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

Influence of Magnetic Field on the Midgut Invertase of Silkworm, *Bombyx mori L.*

Sonali S. Sonar[1], Snehal D. Londhe[2] and Alka K. Chougale[3]

[1]Department of Zoology, The Institute of Science, 15 Madam Cama Road, Mumbai 400032, sonalidhl100@gmail.com
[2]Department of Zoology, Institute of Science, 15 Madam Cama Road, Mumbai 400032, snehallondhe.londhe@gmail.com
[3]Department of Zoology, The Institute of Science, 15 Madam Cama Road, Mumbai 400032, dr.akchougale@gmail.com

Abstract: **The influence of magnetic field on the midgut invertase of silkworm, *Bombyx mori L*. was investigated during growth and development. Exposure of larvae to the magnetic field of 1000G to 3500G showed gradual increase in the enzyme activity, beyond which activity decreased. The variations obtained in the activity of enzyme were significant for exposure of larvae during their late instars. The results are discussed.**

***Index Terms: Bombyx mori L.*, electromagnet, invertase, magnetic field, mid gut**

I. INTRODUCTION

In sericulture production of quality cocoons are influenced by the quantity of quality leaves provided to them. (Benchmin & Jolley, 1986; Koul, 1986; Ramadevi et.al. 1993). Nutritive reserve of mulberry leaf is efficiently utilized by late instars of a silkworm. The midgut of insect's secrets most of the digestive enzymes and is the main site of digestion (Dadd, 1970;Wigglesworth, 1927). There exists a functional differentiation between the digestive fluid and midgut tissues (Jadhav & Kallapur, 1988). The carbohydrates and lipids play an important role in the growth and development of insects (Ito & Horle 1969, Wyatt 1961 & 1967). Variety of midgut enzymes like protease, invertases are involved in nutrition and silk production in silkworm.

Exposure of biological systems to magnetic fields produces morphological, physiological, and biochemical changes (Patnav & Mankova, 1986). It has increased seed germination (Patnav, 1965) and changed the characters of cotton fibers (Kalantrao & Melikova 1973). It causes a change in the feeding behavior of silkworms (Chougale et.al.,1992) and migratory behavior of bees (Cldwell & Russo, 1968), acid phosphatase in mouse (Conley et. al.,1966), and hormone levels in the rat (Udinstev & Moroz, 1982). Alterations in molecular configurations of an enzyme as a molecule have been obtained by Young (1969) by applying biological systems to the magnetic fields. The present paper analyses the influence of magnetic field on midgut invertase of silkworm *Bombyx mori L*.

II. MATERIALS AND METHODS

Larvae of pure multivoltine PM *Bombyx mori L*. were used in the present investigation. The pure multivoltine silkworm strain PM was used in the present investigation. Quality disease-free laying's (DFLs) were obtained from the National Silkworm Seed Organization, Mysore (NSSO, Mysore). Eggs were incubated at 250 C (I) and 80 to 35% R.H. The larvae were maintained under constant conditions of mulberry leaves V1 as per Narsimha & Krishnaswami (1970).

Larvae from each DFLs were divided into experimental and control groups. The first group was further divided into many batches, one for each magnetic field and for each larval instar. The larvae were separately exposed during their I, II, III, IV, and V instars. The field strength 1000G, 2000G, 3500G, and 4000G selected for each experimental setup.

The silkworm was exposed to the magnetic field as per the procedure devised by Chougale, (1992). The larvae once exposed were not exposed again during their remaining life cycle. Each treatment was replicated three times.

Five larvae from each group were collected randomly on the fifth day of the V instar. They were dissected in chilled distilled water. The midgut was removed, weighed, and homogenized in chilled distilled water using chilled mortar and pestle. The homogenates were centrifuged at 4000 rpm and supernatant were used to determine invertase activity.

III. Results and Discussion

The variation obtained in the activity of midgut invertase in the larvae of *Bombyx mori L*. exposed to the magnetic field of different strengths is given in Table1 and Fig 1.

Exposure of larvae to the magnetic field showed a gain in an invertase activity (Table1 and Fig. 1). The gain was different for different various instars exposed to the magnetic fields. This was also true for different exposure to field strengths. A gain in enzyme activity was gradual for exposure of larvae to the magnetic field strength of 1000G to 3500G. Beyond that, there is a decline in a gain of midgut invertase activity. The increase in enzyme activity was more significant when larvae were exposed during late instars than their exposure at early instars.

