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Scientific Note

Nutritive effects of edible salts on the growth and development of silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae)

Rezina Laz* and M. Anwar Hossain
Department of Zoology, University of Rajshahi, Rajshahi-6205, Bangladesh

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The mulberry silkworm, *Bombyx mori* L. is known to man from ancient times as a beneficial insect. It is the most important source of natural silk, is a bio-tool that converts mulberry leaf into an exquisite textile fiber. This conversion process is achieved through silkworm rearing that has now developed into an applied and well integrated basic science. Sericulture is a highly labor-intensive agro-based industry which depends on cultivation of mulberry plants and rearing of silkworms. The silkworm and mulberry tree have a great partnership because the silkworm, *B. mori* is a monophagous insect and cannot thrive without the leaves of mulberry plants, *Morus alba* L. In all the years silkworms never changed their beeding habits, so, the quality of leaves greatly influenced the biology of these worms (Frassie & Arnoux, 1954; Arai & Ito, 1963).

It is obvious that the study of larval growth is an important aspect of research for the insects which are economically important. Successful cocoon crops in sericulture depend mostly on a healthy larval growth. So, nutrition is an important growth regulatory factor in the silkworm like in any other organisms. According to Krishnaswami *et al*. (1971) feeding of nutritionally enriched leaves showed better growth and development of silkworms as well as gain in economic characters of cocoons. Vishwanath & Krishnamurthy (1983) also studied influence of micronutrients on larval development and cocoon characters of silkworm. According to

rapid growth. Significant developments in the research on silkworm nutrition started with the formulation of artificial diets with different nutrients. Researchers have been carried out experiments on the effects of hormones (Trivedy *et al*.,1993; Reddy *et al*., 1994; Saha & Khan, 1997b), antibiotics (Tayada *et al*., 1988), amino acids (Saha & Khan, 1995; Laz *et al*., 2006; Laz, 2010), vitamins (Saha & Khan, 1997a; Faruki, 1998) etc. on the growth and development of *B. mori* L.

Minerals take part in the regulation of osmotic pressure of the intra- and extra- cellular fluids for maintaining and ionic balance optimum for the activities of living cells. The importance of minerals on the growth and development of silkworms has been studied by a number of researchers (Padki, 1991; Magadum *et al.,* 1992; Islam & Khan, 1993; Khan & Saha, 1995). Administration of potassium sulphate in the food determines protein decrease in the fat body and the hemolymph in silkworm (Nirwani & Kaliwal, 1996). Zinc chloride causes a significant decrease of fat body protein content and significant increase in hemolymph protein content (Hugar *et al.,* 1998). According to Bhattacharya & Kaliwal (2004) observed that oral administration of potassium permanganate lead to increase of protein content in both the fat body and hemolymph. Islam *et al.* (2004) observed the effects of nickel chloride on silkworm growth. So, the present study was aimed at determining the nutritive effects of edible salts (common salt, rock salt, baking salt and

*Corresponding author: rezina_laz@yahoo.com

The materials for these experiments were an improved multivoltine variety of silkworm, *B. mori* L. BSRI-85/2. Cocoons are yellow in color, elongated, oval in shape, soft without floss. It is comparatively resistant to adverse climatic conditions. To study the effects of different edible salts, common salt (NaCl), Rock salt (NaCl), Baking salt ($NaHCo_3$) and Tasting salt ($C_5H_8NO_4Na$) were used. The fresh mulberry leaves were dipped in 50ppm salt solutions separately. The leaves were then dried up by fanning and chopped. Then the treated leaves were supplied to the worms only of their first feeding from 3rd-5th instars. Control insects were reared on mulberry leaves dipped in distilled water (DW) only. There were three replications per treatment containing thirty (30) healthy larvae and continued upto spinning and succeeded by parental and F_1 generations. The data were collected and used for the statistical analysis.

Table1. Nutritive effects of some edible salts on the larval growth of *B. mori* L.

