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Studies on the Impact of Albumin and Papain on the Growth and Economic Characters of *Bombyx mori* (Linnaeus)

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Abstract: In this investigation, an attempt has been made to study the tissue growth and economic characteristics of *Bombyx mori* fed with supplements. *B. mori*is a monophagous lepidopteran insect feeding on mulberry leaves. Dietary supplementation increased the economic characteristics of the silkworms. Albumin (protein) (isolated from the egg) and papain (proteolytic enzyme) (isolated from the papaya plant) were given to silkworms separately in order to increase the weight of the silk gland and cocoon size.

Keywords: Silkworm, Mulberry leaves, Albumin, Papain, Silk gland

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Introduction

Feed supplementation to silkworms includes ascorbic acid, thiamin, niacin, folic acid and multi-vitamins. In order to enhance the quality of silk, supplements such as albumin are given. Digestion of albumin was augmented using papain (proteolytic enzyme). Papain's are plant-derived proteolytic enzymes. Peptizyme (a special serrapeptase) is derived from a bacteria that resides in the intestines of silkworms. It is also called silkworm enzyme as it is the enzyme used to break the cocoon of the silkworm, concentration of potassium iodide, decrease fecundity, increase silk gland weight, enhance metabolic activity, acid and alkaline phosphatase activity (Bhattacharyya and Medda, 1981a, b). Cobalt chloride-treated leaves increased the larval and cocoon shell weight and fecundity (Chakraborthi and Medda, 1978), and the worms fed with leaves treated with potassium iodide increased the economic parameters and reduced the larval duration. The smaller feed index increased the level of efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) in silkworm, *Bombyx mori*

Table 1: Calculation method

Food Consumption	The initial weight of leaves - the weight of unconsumed leaves. (in mg dry weight)
Assimilation	Food consumed - weight of faecal matter (in mg dry weight)
Tissue growth	Final body weight - Initial body weight of the caterpillar(in mg dry weight)
Approximate digestibility (AD)	$\frac{Assimilation}{Consumption} \times 100(in\%)$
Tissue growth efficiency (ECD)	$\frac{Tissuegrowth}{Assimilation} \times 100(in\%)$
Ecological growth efficiency (ECI)	$\frac{Tissuegrowth}{Consumption} \times 100(in\%)$

The cocoons were harvested on the fourth day and characters were observed.

(Smioka *et al.*, 1982). In the present study impact of albumin and papain on the growth and economic characteristics of *Bombyx mori* (Linnaeus) was investigated.

Materials and Methods

This investigation was carried out on mulberry silkworm *B. mori* (PM x NB_4D_2) and was incubated at 27±1°C and 70 - 80% humidity. The emerging caterpillars were transferred to clean bamboo baskets (25 cm diameter and 5 cm deep) with a scaffolding of paraffin paper (Krishnaswamy, 1978). The young caterpillars were fed with adlibitum mulberry leaves (V_1 hybrid). Fourth and fifth instar caterpillars were used. The present investigation was designed to supply protein such as albumin (separated from the egg) and proteolytic enzyme papain (separated from the papaya)as feed supplements to silkworm caterpillars. Albumin was given to silkworm at a concentration of 100 µl individually. Then, a mixture of albumin and papain at a **concentration of 50:50** was supplied to silkworms along with leaves. The energy parameters of silkworm caterpillars were analyzed (Table 1) based on the methods developed by Kam and Degen (1997).

Results and Discussion

The growth and silk quality of *B. mori* larvae significantly increased when the worms were fed with albumin. Table 2 clearly shows that food consumption was increased (17.47 per cent) at the second set of the fifth instar when fed with albumin (individual) than binary mixture (albumin + papain). Assimilation was higher (158.08 per cent) when fed with albumin (individual) at the second set of the fifth instar. The highest tissue growth (603.94 per cent) was seen in the fifth instar at the second set when fed with albumin. Approximate digestibility also increased (119.72 per cent) when fed with albumin in the case of the fifth instar larva at the second set than a binary mixture. Similarly, other parameters such as tissue growth efficiency (172.76 per cent) and Ecological growth efficiency (499.33 per cent) increased at the second set of the fifth instar when fed with albumin than in binary mixture (Figs. 1 to 4).

Economic characters such as cocoon weight (mg), shell weight (mg), shell ratio (%), and pupal weight (mg) were more effective in the case of albumin (supplement) at the first set of fifth instar than in binary mixture (Table 3).

