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Effect Of Mulberry Leaves Supplemented Maize Extract On The Growth Performance Of Silkworm (*Bombyx Mori* L)

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Abstract

Since the couple of decades the demand for silk has been increasing day by day but the average silk production is not enough to meet its demand. In this study, we investigated the effect of with Maize extract in different concentration (0.5%,1.0 %,1.5 %,2.0%, 2.5 %)on the growth 5th stage silkworm larvae on the biological and commercial traits of *Bombyx mori* L. The silkworm larvae at 5th instar stage were taken and fed with fresh and healthy mulberry leaves coated with Maize extract in different concentration. Results of the current study revealed that the higher growth parameters of 5th stage silkworm larvae, the cocoon weight, shell weight, and shell ratio were increased, and thus improved the quality of silk as compared to the control. The commercial traits of larvae fed with Maize extract in different concentration leaves also improved significantly. The larvae fed with Maize extract in different concentration treated mulberry leaves showed the maximum cocoon weight, cocoon length, cocoon width, cocoon shell ratio and fibroin content as compared to the control group. It is evident from the results that the fed with Maize extract coated mulberry leaves have a positive effect on the commercial and biological traits of *Bombyx mori* (L.).

Keywords: V1 variety, Maize extract, 5th stage silkworm larvae.

1. INTRODUCTION.

Sericulture is a technology-driven art and science that is mostly focused on welfare and village life, and it makes a substantial economic contribution to our country. It is the classic cottage industry, with its labor-intensive nature, industrial superstructure, and foundation in forestry and agriculture (Singh *et al.,* 2005). Silk production is intimately correlated with the growth and development of the larvae on mulberry leaves, which is the foundation of sericulture. Silkworms are raised on these leaves. Mulberry leaf yield varies depending on field methods and environmental conditions, both in terms of quantity and quality. Because of the advancement of cutting-edge technologies in the raising of silkworms and mulberry cultivation, in India is both the world's largest consumer and producer of silk. The cocoons of mulberry silkworm *Bombyx mori* larvae grown in captivity (sericulture) yield the highest grade silk. Lepidopteran insects called silkworms (*B. mori*) have a long history of reproducing to produce silk. The queen of textiles, natural fiber—secreted by silkworms—stands for comfort, elegance, sophistication, and wealth. India is both the world's largest consumer and the second-largest

producer of silk. The mulberry is the sole food source for the monophagous silkworm throughout its whole life cycle. Because of this, silkworms need varying leaf qualities at different stages of their growth, which highlights the significance of mulberry production techniques. The ability of the silkworm to transform plant protein into silk protein is one of its most crucial traits (Ude *et al.,* 2014). Many industrial and medical applications exist for silk proteins (Khyade, 2016; Ageitos *et al.,* 2019). An important monophagous insect for the sericulture sector is the silkworm (*B. mori* L.). Because morin is present in mulberry leaves, silkworm larvae frequently eat them. To produce more silk, silkworm larval instars' appetites or food quality—or both—must be improved. Legay (1958) discovered that the growth of superior cocoons depends on the feeding of mulberry larvae with nutritionally valuable leaves, which is the foundation for silk production. Proteins are necessary for the growth and development of silkworms as well as the synthesis of silk proteins. The amino acids needed for survival are provided by the free amino acids found in body fluid and the amino acids generated in the cells of the posterior silk gland. For growth and development, the silk worm needs all ten essential amino acids (Ito, 1978). Silk is composed of two proteins: fibroin and sericin. In the core is fibroin, encircled by sericin. These two proteins differ in their properties and 14(2a): 141-148 in Biological Forum: An International Journal (2022) Biological Forum: An International Journal, 14(2a), 141-148, Bhat et al. (2022) 142 are released by the silk gland in various locations. The centre region of the silk gland secretes sericin, while the posterior section secretes fibroin. Amino acids produced by posterior silk gland cells make up fibrin. A cocoon's sericin quality is one of its most crucial features. The cocoon's sericin content differs throughout *B. mori* strains. The concentrations of these biomolecules are dependent on the quality of mulberry leaves. Throughout growth, the proteins in the haemolymph become increasingly concentrated and can be utilised to create silk proteins. This study set out to ascertain the effects of varying maize flour concentrations on the biological, economic, characteristics of the silkworm *B. mori*.