Concentration	Treatments	Generations	Parameters			
			Larval weight(gm) Mean ± sd	Larval length(cm) Mean ± sd	Weight of silk gland (gm) Mean ± sd	Weight of digestive tract (gm) Mean ± sd
Control (DW)		Parental	2.29±0.22	6.26±0.35	0.40±0.02	0.25±0.02
		F_1	2.70±0.25	6.70±0.42	0.47±0.02	0.38±0.02
50 ppm	Common salt	Parental	2.36±0.31	6.30±0.37	0.57±0.02	0.27±0.02
		F_1	2.74±0.26	6.77±0.46	0.58±0.02	0.37±0.03
	Rock salt	Parental	2.40±0.25	6.30±0.47	0.61±0.04	0.28±0.01
		F_1	2.70±0.22	6.73±0.28	0.62±0.03	0.35±0.06
	Baking salt	Parental	2.44±0.29	6.38±0.34	0.69±0.02	0.38±0.01
		F_1	2.75±0.28	6.79±0.25	0.73±0.02	0.39±0.02
	Tasting salt	Parental	2.41±0.27	6.24±0.37	0.64±0.02	0.32±0.02
		F_1	2.69±0.22	6.76±0.22	0.71±0.02	0.38±0.04
F-values	Between treatments (Parental)		0.694^{NS}	3.19^{NS}	29.76***	34.00**
	Between treatments (F_1)		0.071^{NS}	0.19^{NS}	78.01***	0.04^{NS}
	Between generations		143.60***	32.41***	4.50^{NS}	7.31^{NS}

Note: *** P<0.001, NS=Not significant

Nutritive effects of 50ppm edible salts on the larval growth of *B. mori* L. were studied and results are shown in the Tables 1, 2 and 3. In the present investigation it was observed that the weight and length of matured 5^{th} instar larvae were increased in the treated line when compared with the control in the parental and F_1 generations (Table 1). The heaviest larvae 2.44±0.29gm and 2.75± 0.28gm were produced in baking salt in the parental and F_1 generations when compared with the control line 2.29±0.22gm and 2.70±0.25gm respectively. Analysis of variance showed no significant differences between the treatments (0.69^{NS} and 0.071^{NS}) but highly significant differences were observed between the generations (143.60, P< 0.001).The highest length of matured larvae were 6.38±0.34cm and 6.79±0.025cm in baking salt in the parental and F_1 generations when compared with the control (6.26±0.35cm and 6.70±0.42cm) respectively. Although there exhibit no significant differences between the treatments (3.19^{NS} and 0.19^{NS}) but highly significant differences were observed between the generations (32.41, P< 0.001). Baking salt also increased the weight of silk glands (0.69±0.02 and 0.73±0.02gm) at 50ppm in the parental and F_1 generations which was highly significantly differed between the treatments (29.76 and 78.01, P<0.001) respectively (Table 2).

Table 2. Nutritive effects of some edible salts on the pupal weight and shell weight of *B. mori* L.

Concentration	Treatments	Generations	Pupal weight (gm) Mean ± sd		Shell weight (g) Mean ± sd	
			♂♂	♀♀	♂♂	♀♀
Control (DW)		Parental	0.82±0.17	1.21±0.05	0.13±0.02	0.12±0.02
		F_1	0.99±0.09	1.30±0.11	0.20±0.03	0.20±0.02
50ppm	Common salt	Parental	0.89±0.08	1.24±0.07	0.15±0.01	0.14±0.03
		F_1	1.02±0.12	1.31±0.20	0.20±0.02	0.20±0.02
	Rock salt	Parental	0.89±0.54	1.15±0.08	0.15±0.01	0.17±0.02
		F_1	1.04±0.06	1.23±0.06	0.20±0.02	0.24±0.02
	Baking salt	Parental	0.96±0.12	1.25±0.07	0.14±0.02	0.17±0.01
		F_1	1.05±0.09	1.32±0.06	0.24±0.03	0.27±0.02
	Tasting salt	Parental	0.91±0.07	1.24±0.08	0.14±0.02	0.12±0.02
		F_1	1.04±0.10	1.30±0.06	0.22±0.03	0.17±0.02
F-values	Between treatments (Parental)		0.036^{NS}	0.023^{NS}	0.103^{NS}	0.045^{NS}
	Between treatments (F_1)		0.020^{NS}	0.031^{NS}	0.103^{NS}	0.121^{NS}
	Between generations		60.16***	210.61***	12.81*	1.97^{NS}

Note: *** P<0.001, *=P<0.05, NS=Not significant

But between the generations ANOVA showed no significant differences. In case of weight of the digestive tract the heaviest tract were found 0.38±0.01 and 0.39±0.02gm in baking salt respectively in the parental and F_1 generations. Analysis of variance showed highly significant differences between the treatments only in the parental generation (34.00, P<0.001).