In the present study, albumin and papain (binary mixture) were used as a supplementary feed, and albumin (protein) was more effective and powerful for the formation of high percentage shell weight and cocoon weight, and it shows high energy parameters at the fourth and fifth instar levels. Binary mixture is also more

Table 2: Energy parameters of silkworm *B. mori* fed with albumin and combination of albumin and papain

Energy Parameters	The first set of V instar			Second set of V instar		
	Control	Individual (albumin) (µl)	Binary mixture (albumin + papain) (µl)	Control	Individual (albumin) (µl)	Binary mixture (albumin + papain) (µl)
Food consumption (in mg)	847.00±0.03	982.00 ± 0.006 (15.94)	964.00 ± 0.05 (13.81)	915.00±0.09	995.00±0.006 (8.74) **(17.47)	973.00±0.05 (6.34) **(14.88)
Assimilation (mg)	371.20±0.08	934.00±0.06 (151.62)	860.00±0.05 (131.68)	795.00±0.08	958.00±0.06 (20.50) **(158.08)	875.00±0.05 (10.06) **(135.72)
Tissue growth (mg)	127.00±0.09	867.00±0.15 (582.68)	800.00±0.12 (529.92)	659.00±0.18	894.00±0.29 (35.66) **(603.94)	813.00±0.10 (23.36) **(540.16)
Approximate digestibility (%)	43.82±0.06	96.02±0.05 (119.12)	89.21±0.10 (103.58)	86.88±0.09	96.28±0.06 (10.81) **(119.72)	89.92±0.05 (3.49) **(105.20)
Tissue growth efficiency (%)	34.21±0.08	92.82±0.11 (171.32)	93.02±0.10 (171.91)	82.89±0.13	93.31±0.18 (12.57) **(172.76)	92.91±0.08 (12.08) **(17.59)
Ecological growth efficiency (%)	14.99±0.07	88.28±0.10 (488.93)	82.98±0.08 (453.57)	72.02±0.14	89.84±0.18 (24.74) **(499.33)	83.55±0.08 (16.00) **(457.37)
						n=10

Per cent deviation over control values in parentheses. *t-test values significant at P ≤ 0.05; **per cent deviation (second set) over control values of first set in parentheses

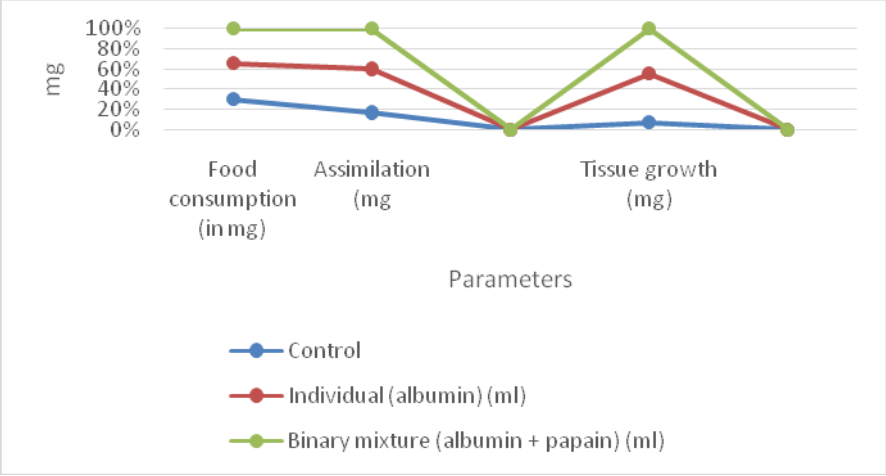

Fig.1: Energy parameters of silkworm *B. mori* fed with albumin and combination of albumin and papain (First set of V instar).

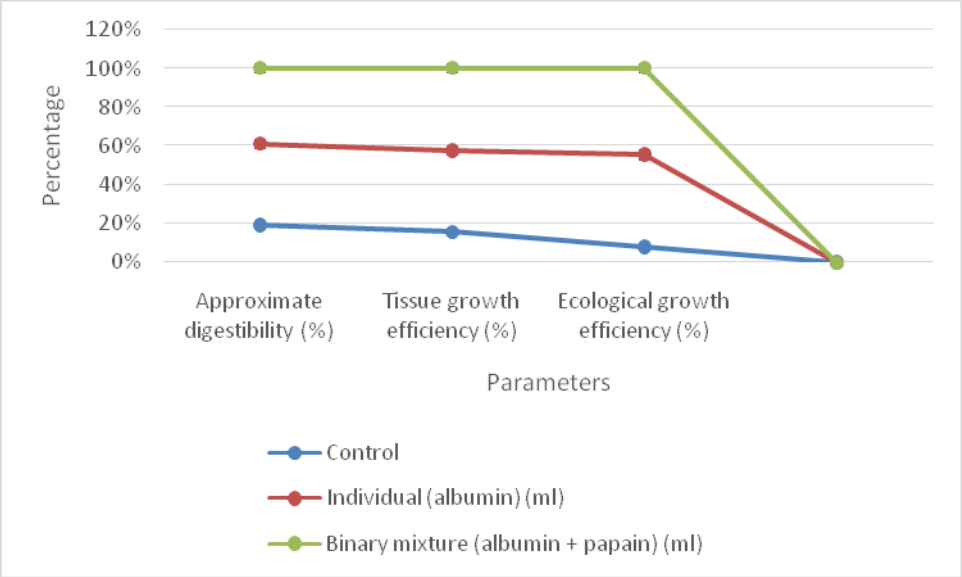

Fig. 2: Energy parameters of silkworm *B. mori* fed with albumin and combination of albumin and papain (First set of V instar).