Table I. Influence of magnetic field on silkworm midgut invertase activity (µg Glucose liberated/mg Protein/hr)

Sr. No.	Exposed instar	1st instar	2nd instar	3rd instar	4th instar	5th instar
1	Control	0.014	0.014	0.014	0.014	0.014
2	1000G	0.01488 106.25 (6.25%)	0.0149 101.42 (1.43%)	0.0150766 107.69 (7.69%)	0.01925 137.5 (37.5)	0.0168 120 (20%)
3	2000G	0.01575 112.5 (12.5%)	0.01443 103 (3%)	0.0161 115.38 (15%)	0.0218 156.25 (56.25%)	0.0261 186.67 (86%)
4	3500G	0.0183 131.25 (31.25%)	0.016 114.29 (14.29%)	0.0172 123.07 (23.07%)	0.02275 162.5 (62.5%)	0.0317 226.67 (126.67%)
5	4000G	0.0175 125 (25%)	0.0149 107.14 (7.14%)	0.01507 107.69 (7.69%)	0.020125 143.75 (43%)	0.0298 213.33 (113.33%)
6	T test	***	***	**	***	**

Figures in parenthesis indicate % increase; ** significant at P<0.01 level; ***significant at P<0.001 level

Exposure of the first instar larvae at 1000G and 3500G showed an increase of 6.25% and 31.25% activity in their midgut invertase activity (Table 1). Exposure of their late instar at 1000G and 3500G showed a gain of 20% and 113.33% respectively in enzyme activity. 25% and 113.33% gain were seen in enzyme activity was seen when larvae were exposed at 4000G during their early and late instars respectively (Table I and Fig. 1)

The results obtained indicate that exposure of silkworms to the different magnetic field enhanced the midgut invertase activity. This is true for all the field strengths when the strength of magnetic field applied instars exposed separately to different magnetic field gain in activity of the enzyme was more significant for magnetization of larvae during late instars at 3500G field strength.

Chougale & More (1993) have reported the gain in acid phosphatase activity and midgut protease activity (1995) after magnetization of larvae of *Bombyx mori L*. In in-vitro studies an activation of some enzymes like carboxymutase (young 1969), catalase (1969), glutamate, dehydrogenase (Akoyunoglou 1965) have been obtained by application of a magnetic field.

An increase in midgut protein and RNA content of silk gland and midgut protease activity has been reported in silkworm various races of silkworm after their magnetization (Chougale, 1993; Chougale et.al., 1995; Chougale & More, 1993). According to Eid et al. 1989; Prudhomme et al., 1985; Chougale et al. (1995) indicate the 20% and 35% increase in food consumption (Prasad & Upadhyay, 2011). Increased lipase activity is reported by Todern et al. (1967) in Cucurbita maxima after application of magnetized water.

An enzymatic reaction in the living systems is influenced by the magnetic field (Alexander & Ganeshan, 1990). The magnetic field effect appears to be due to a change in the rate or pattern of translocation and accumulation of magnetically active microelements in cell and organ systems (Barnothy, 1966). The low field is responsible for no effect or stimulatory one whereas, the higher field strength is an inhibitory effect (Mulay & Mulay, M.F. Barnothy (ed.) 1966). According to Young (1969), a low magnetic field produces a conformational change in the enzyme molecule. This change was responsible for the activation of the concerned enzyme system due to the stimulatory effect of a low magnetic field there was an increase in an invertase activity.

Protein in the food stimulates enzyme to decide the rate of enzyme secretion (Ishaya et.al.; 1971) in invertase activity is most important during late instars. About 75% of the total