2. MATERIALS AND METHODS

This study focused on fourth-instar larvae of the mulberry silkworm *Bombyx mori* L. The commercial crossbreed race CSR 2 x CSR 4 was used for the present study. The silkworm larvae were obtained from a farmer who practices sericulture at the Assistant Directorate of Sericulture in Nannagaram, Tamil Nadu. The silkworm larvae were transported successfully to the laboratory under cold circumstances. The worms had acclimatised to the raising conditions, thus the fourth instar larva was kept in the rearing chamber. Fresh, healthy Morus alba V1 leaves were gathered from the mulberry farm in the morning. They were stored in a laboratory under cold circumstances in wet gunny bags to keep them fresh. About 75 grams of rice bran were mixed with sugar in various proportions, such as 5 gm rice bran + 0.5 gm sugar + 1 litre hot water, 10 gm rice bran + 1 gm sugar + 1 litre hot water, 15 gm rice bran + 1.5 gm sugar + 1 litre hot water, 20 gm rice bran + 2 gm sugar + 1 litre hot water, and 25 gm rice bran + 2.5 gm sugar + 1 litre hot water. Then it was filtered through a cotton cloth. After proper cooling, it was sprayed onto V1 mulberry leaves and fed to silkworms.

The experimental rearing lasted 6 days, with 100 uniform stage 5 larvae chosen from the raised and acclimatised stock. The growth rate pattern of silkworm larvae weight from V1 (mulberry leaves) and mulberry leaves reinforced with rice porridge were administered to 5th-age silkworms prior to cocoon spinning. The mature larvae were put in plastic collapsible montages separately for each treatment, and the cocoons were removed on the sixth day, after which they were assessed. A single cocoon's weight. Shell weight, shell ratio, and Effective Rearing Rate (ERR) by number and weight were all recorded.

$$\text{Growth index} = \frac{Final\ weight\ of\ the\ larvae\ (g) - Initial\ weight\ of\ the\ larvae\ (g)}{Initial\ weight\ of\ the\ larvae}$$

$$Weight\ gain\ of\ silkworm = Final\ weight - Initial\ weight$$

$$Specific\ growth\ rate\ of\ silkworm\ (SGR) = 100\ X\ \frac{(ln\ final\ weight - ln\ initial\ weight)}{Total\ days}$$

$$Feed\ conversion\ ratio = \frac{Feed\ intake}{Weight\ gain}$$

$$Weight\ of\ single\ cocoon = \frac{Weight\ cocoons\ (gm)}{Number\ of\ cocoons\ taken}$$

$$Single\ shell\ weight = \frac{Total\ shell\ weight\ of\ cocoon\ (gm)}{Total\ number\ of\ cocoons\ taken}$$

$$Shell\ ratio\ (\%) = \frac{Single\ shell\ weight\ (gm)}{Single\ cocoon\ weight\ (gm)}\ x\ 100$$

$$ERR\ by\ number = \frac{Total\ no.of\ good\ cocoons\ harvested}{Total\ no.of\ larvae\ retained\ after\ 4th\ moult}x\ 10000$$

3. RESULT AND DISCUSSION

Effect of mulberry leaf V 1- variety supplemented with Maize extract in different concentration (0.5%,1.0 %,1.5 %,2.0%, 2.5 %)on the growth 5th stage silkworm larvae