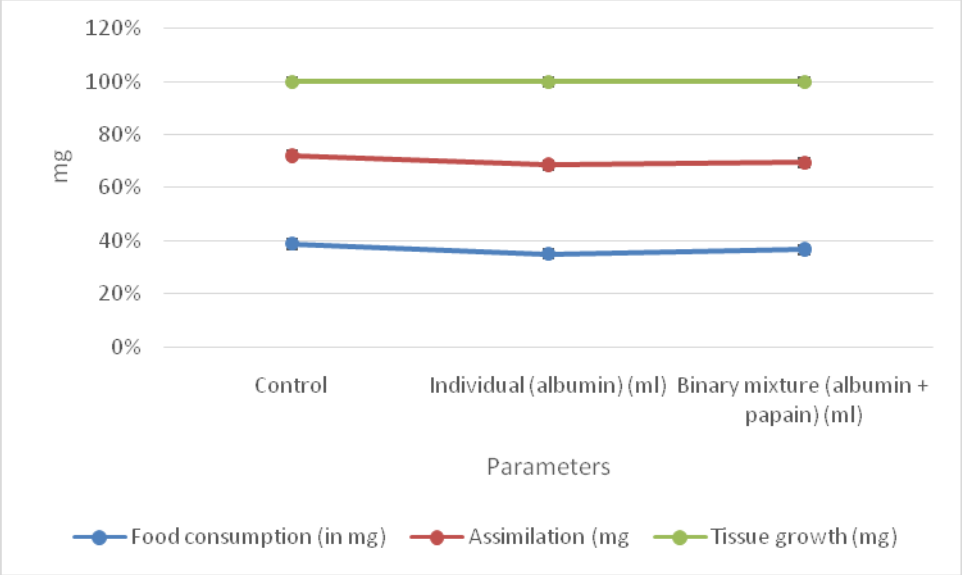

Fig. 3: Energy parameters of silkworm *B. mori* fed with albumin and combination of albumin and papain (Second set of V instar).

effective than control (Figs. 5 and 6) but less effective than albumin (individual).

The quality and quantity of food ingested by an insect larva influences its survival, growth, rate of development and final instar body weight (Slansky and Scriber, 1985). Khalequzzaman and Ansary (1982) also reported increased fecundity and hatchability due to the effect of different vitamin compounds in *B. mori*. Role of ascorbic acid in the development of silkworm larvae was also noted by Ito (1961). Chloramphenicol influences the conversion of more food towards shell content. The supplementation of calcium and magnesium chlorides showed an increase in cocoon shell weight and shell ratio (Subburathinam *et al.*, 1990).

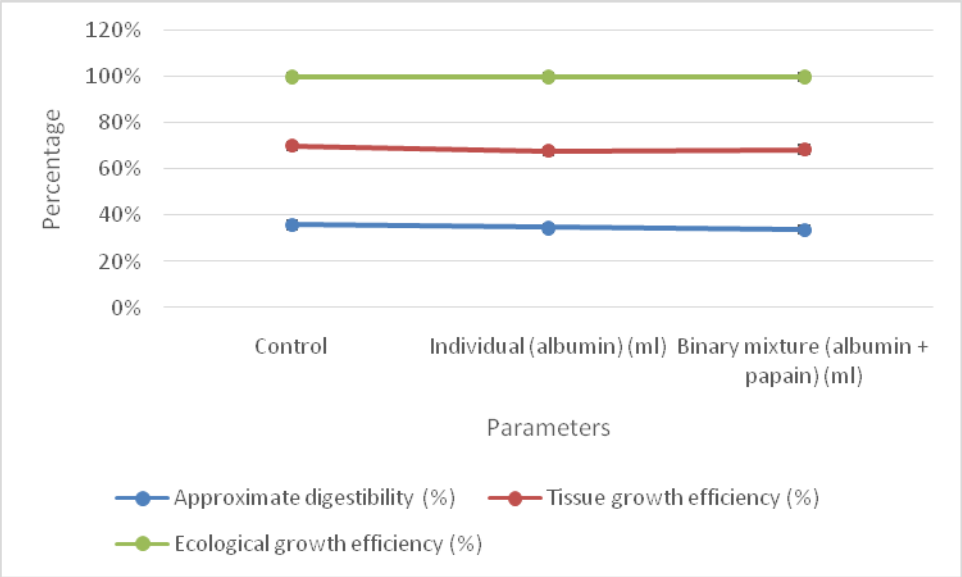

Fig. 4: Energy parameters of silkworm *B. mori* fed with albumin and combination of albumin and papain (Second set of V instar).

