Volume 65, Issue 2, 2021
Journal of Scientific Research
Institute of Science,
Banaras Hindu University, Varanasi, India.

Effects of Magnetization on Carbohydrates in Various Tissues of Silkworm *Bombyx mori L.*

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Abstract: **Effects of magnetization on carbohydrates in various tissues of silkworm, Bombyx mori L. were investigated. Fat bodies of magnetized larvae showed gradual gain in carbohydrates while haemolymph and silk gland showed decrease in it. Gain in fat body carbohydrates was gradual after exposure of larvae to magnetic field of 1000 Gauss to 3500 Gauss, beyond which (4000 Gauss) the carbohydrate contents of fat body decreased. Reductions in haemolymph and silk gland carbohydrates were more pronounced when larvae were exposed to low magnetic field (1000 Gauss to 3500 Gauss) than higher magnetic field (5000 Gauss). The results are discussed in relation to silk gland and silk production.**

***Index Terms: Bombyx mori L.*, Carbohydrates, Fat body, Haemolymph, Magnetic field, Silk gland**

I. Introduction

Sericulture has become one of the major cottage industries in a number of countries. Efforts are being made to enhance the yield quality of silk by introducing efficient and eco-friendly techniques. Morphological (Pittman and Anstey, 1967), physiological and biochemical changes have been reported in various biological systems due to their exposure to the magnetic field. Chougale (1992); Chougale & More (1993); Chougale et al., (1995) have reported gain in silk gland proteins, acid phosphatase, midgut protease of the silkworm.

Application of magnetic field in the development of silkworm showed gain in silk gland proteins, RNA and acid phosphatase of silk gland (Chougale et al., 1992; Chougale and More, 1993; Chougale et al., 1995) and midgut protease (Chougale et al., 1995). It also enhances the silk synthesis and silk production (Chougale 1992; Chougale et al., 1995; Chougale & More, 1992) in silkworm. Alterations in glycogen contents in silkworm have been studied in larvae developed from magnetized cocoons (Prasad & Upadhyay, 2015). This communication reports the effects of magnetization in various tissues of the silkworm, *Bombyx mori L.*

II. Materials and Methods

Quality disease-free laying's (DFLs) of PM strain of silkworm were obtained from National Silkworm Seed Organization (NSSO), Mysore. The eggs were incubated at 25°C and relative humidity 80% - 85% was maintained. The larvae hatched from each DFLs were supplied with V1 variety of mulberry leaves and were reared separately under constant conditions of temperature and relative humidity. The rearing technique of Krishnaswami et al. (1973) was followed.

Larvae from each DFL were divided into five groups. Larvae of one group were reared as control and that of other group were exposed to 1000 G, 2000 G, 3500 G and 4000 G separately during first three days of their fifth instar. The silkworm was exposed to magnetic field as per the procedure designed by Chougale (1992).

Five larvae of each group were collected randomly on the 5th day of fifth instar. They were dissected in chilled distilled water. Their silk gland and fat bodies were removed, weighed and homogenized separately in chilled distilled water using chilled mortar and pestle. The homogenate was centrifuged at 4000 rpm and supernatants were used to estimate carbohydrates. Haemolymph from experimental and control group larvae were obtained in eppendorf's by puncturing the abdominal legs of larvae. In each eppendorf containing haemolymph, chilled distilled water was added and centrifuged at 4000 rpm and supernatants were used to determine carbohydrates.

Carbohydrates content in silk gland, fat body and hemolymph of silkworm *Bombyx mori L.* were estimated according to Noelting & Bernfield (1948) using the 3, 5 dinitrosalicylic acid reagent as modified by Ishaaya & Swirski (1976).

III. RESULTS AND DISCUSSION

Alterations in the carbohydrate contents in the fat body, haemolymph and silk gland due to exposure of silkworm larvae to the magnetic field are indicated in Table I and Fig. 1. The carbohydrate contents of the fat body were increased after magnetization (Table I). The exposure of larvae to the magnetic field between 1000 G and 3500 G showed a gradual increase in carbohydrate content of the fat body. Exposure of larvae to higher magnetic field showed gain in carbohydrate content in the fat body. However, % gain obtained for this group was less than that obtained after exposure of larvae to the magnetic field of 3500 G (Table I and Fig. 1). 11.11%, 87.30% and 65.07 % gain in carbohydrate contents in the fat body were observed due to exposure of larvae to the magnetic field of 1000 G, 3500 G and 4000 G respectively.

The changes in carbohydrate content in haemolymph and silk gland of magnetized silkworm are presented in Table 1. Reduction in carbohydrate content in both haemolymph and silk gland is observed due to exposure of larvae to magnetic field strength 1000 G, 2000 G, 3500 G separately. Exposure of larvae to 4000 G showed reduction (16.84%) and gain (22.00 %) in carbohydrate content of haemolymph and silk gland respectively (Table I, & fig. 1). A gradual reduction in carbohydrate contents of silk gland was seen due to exposure of larvae to 1000 G to 3500 G separately. However, this trend was not observed for the carbohydrate content of haemolymph in magnetized larvae. 23.84% and 13.4% reduction in carbohydrate contents in haemolymph were found in larvae magnetized at 1000 G and 3500 G respectively. The respective figures for carbohydrates in silk glands were 25.97% and 91.81%.