The 5th stage silkworm larvae were fed with supplemented Maize extract (0.5 %) mulberry leaf (V 1- variety) and the growth parameters was recoded at 12-hour interval. During the culture period, all the silkworm was reposted alive. The total weight and mean weight the (108 g) and mean weight (1.08 ± 0 g) were recorded minimum during 12 h of culture period and attained maximum total weight mean weight (0.453 ± 0 g) in 144h. Similarly, the leaf consumed by the 5th stage silkworm larvae were minimum (112 g) during 12 h of culture period and it was increased to 589 g in 96 h. The unconsumed leaf waste was recorded as 39 g in 12 h growth period, 31 g in 24 h, 10 g during 36 h, and 48 g in 48 h ,121 g in 60 h, 94 g in 72 h, and 61 g in 84 h, and 142 g in 96 h, and 97 g in 108 h, and 114 g in 120 h, 145 g in 132 h, and 134 g in 144 h, respectively. During the culture period the silkworm excreted 17 g of waste during 12 h,25 g and 24 h, 16 g in36 h, 49 g in 48 h, 46 g in 60 h, and 58 g in 72 h, 56 g in 84 h, 54 g in 96 h, 69 g in 108 h, 73 g in 120 h, 58 g in 132 h, and 51 g in 144 h, respectively.

Table. 1 Mulberry leaf V1 variety supplemented with Maize extract (0.5%)on the growth 5th stage silkworm larvae

S.No	No.of silkworm		Growth (Hours)	Total weight silkworm (g)	Mean weight silkworm (g)	Leaf Supplied (g)	Leaf waste (g)	Silkworm excreta (g)
	Live	Dead						
1	100	-	12	108	1.08 ± 0.	112	39	17
2	100	-	24	142	1.42 ± 0.	148	31	25
3	100	-	36	190	1.90 ± 0.	182	10	16
4	100	-	48	252	2.52 ± 0.	286	48	49
5	100	-	60	290	2.90 ± 0.	416	121	46
6	100	-	72	376	3.76 ± 0.	425	94	58
7	100	-	84	398	3.98 ± 0.	542	61	56
8	100	-	96	414	4.14 ± 0.	589	142	54
9	100	-	108	396	3.96 ± 0.	534	97	69
10	100	-	120	416	4.16 ± 0.	512	114	73
11	100	-	132	460	4.60 ± 0.	457	145	58
12	100	-	144	453	4.53 ± 0.	411	134	51

The 5th stage silkworm larva were fed with supplemented Maize extract (1.0 %) fed with mulberry leaf (V1 - variety) and the growth parameters were recorded at 12-hour interval. During the culture period, all the

silkworm was reposted alive. The total weight (90 g) and mean weight (0.90 ± 0 g) were recorded minimum during 12 h of culture period and attained maximum total mean weight (400 g) and (0.527+ 0 g) in 144 h. Similarly, the leaf consumed by the 5th stage silkworm was minimum (133 g) during 12 h of culture period and it was increased to 890 g in 132 h. The unconsumed leaf waste was recorded as 54 g in 12 h growth period, 43 g in 24 h, 50 g in 36 h, and 97 g in 48 h ,140 g in 60 h, 185 g in 72 h, and 167 g in 84 h, and 257 g in 96 h, and 233 g in 108 h, and 274 g in 120 h, 222 g in 132 h, and 315 g in 144 h, respectively. During the culture period the silkworm excreted 14 g of waste during 12 h,30 g and 24 h, 20 g in 36 h of culture period, 38 g in 48 h, 45 g in 60 h and 63 g and in 72 h, 65 g in 84 h, 69 g in 96 h, 64 g in 108 h, 65 g in 120 h, 74 g in 132 h, and 65 g in 144 h, respectively.

Table. 2 Mulberry leaf V1 variety supplemented with Maize extract (1.0%)on the growth 5th stage silkworm larvae.

S.No	No.of silkworm		Growth (Hours)	Total weight silkworm (g)	Mean weight silkworm (g)	Leaf Supplied (g)	Leaf waste (g)	Silkworm excreta (g)
	Live	Dead						
1	100	-	12	90	0.90 ± 0.	133	54	14
2	100	-	24	112	1.12 ± 0.	300	43	30
3	100	-	36	163	1.63 ± 0.	200	50	20
4	100	-	48	196	1.96 ± 0.	552	97	38
5	100	-	60	292	2.92 ± 0.	605	140	45
6	100	-	72	365	3.65 ± 0.	667	185	63
7	100	-	84	413	4.13 ± 0.	610	167	65
8	100	-	96	434	4.34 ± 0.	955	257	69
9	100	-	108	451	4.54 ± 0.	800	233	64
10	100	-	120	418	4.18 ± 0.	822	274	65
11	100	-	132	473	473 ± 0.	890	222	74
12	100	-	144	400	4.00 ± 0.	600	315	65