Table 3: Effect of supplements (Albumin and papain) on the economic characters of *B. mori*

Cocoon characters	**First set**			**Second set**		
	Control	**Individual (albumin) µl**	**Binary mixture (albumin and papain) µl**	**Control**	**Individual (albumin) µl**	**Binary mixture (albumin &papin) µl**
Cocoon weight (mg)	1056.40±0.17	1301.20±0.19 (23.17)	1275.50±0.12 (20.74)	1075.00±0.15	1320.60±0.18 (22.85)	1298.04±0.11 (20.74)
Shell weight (mg)	185.21±0.04	296.50±0.05 (60.08)	257.00±0.009 (38.76)	191.15±0.07	291.58±0.05 (52.53)	276.40±0.08 (44.59
Shell ratio (%)	17.53±0.10	22.60±0.12 (28.93)	20.15±0.10 (14.94)	17.78±0.11	22.08±0.12 (24.18)	21.30±0.09 (19.80)
Pupal weight (mg)	87.1.19±0.07	1004.70±0.08 (15.33)	1018.50±0.09 (16.09)	883.85±0.04	1029.02±0.06 (16.42)	1021.64±0.04 (15.58)
						n = 10

The increase in silk gland weight might be due to the stimulatory effect on the metabolic activity of the silk gland, as was seen in the Nistari race of *B. mori* treated with cobalt chloride (Bhattacharyya and Medda, 1983). Koul (1986) reported the least leaf ingestion in the variety Tchinose' with the best cocoon characteristics. It is widely known that the development and function of silk glands are under the control of juvenile hormones, ecdysteroids and neuro-hormones (Prudhome *et al*., 1985).

Conversion efficiency greatly influences the

Fig. 5: Effect of supplements (Albumin and papain) on the economic characters of *B. mori* (First set)

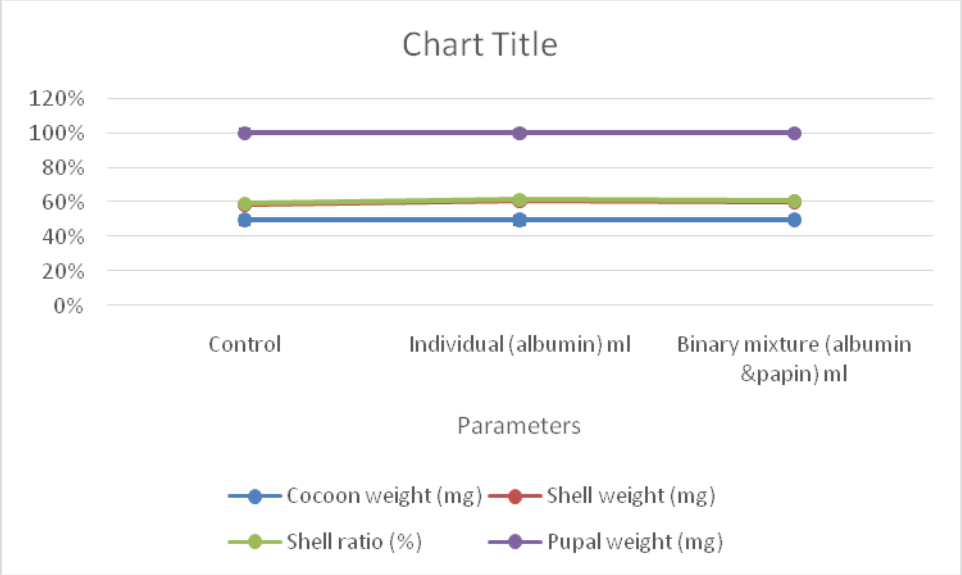

Fig. 6: Effect of supplements (Albumin and papain) on the economic characters of *B. mori* (Second set).

growth of larvae rather than the quantum of feeding (Remadevi *et al.* 1993). Yamamoto and Gamo (1976) observed a high positive correlation between ingesta and cocoon weight, shell weight and larval weight.

Conclusion

Mulberry leaf-eating *B. mori* is a type of lepidopteran insect. The silkworms' economic traits were enhanced by dietary supplementation. The enhancement in the size and weight of the silk gland in silkworms was witnessed by supplementing albumin (a protein) and papain (a proteolytic enzyme) extracted from the egg and papaya plant, respectively.

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