mulberry leaves are consumed during the entire larval life are

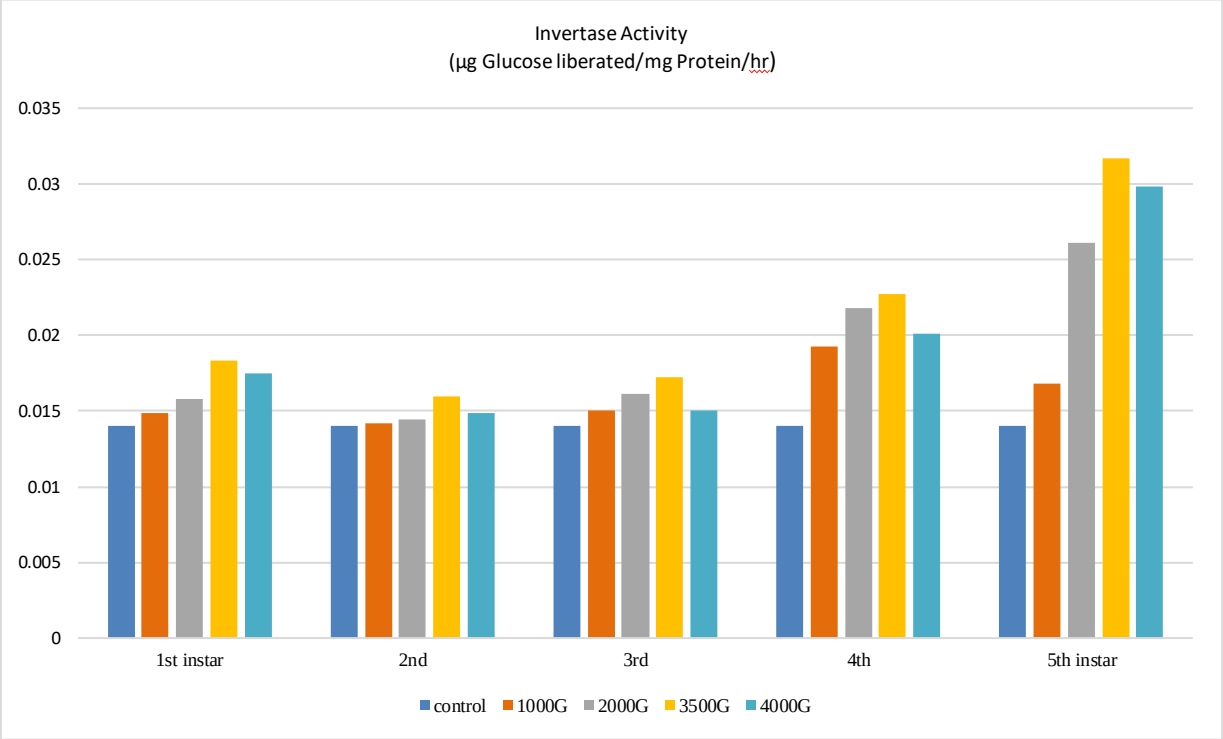

Fig.1 Influence of magnetic field on silkworm midgut invertase activity (µg Glucose liberated/mg Protein/hr)

consumed during late instars (IV and V) (Sarangi, 1986). About 70 to 80% of consumed food is utilized for silk synthesis (Jadhav & Kallapur, 1988; Sarangi, 1986). Midgut protease is the conversion of complex proteins of mulberry leaves to simple forms and they are used as metabolites during the growth and development of silkworm. During late instars, most of the metabolites are utilized by the silk gland for the synthesis of silk (Sarangi, 1986; Wigglesworth, 1972).

Conclusion

From above it can be concluded that a magnetic field up to 3500G stimulates the activity of midgut invertase in silkworm larvae. The increased invertase activity is in turn reflected in the consumption of more mulberry leaves, providing more proteins to the silk gland for the synthesis of additional silk.

References

Alexander, M.P., & Ganeshan, S. (1990), Electromagnetic field-induced in vitro pollen germination and tube growth, *Current Science*, 59 (5) ,276-277.

Bakkali, F., Averbeck, S., Averbeck, D., & Idaomar, .M.M. (2008), Biological effects of essential oils- a review. *Food & Chemical Toxicology*, 46; 446-475

Barnothy, J.M., (1964), "Introduction in Biological Effects of Magnetic Field", (Ed. Barnothy M.F.) *Plenumm Press*, New York 1, 3-24.

Benchamin, K.V., Gopuz, J.V., & Jayaramaraju, P. (1990) Influence of photoperiod on emergence, fecundity and fertility in multivoltine breeds of silkworm, *Bombyx mori* L. *Indian Journal of Sericulture*, 29,110-118

Bricks, Y, Harpaz, I., Ishaaya, I., & Bondi, A., (1962), "Studies on the Proteolytic activity of the bettle Tenebrio and Tribolium", *Journal of Insect physiol*ogy,, 8, 417-429.

Cappellozza, L., Cappellozza, S. Savine, A., & Sbrenna, G.; (2005), "Artificial Diet Rearing System for Silkworm *Bombyx mori* (L.). Effect of Vitamin C Deprivation on Larval Growth and Coccon Production". *Applied Entomology & Zoology*, 40(3), 405-412.