The 5th stage silkworm larva were fed with supplemented maize extract (1.5%) and mulberry leaf (V1- variety) and the growth parameters was recoded at 12-hour interval. During the culture period. all the silkworm was reposted alive. The total weight (96 g) and mean weight (0.96 ± 0.) were recorded minimum during 12 h of culture period and attained maximum total (351 g) mean weight (0.496 ± 0.g) in 144 h. Similarly, the leaf consumed by the 5th stage silkworm larvae were minimum (106 g) during 12 h of culture period and it was increased to 781 g in 108 h. The unconsumed leaf waste was recorded as 59 g in 12 h growth period, 36 g in 24 h, 27 g during 36 h, and 95 g in 48 h ,164 g in 60 h, 137 g in 72 h, and 146 g in 84 h, and 230 g in 96 h, and 235 g in 108 h, and 131 g in 120 h, 165 g in 132 h, and 216 g in 144 h, respectively. During the culture period the silkworm excreted 10 g of waste during 12h, 35 g and 24 h, 21 g in 36 h of culture period, 37 g in 48 h, 53 g in 60 h and 64 g and in 69 h, 59 g in 84 h, 65 g each in 96 h, 108 h, 67 g in 120 h, 63 g in 132 h. and 54 g in 144h, respectively.

Table. 3 Mulberry leaf V1 variety supplemented with Maize extract (1.5%)on the growth 5th stage silkworm larvae

S.No	No.of silkworm		Growth (Hours)	Average weight silkworm (g)	Mean weight silkworm (g)	Leaf Supplied (g)	Leaf waste (g)	Silkworm excreta (g)
	Live	Dead						
1	100	-	12	96	0.96 ±	106	59	10
2	100	-	24	121	1.21 ±	184	36	35
3	100	-	36	176	1.76 ±	231	27	21
4	100	-	48	214	2.14 ±	514	95	37
5	100	-	60	243	2.43 ±	589	164	53
6	100	-	72	378	3.78 ±	661	137	64
7	100	-	84	411	4.11 ±	619	146	69
8	100	-	96	463	4.63 ±	715	230	65
9	100	-	108	488	4.88 ±	781	235	65

10	100	-	120	521	5.21 ±	560	131	67
11	100	-	132	513	513 ±	593	165	63
12	100	-	144	496	496 ±	439	216	54

The 5th stage silkworm larva were fed with supplemented Mize extract (2.0%) and mulberry leaf (V1- variety) and the growth parameters was recoded at 12-hour interval. During the culture period eight silkworm larvae were reported deed at 144 h. The total weight (88 g) and mean weight (0.88 ± 0. g) were recorded minimum during 12 h of culture period and attained maximum total weight (481 g) mean weight (0. 481±0.g) in 156 h. Similarly, the leaf consumed by the 5th stage silkworm larvae were minimum (101 g) during 12 h of culture period and it was increased to 610 g in 108 hours. The unconsumed leaf waste was recorded as 85 g in 12 h growth period 34 g in24 h,56 g in 36 h,107 g in 48 h,59 g in 60 h,104 g in 72 h, 126 g in 84 h, and 124 g in 96 h, and 156 g in 108 h, and 161 g in 120 h, 159 g in 132 h, and 146 g in 144 h, respectively. During the culture period, the silkworm excreted 19 g of waste during 12 h,26 g and 24 h, 29 g in 36 h, 54 g in 48 h, 59 g in 60 h and 61 g and in 72 h, 73 g in 84 h, 68 g in 96 h, 61 g in 108 h, 69 g in 120 h, 71 g in 132 h. and 56 g in 144 h, respectively.

Table. 4 Mulberry leaf V1 variety supplemented with Maize extract (2.0%)on the growth 5th stage silkworm larva.