Morphological, physiological and biochemical changes have been reported in biological systems due to their exposure to magnetic fields (Boe & Salunkhe, 1963; Pittman & Anstey, 1967; Pittman & Ormond, 1970). Biochemical alterations occurring during growth and development of insects show a significant role of carbohydrates, proteins and lipids (Ito and Horie, 1959; Wyatt, 1967). Quantity of mulberry leaf reflects in the concentration of carbohydrate content in haemolymph (Kumar et al., 2012) of the silkworm. Late age silkworms accumulate more carbohydrate than early instars.

Increased glucose level has been reported in fat body, silk gland and haemolymph of silkworm developed from magnetized cocoons (Prasad, 2011). An increase in carbohydrate contents of the fat body was obtained in the study up to the field strength of 3500 G, beyond which the trend reversed. The magnetic field treatment is reversible in nature. The enhancement in feeding activity has been reported by Chougale & More (1993); Chougale et al., (1995 & 1996). Increased number of feeding leads to higher accumulation of carbohydrates (Prashanth Kumar & Umakanth, 2017). In insects, carbohydrates serve as the main source of energy (Chino & Gilbert, 1965). In diseased condition various tissues of silkworm showed decreased levels of carbohydrates, proteins and lipids (Nirupama, 2015). To meet the energy demand under stressed conditions breakdown of carbohydrates take place (Manohar & Reddy, 2004). Alexander & Ganeshan, (1990) have indicated an enhancement in the metabolic efficiency after application of the magnetic field.

Table I. Carbohydrate content of various tissue of silkworm *Bombyx mori L.* after its magnetization

Sr. No.	Parameter	Carbohydrate content in V Instar (µg/mg)		
		Fat body	Haemolymph	Silk gland
1	Control	0.315	0.890	0.77
2	1000 G	0.35 (+11.11)	0.66 (-23.84)	0.57 (-25.97)
3	2000 G	0.51 (+61.90)	0.63 (-29.21)	0.560 (-27.27)
4	3500 G	0.59 (+87.30)	0.77 (-13.4)	0.063 (-91.081)
5	4000 G	0.52 (+65.07)	0.74 (-16.84)	0.94 (+22.00)
6	T test	**	**	**

Figures in Parenthesis indicate percent increase or decrease. ** significant $P<0.01$ levels; ***significant $P<0.001$ level

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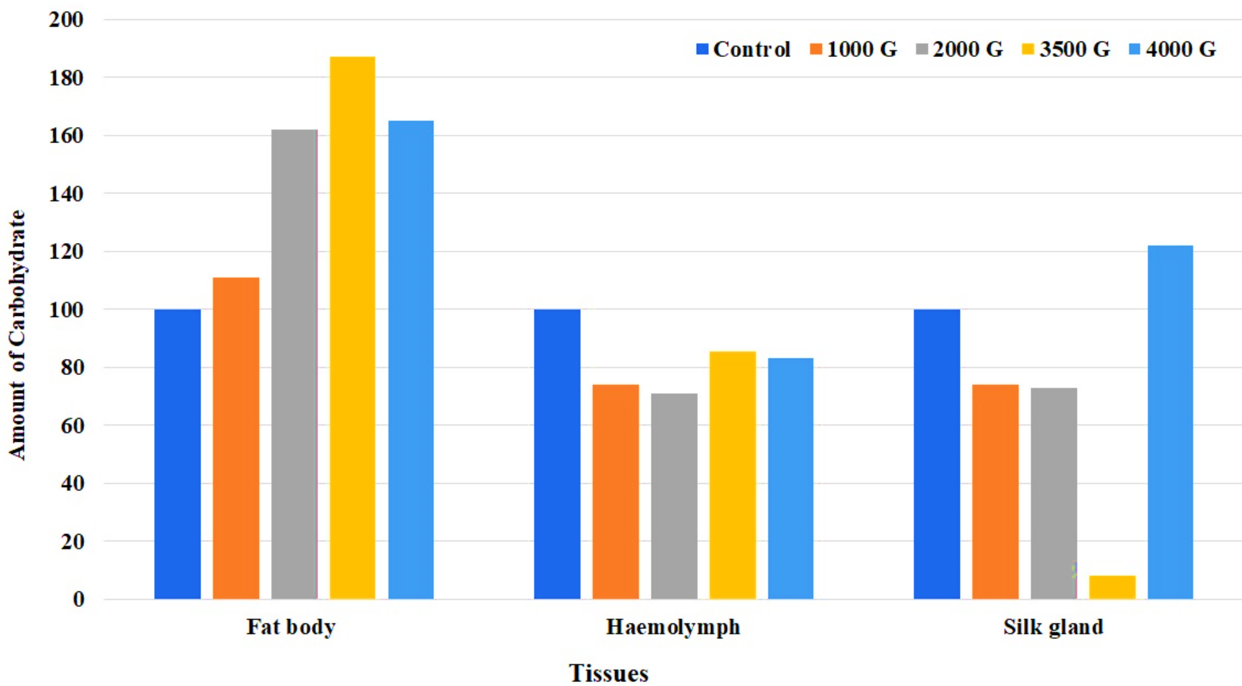

Fig.1 Carbohydrate content of various tissue of silkworm *Bombyx mori* L. after its magnetization

Conclusion

In present investigation, gain seen in carbohydrate content in fat body may be due to excess feeding in magnetized larvae. On the other hand, depletion in carbohydrate content in haemolymph and silk gland may be due to excess utilization of carbohydrate molecules to meet the high demand for energy under influence of the magnetic field.

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