Chougale, A.K., & More N.K; (1992), Magenitisation of the Development Period of Coccon Characters of Silkworm, *Bombyx mori* (L.). *Indian Journal of Sericulture*. 31 (2), 115-122.

Chougale, A.K., (1993), Effect of Magnetic Energy on Silkworm Development and Silk Production. Ph.D., Thesis, Shivaji University, Kolhapur, India

Chougale, A.K., & More N.K; (1995). Influence of Magnetic Field on Midgut Protease of the Silkworm, *Bombyx mori* (L.). *Sericologia* 35 (3), 465-472.

Chougale, A.K; (2003), Influence of Magnetic Field on the Silkworm Development and Silk Production- an overview, *Indian Journal of Comparative Animal Physiology* 2, 41-47.

Conely, C.C., Mills, W.J., & Patricia, A.G., (1966), Enzyme Activity in Macrophages from Animals Exposed to a very Low Magnetic Field, 3rd International Biomagnetic Symposium, University of Illinois, Chicago, 13-15.

Jadhav, G., & Kallapur, V.L.(1988) Influence of age , sex and feeding on the protease activity of certain tissues of fifth instar silkworm, *Bombyx mori* L., *Entomon*, 13, 289- 293

Jadhav, G., & Kallapur, V. L.(1989) Contribution of tissue proteins to the cocoon shell in the 5th instar silkworm, *Bombyx mori* L. *Entomon*, 14(1/2) , 21-24.

Kanarev, G., & Cham, G.T., (1985), Effect of Laser Irradiation of Silkworm Eggs on Silkworm *bombyx mori* (L.) Development and Productivity, *Zhivotnov Nauki*, 22, 47-53.

Kerap, M.B.S., & Mayers, D.K., (1954) A colorimetric micromethod for the determination of glucose, *Biochemical Journal*, 56, 639–645

Krishanaswami, S., (1978), New technology of silkworm rearing Central Sericulture Research and Training Institute, Mysore, *Bulletin*. 3 (2), 1-23.

Mulay, I.L., & Mulay, L.N. (1964) Effects on Drosophilla Melanogaster and S-37 tumour cells: postulates for magnetic field interactions. In Biological Effects of Magnetic fields, (Ed. Barnothy M.F.), *Plennum Press*. 1,146-169

Patnev, T.P., & Mankova, M.I., (1986), Direct And Indirect Effect of a Constant Magnetic Field on Biological Objects. *Kosm Biol. Avikosm Med*; 20, 73-76.

Prudhomme, J.C., Couble, P., Garel, J.P. & Daillie, J., (1985) Silk synthesis. In Comrehensive Insect Physiology, Biochemistry and Pharmacology (G.A. Kerkut L.I. Gilbert, eds), Vol. 10, pp *Bombyx mori* L.", Races at Different Developmental Stages. *International Journal of Current Microbiology & Applied Science*, 4(10), 101-109.

Roli, S., Prasad, S., & Upadhyay, V.B., (2013), Effect of Bioactive Phytojuvenoid on the Reproductive Potential of Multivoltine Mulberry Silkworm (*Bombyx mori* Linn.), *Academic Journal of Entomology*, 6(2), 85-92.

Todorn, S.I; Goran & Gemishev, Is.M. (1967), Stimulative Biomagnetic Effect Under Action of a Magnetic and Magnitsed Water upon the Seeds of Cucurbita, maxima Dutch. God. Sofii. Skiya, Unic. Biol. Fak. Kn. 2 *Bot. Mikrobiol. Fizol, Biokhim. Rast*,61, 239-250.

Upadhyay, V.B. & Prasad S, (2010), Magnetization for the Improvement of Silk Producing Potential in Multivoltine Mulberry Silkworm (*Bombyx Mori* Linn). *The Bioscan* 5(2), 285-289.

Wanve, Hanumant V. , Sadashiv N. Belpatre & Vitthalrao B. Khyade; (2016), Influence of Magnetic Energy on Protein Contents in the Fifth Instar Larvae of Silkworm, *Bombyx mori* (L.), (Race: PM x CSR2), *World Scientific News*, (42), 73-86.

Wigglesworth, V.B. (1972) b Digestion and Nutrition. In: The Principle of Insect Physiology, Butler and Tanner Ltd., Frome 476-552.

Young, W., (1969), Magnetic Field and In Situ Acetylcholineesterase in the Vagal Heart System. in., Biologicl Effects of Magnetic Field, (Ed. Barnothy, M.F.) *Plennum Press*, New York, 2, 79-102.

***