S.No	No.of silkworm		Growth (Hours)	Total weight silkworm (g)	Mean weight silkworm (g)	Leaf Supplied (g)	Leaf waste (g)	Silkworm excreta (g)
	Live	Dead						
1	100	-	12	88	0.88 ± 0.	101	85	19
2	100	-	24	105	1.05 ± 0.	170	34	26
3	100	-	36	160	1.60 ± 0.	250	56	29
4	100	-	48	271	2.71 ± 0.	425	107	54
5	100	-	60	329	3.29 ± 0.	410	139	59
6	100	-	72	350	3.50 ± 0.	530	104	61
7	100	-	84	330	3.30 ± 0.	585	126	73
8	100	-	96	387	3.87 ± 0.	590	124	68
9	100	-	108	410	4.10 ± 0.	610	156	61
10	100	-	120	445	4.45 ± 0.	570	161	69
11	100	-	132	492	4.92 ± 0.	620	159	71
12	100	8	144	481	4.81 ± 0.	428	146	56

The 5th stage silkworm larva was fed with supplemented Mize extract (2.5%) and mulberry leaf (V1- variety) and the growth parameters was recoded at 12-hour interval. During the culture period, three silkworm larva was deed recorded during at 132and of silkworm larva six in 144 h. The total weight (89 g) and mean weight (0.89 ± 0. g) were recorded minimum during 12 h of culture period and attained maximum total weight (428 g) mean weight (0.428 ± 0 g) in 156 h. Similarly, the leaf consumed by the 5th stage silkworm larvae were minimum (157 g) during 12h of culture period and it was increased to 650 g in 96 h. The unconsumed life waste was recorded as 62 g in 12 h growth period, 48 g in 24 h, 64 g during 36 h, and 59 g in 48 h ,87 g in 60 h, 120 g in 72 h, and 106g in 84 h, 101 g in 96 h, 112 g in 108 h, 86 g in 120 h, 135 g in 132 h, and 165 g in 144 h, respectively. During the culture period, the silkworm excreted 14 g of waste during 12 h,19 g and 24 h, 34 g in 36 h of culture period, 56 g in 48 h, 67 g in 60 h, and 68 g and in 72 h, 65 g in 84 h, 68 g in 96 h, 65 g in 108 h, 61 g in 120 h, 59 g in 132 h, and 52 g in 144 h, respectively.

Table. 5 Mulberry leaf V1 variety supplemented with Maize extract (2.5%)on the growth 5th stage silkworm larva.

S.No	No.of silkworm		Growth (Hours)	Average weight silkworm (g)	Mean Weight of Silkworm (g)	Leaf supplied (g)	Leaf waste (g)	Silkworm excreta (g)
	Live	Dead						
1	100	-	12	89	0.89 ± 0.	157	62	14
2	100	-	24	108	1.08 ± 0.	226	48	19
3	100	-	36	139	1.39 ± 0.	256	64	34

4	100	-	48	186	1.86 ± 0.	312	59	56
5	100	-	60	270	2.70 ± 0.	458	87	67
6	100	-	72	327	3.27 ± 0.	535	120	68
7	100	-	84	392	3.92 ± 0.	580	106	65
8	100	-	96	410	4.10 ± 0.	650	101	68
9	100	-	108	435	4.35 ± 0.	589	112	65
10	100	-	120	510	5.10 ± 0.	568	86	61
11	100	3	132	559	5.59 ± 0.	545	135	59
12	97	6	144	428	4.28 ± 0.	473	165	52

