a}$	3.47
Mean	2.91	3.09	3.05	3.05	2.96	3.01

Note: Means followed by the same superscript letter for each row are not significantly different at α= 5% (HSD); Means followed by the same subscript letter for each column are not significantly different at α= 5% (HSD).

Reelability

In terms of the reliability percentage of cocoons, silkworms fed with mulberry leaves sprayed with 20 g/li turmeric tea concentrations were comparable to 10 g/li, 5 g/li, and unsprayed mulberry leaves, but significantly higher than those sprayed with 15 g/li turmeric tea (Table 8).

Evaluation Index (EI) and Rank of silkworms during the three rearing seasons

Dry Season

Based on the result of Evaluation Indices (EI) of all the larval, cocoon and post-cocoon traits (silkworm length, silkworm weight, disease incidence, cocoon shell weight, cocoon shell percentage, filament length, denier and reliability), silkworms reared in the dry season (Table 9) and fed with mulberry leaves applied with 15 g/li turmeric tea concentration ranked first (EI=53.55). This implies that the said turmeric tea formulation can be used during dry rearing season considering the above parameters.

Wet Season

Similarly, silkworms reared during the wet season and fed with 15 g/li turmeric tea-enriched mulberry leaves ranked first (EI=52.83) among all the treatments (Table 10). This formulation obtained the same results in terms of the larval, cocoon, and post-cocoon parameters. This further implies that the 15 g/li turmeric tea formulation can also be used during the wet season.

Table 8. Average reliability percentage per rearing season and turmeric tea concentration.

Rearing season (A)	Turmeric tea concentration (B)					Mean
	0	5 g/li	10 g/li	15 g/li	20 g/li	
Dry Season (April)	88.38	81.19	88.38	77.92	88.38	84.85^{ab}
Wet Season (July)	79.75	77.23	85.86	77.92	90.91	82.33^{b}
Cool Season (September)	91.41	93.94	89.28	83.72	96.97	91.06^{a}
Mean	86.52^{ab}	84.12^{ab}	87.84^{ab}	79.85^{b}	92.09^{a}	86.08

Note: Means followed by the same letter are not significantly different at α= 5% (HSD)

Table 9. Evaluation indices (EI) and ranking of silkworms reared during the dry season.

Turmeric Tea Level	Evaluation Indices								Mean EI	Rank
	SWL	SWW	DI	CSW	CSP	AFL	DS	R		
0g (Control)	37.18	37.51	32.39	34.95	32.75	64.75	55.78	57.10	44.05	5
5 g/li	44.15	44.36	53.91	49.55	51.20	55.25	34.51	42.64	46.95	4
10 g/li	53.55	50.40	51.96	47.30	57.88	46.78	55.78	57.10	52.60	3
15 g/li	63.66	64.10	54.89	58.53	52.38	40.29	58.51	36.06	53.55	1
20 g/li	51.46	53.63	56.85	59.66	55.78	42.92	45.42	57.10	52.85	2

Legend: SWL- silkworm length, SWW- Silkworm weight, DI- Disease incidence, CSW- Cocoon shell weight, CSP- Cocoon shell percentage, AFL- Average filament length, DS- Denier size, R- reliability

Table 10. Evaluation index (EI) and ranking of silkworms reared during the wet season.

Turmeric Tea Level	Evaluation Indices								Mean EI	Rank
	SWL	SWW	DI	CSW	CSP	AFL	DS	R		
0g (Control)	33.04	32.46	55.27	39.60	33.15	55.11	46.46	45.60	42.59	5
5 g/li	55.50	52.01	44.09	59.99	57.29	35.98	67.12	41.32	51.66	2
10 g/li	52.22	53.16	40.10	58.97	49.53	56.91	43.51	56.00	51.30	4
15 g/li	58.78	57.19	45.69	51.84	57.51	58.99	50.15	42.49	52.83	1
20 g/li	50.45	55.17	64.85	39.60	52.52	43.02	42.77	64.49	51.62	3

Legend: SWL- silkworm length, SWW- Silkworm weight, DI- Disease incidence, CSW- Cocoon shell weight, CSP- Cocoon shell percentage, AFL- Average filament length, DS- Denier size, R- Reliability

Cool Season

During the cool rearing season, however, silkworms fed with mulberry leaves sprayed with the 5 g/li turmeric tea concentration ranked first (EI=56.89), contrary to the other two rearing seasons (Table 11). This implies that the said formulation can give better results when used during the cool rearing season.

Table 11. Evaluation indices (EI) and ranking of silkworms reared during the cool season.

Turmeric Tea Level	Evaluation Indices								Mean EI	Rank
	SWL	SWW	DI	CSW	CSP	AFL	DS	R		
0g (Control)	32.31	32.36	51.72	44.35	37.26	53.52	34.46	50.69	42.08	5
5 g/li	52.80	54.87	49.57	63.68	54.80	61.80	61.83	55.74	56.89	1
10 g/li	53.80	53.03	47.43	56.25	58.66	55.41	53.88	46.44	53.11	2
15 g/li	56.80	56.92	36.69	47.32	57.99	38.13	48.59	35.34	47.22	4
20 g/li	54.30	52.82	64.60	38.40	41.29	41.15	51.24	61.79	50.70	3

Legend: SWL- silkworm length, SWW- Silkworm weight, DI- Disease incidence, CSW- Cocoon shell weight, CSP- Cocoon shell percentage, AFL- Average filament length, DS- Denier size, R- reliability

Conclusions

Based on the results of the study, the different levels of turmeric tea sprayed on the mulberry diet of silkworms could affect cocoon shell ratio, reliability percentage, and disease incidence. Spraying the mulberry leaves with at least 5g/l turmeric tea could increase the average cocoon shell percentage (19.18%) compare to unsprayed mulberry leave (16.88%). Further, the rearing season could also influence disease incidence at larval stage and the reliability of silk produced. Silkworms reared during the cool season had significantly lower disease incidence (11.60%) than those reared during wet season (20.27%). The highest disease incidence was recorded during the dry season at 38.67%. Further, silk produced during the cool season has a significantly higher reliability percentage at 91.06% as compared to those from silkworms produced during the wet season with reliability at only 82.33%, on the average. There is a significant interaction between turmeric tea concentration and rearing season on the length and weight of silkworm, cocoon shell weight, filament length, and filament size. During the dry season, at least 10 g/li of turmeric tea concentration is needed to obtain a longer silkworm larvae (5.407 cm), and at least 15 g/li of turmeric tea concentration to obtain a heavier silkworm larva (2.497 g). On the other hand, during the wet or cool season, at least 5 g/li turmeric tea concentration is necessary to obtain silkworm larvae with longer length and heavier weight. Further, silkworms reared during the dry or wet season, and fed with mulberry leaves sprayed with at least 5 g/li turmeric tea concentration had resulted to heavier cocoon shell weight at 1.307 g and 1.570 g on the average, respectively. For post-cocoon characteristics, the mulberry leaf diet of silkworms sprayed with at least 10 g/li turmeric tea during the dry season and at least 15 g/li during the cool season would yield silk with shorter filament length as compared to the control group. Further, spraying the mulberry leaves diet of silkworms with at least 5 g/li turmeric tea resulted to a higher filament size (3.74 denier).

Recommendations

Based on the conclusions made, the researchers recommend the following:

During dry and wet rearing seasons, it is best to spray 15 g/li of turmeric tea on the mulberry leaves to be fed to silkworms. For the cool rearing season, it is best to spray 5 g/li turmeric tea on the mulberry leaves to be fed to silkworms.

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