The pupal weight, shell weight, cocoon weight and silk-ratio were also greatly influenced by the different types of salt supplementation, although they did not differ significantly between the treatments in the parental and F_1 generations (Table 3). The heaviest pupae were produced at baking salt in the parental and F_1 generations. In case of male it was 0.96±0.12gm, 1.05±0.09gm and in female 1.25±0.07gm and 1.32±0.06gm respectively. Similar results were found in shell weight (0.14±0.02, 0.24±0.03 in male and 0.17±0.01, 0.27±0.02 in female), cocoon weight (1.10±0.17, 1.27±0.09 in male and 1.42±0.12, 1.59±0.07 in female) and silk-ratio (12.73±0.86, 18.60±1.40 in male and 11.97±0.60, 16.98±0.70 in female) respectively in the parental and F_1 generations. ANOVA showed significant differences between the generations only (F=60.16, P<0.001; F=210.61, P<0.001; F=12.81, P<0.05 in pupal & shell weight (Tabel 2); F=47.66, P<0.001 and F=18.19, P<0.05 in cocoon weight (Tabel 3).

These results are in accord with the findings of Horie & Watanabe (1980). They observed that the minerals are essential for the nutrition of silkworm including potassium, phosphorus, magnesium and zinc. Minerals take part in the regulation of osmotic pressure of the intra and extra-cellular fluids for maintaining the ionic balance optimum for the activities of living cells. The importance of minerals on the growth and development of silkworms have been studied by many researchers. Magadum *et al.* (1992) observed that the supplementation of food with copper sulphate significantly increased the larval and cocoon shell weight. Islam & Khan (1993) also noted that magnesium sulphate enhanced the cocoon characters. According to Islam *et al.* (2004) administration of additional salts e.g. copper sulphate, nickel chloride and potassium iodide in the food increased the economic parameters of the silkworm. Morimoto *et al*. (1968) reported that posterior silk gland and larval body weight increased

Table 3. Nutritive effects of some edible salts on the cocoon weight and silk-ratio of *B. mori*

Concentration	Treatments	Generations	Parameters			
			Cocoon weight (gm) Mean ± sd		Silk-ratio (%) Mean ± sd	
			♂♂	♀♀	♂♂	♀♀
Control (DW)		Parental	1.05±0.18	1.33±0.08	12.38±1.80	9.02±1.05
		F_1	1.19±0.10	1.50±0.12	16.81±1.50	13.33±0.60
50 ppm	Common salt	Parental	1.04±0.12	1.38±0.11	14.42±3.20	10.14±0.60
		F_1	1.22±0.11	1.51±0.04	16.39±1.50	13.24±1.40
	Rock salt	Parental	1.04±0.09	1.32±0.12	14.42±2.04	12.88±0.60
		F_1	1.24±0.06	1.47±0.07	16.13±2.10	16.33±0.90
	Baking salt	Parental	1.10±0.17	1.42±0.12	12.73±0.86	11.97±0.60
		F_1	1.27±0.09	1.59±0.07	18.60±1.40	16.98±0.70
	Tasting salt	Parental	1.05±0.14	1.33±0.12	13.33±1.50	9.02±0.70
		F_1	1.26±0.12	1.47±0.07	17.46±1.70	11.56±0.41
F-values	Between treatments (Parental)		0.027^{NS}	0.023^{NS}	1.80^{NS}	2.54^{NS}
	Between treatments (F_1)		0.012^{NS}	0.026^{NS}	1.85^{NS}	4.93^{NS}
	Between generations		47.66***	18.19*	0.20^{NS}	0.22^{NS}

Note: ***P<0.001, *P<0.05, NS=Not significant

logarithmically in the early stage of 4th instar. According to Qader *et al*. (1993) development of silk gland is greatly influenced by different types of mulberry leaves. Nirwani & Kaliwal (1996) observed that administration of potassium sulphate in the food protein content decreased in the fat body and the hemolymph. But Hugar (1998) observed that zinc chloride significantly increased the protein content of hemolymph in the silkworm. Again Bhattacharya & Kaliwal (2004) also observed that oral supplementation of potassium permangannate lead to increase of protein content in both the fat body and the hemolymph. Bhattacharya & Medda (1981a, b) also observed the positive results when treated silkworm with the cyanocobalamine and cobalt chloride.

Because any investigation regarding the nutritive effects of edible salts e.g. Common salt, Rock salt, Baking salt and Tasting salt in the silkworm, *B. mori*.L has not yet been worked out, so, it may be suggested that of increase the economic parameters of the silkworm, *B. mori* L. may use the edible salts.

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