Similar results were reported by Mahmoud, 2013 indicated that the 5th instar larval fed on diet contained mulberry leaves with Corn flour gave the highest significant weights of larvae, silk glands and pupae. Mihai Bentea *et al.,* (2012) studied the effect of zinc supplementation and reported that the use of Zinc in silkworms has improved larval weight, serigene gland weight, cocoon weight and shell weight. The maximum dose of administration did not have any negative effects. Geetha *et al.,* (2017) conducted the combined foliar spray of micronutrients (ZnSO4, FeSO4, MnSO4 and citric acid) on 5th in star larvae. Significant increase might be due to increased DNA synthesis in the silk gland or may be due to the general growth stimulatory effect of those chemicals on silk glands as indicated by Manimala (1995). The importance of these elements were indicated by Ito and Niminura (1966) as well as Horie *et al.,* (1967) where they reported that it accelerated the growth of larvae. Hugar *et al.,* (1999); Ashfaq *et al.,* (2000) reported that Zn increases the weight of the larvae and sericine gland and reduced the mortality rate and the larval duration. During present study increase of larval weight was observed in treated batches compared to control batches. The data showed significant difference between treatments and their interaction in all the parameters. From the data it is evident that the larvae fed with the oral administration of Zea mays has got a profound influence on the growth of silkworms and in turn on cocoon parameters as well as in protein content which is proved by improvement in cocoon weight, pupal weight, shell weight etc., compared to feeding of worms on normal mulberry leaves. He *et al.,* (2021) observed that adding lactic acid at levels of 0.01, 0.1, and 1% improved growth and the quality of female cocoons, resulting in greater larval weight and female cocoon shell weight than in the control group. On the other hand, 10% lactic acid killed Bhat *et al.,* Biological Forum – An International Journal 14(2a): 141-148(2022) 147 the larvae by poisoning them and substantially slowed their growth. The cocoon shell as such contains silk proteins namely fibroin and sericin which are in turn made up of polypeptide chain of amino acids, particularly sericin, alanine and glycine. These amino acids are perhaps assimilated by the worms in the course of supplemented feeding with protein aqueous source in the form of flour can be exploited to enhance shell ratio and shell weight. According to Vanderstoep (1981) germinated mungbeans, common beans (Matki) are associated with turnover of protein and amino acids with the greatest increase in glutamic and aspartic acids. These amino acids are necessary in silk synthesis. The *Zea mays* utilized in present study perhaps optimize quantity of nutrient assimilated which is channelized for maximum silk production by silkworms. Silkworms feeding on mulberry shoots fortified with the palatable nutrient rich source viz., protein, fats, carbohydrates, minerals and amino acids improved the cocoon characters. The total protein content of experimented. The feeding efficiency of the Spirulina supplemented group was significantly lower than that of the control group, according to Kumar *et al.,* (2019). However, compared to the control group of silkworms, the experimental group's cocoon yield was noticeably higher. The results of this inquiry advance our understanding of enhanced silkworm nutrition and its practical commercial use in the sericulture sector. The higher protein concentration of 312.89 µg/ml and the minimum protein content of 250 µg/ml was observed from 4 % and 10 % from the bivoltine hybrid of FC1 × FC2 following the oral administration of *Zea mays* flour. The protein content of 306.14, 291.86, 285.52 and 221.46 µg/ml was recorded from 2, 6, 8 % and control larvae of FC1 × FC2 following the oral administration of *Zea mays* flour. The present findings are in agreement with the findings of Vanisree *et al.,* (1996); Raj *et al.,* (2000a and 2000 b); Manimsegalai *et al.,* (2002) who reported higher cocoon parameters on soyabean protein supplement. Artificial diet containing wheat bran increased female cocoon weight of two multivoltine breeds (Nistari and BSRI-85/3) as reported by Sarkar and Absaram (1995); Nagesh (1998) reported similar trend on 'Sericare', and on cereal flour by Ganga and Gowri (1990); Vanitha (2006); Andal (2006); Sumathi (2007) respectively. According to Senthamarai Selvi *et al.,* 2014, the silk worm *B. mori* dramatically increased morphometric parameters such larval length, width, and weight when exposed to V1 mulberry leaves treated with a 25% concentration of *Spinacia oleracea.*

4. CONCLUSION

The present study suggests that the *Bombyx mori* larvae fed with Maize extract significantly showed uprise almost in all biological and commercial traits as well as in the constituent of growth and development. Because we found out that the 4th and 5th stages of silkworm fed with mulberry leaves (V1) variety fortified with Maize extract showed an increase in growth parameters. Due to the higher growth parameters of 5th stage silkworm larvae, the cocoon weight, shell weight, and shell ratio were increased, and thus improved the quality of silk. As these materials are modest and matter-of-fact, they can be suggested for the farmers use.

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