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Effects of magnetic field on the histology of silk gland of silkworm, *Bombyx mori* L. (Lepidoptera, Bombycidae)

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ABSTRACT: Magnetic field influences the physiology and development of living organisms, depending up on the strength of magnetic field. In silkworm, it enhances enzymes, proteins and nucleic acids of silk gland. On this line, histology of silk gland of silkworm *Bombyx mori* L. (Lepidoptera, Bombycidae) was studied after its magnetization, at 3500 G and 4000 G separately. Exposure of silkworm to magnetic field resulted in increase in diameter of its silk gland/lumen of silk gland/space occupied by secretory substance (silk protein-fibroin). The studies showed 46.15 and 21.19 per cent increase in diameter of silk gland of larvae exposed to 3500 G and 4000 G magnetic field respectively than that in control larvae. Larvae treated with 3500 G magnetic field and 4000 G magnetic field exhibited 51 per cent gain and 1.29 per cent loss in the size of secretory substance respectively than that of control group larvae. Cellular thickness is more in magnetized larvae than that of control larvae. This is favourable for sericulture.

KEYWORDS: Magnetization, physiological, cytoological changes

Sericulture is an important agro-based industry. More than 95 per cent of the total silk production of the world is from mulberry silkworm. In addition to industrial value, the mulberry silkworm *Bombyx mori* L. (Lepidoptera, Bombycidae) acts as laboratory tool in variety of research projects. This is because of its domestication, shorter life cycle with different metamorphic forms, considerable size, weight, easy to handle and good techniques of their culture. The environmental conditions and care taken during rearing of silkworm decides the quality and quantity of silk. Since many decades, efforts have been taken to enhance the silk producing capacity of silkworms by exposing them to various conditions of photoperiod, temperature, humidity, gamma rays, X-rays, amino acids and artificial diets (Chougale, 2003). Alterations in morphological (Gokcimen *et al*., 2002), behavioural (Chougale, 2016), physiological (Conely, 1966; Pittman and Ormond, 1970; Ring, 1973), biochemical (Salem *et al*., 2006; Elyamani 2020) and economical parameters have been reported in biological systems exposed to magnetic fields (Boe and Salunkhe, 1963). Magnetic field influences larval period and economic characters of cocoons (Chougale and More, 1992), enzymes (Chougale and More, 1993), nucleic acids (Chougale *et al*., 1996), carbohydrates (Londhe *et al*., 2021) of silk gland of silkworm and glycogen contents in tissue of pupae of silk moth (Prasad and Upadhyay, 2014).

Quality disease-free laying's (DFLs) of CSR × Kolar strain of silkworm were obtained from National Silkworm Seed Organization (NSSO),

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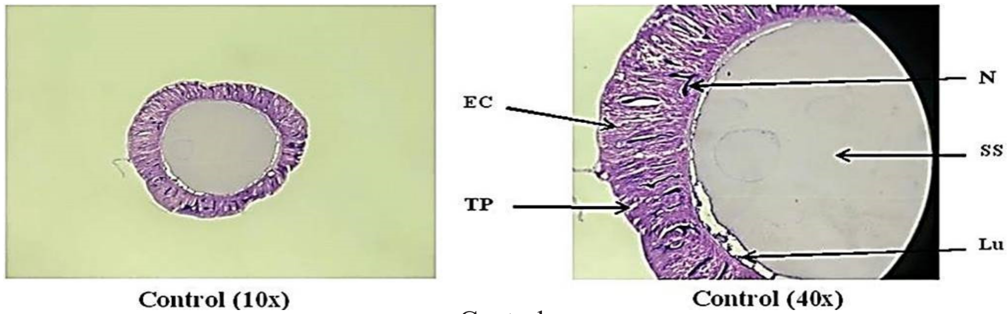
Mysore. The DFLs were incubated at 25°C and relative humidity 80-85 per cent was maintained. The larvae hatched from the DFL were supplied with V_1 variety of mulberry leaves and were reared separately under constant conditions of temperature and relative humidity. The rearing technique of Krishnaswami *et al*. (1973) was followed. On the first day, the 5th instar larvae were divided into three groups. One was reared as control and the two were used for magnetization and exposed to magnetic field as per procedure devised by Chougale and More (1992). Magnetization was done during the first three days of 5th instar by exposing the larvae for 20 minutes daily for magnetic field of 3500 G and 4000 G separately. They were kept in a perforated plastic container and it was placed between two poles of axial field electromagnet. The desired field strength was obtained by adjusting the distance between the poles. It was measured with digital Gauss meter. Five larvae from each experimental and control group were sacrificed. Using Traditional histology technique**,** posterior region of silk glands was fixed in 2 per cent calcium acetate formaldehyde (24 h), and after washing for 12 h they were dehydrated, cleared in xylene and embedded in paraffin wax (59-60°C). Then 0.6 µ transverse sections were taken using rotary microtome. Sections were dewaxed in xylene and stained with hematoxylin and eosin stains.

Transverse sections of posterior silk gland of each experimental group larvae showed alterations which were as follows:

1. The size/diameter of posterior silk gland of magnetized larvae was more than that of control group larvae. This was more pronounced in larval group magnetized at 3500 G than that of 4000 G.
2. The thickness of cellular layer of silk gland was more in experimental group larvae than that of control group larvae.
3. Size of secretory substance in lumen of silk gland was more in 3500 G magnetized larvae.
4. In larvae magnetized at 3500 G, nuclei of silk gland cell appeared more branched than in silk gland of control larvae (Fig. 1).

For conformation of above findings, efforts were made to study morphometry of different regions of T.S. of posterior silk gland. The studies showed 46.15 and 21.19 per cent increase in diameter of silk gland of larvae exposed to 3500 G and 4000 G magnetic field respectively than that in control larvae. Larvae treated with 3500 G magnetic field and 4000 G magnetic field exhibited 51 per cent gain and 1.29 per cent loss in the size of secretory substance respectively than that of control group larvae. Cellular thickness is more in magnetized larvae than that of control larvae.

Chougale (1992) have reported gradual increase in proteins and RNA of silk gland when larvae were exposed to 1000G to 3500G respectively. The magnetic field effect might be due to the change in the rate or pattern of translocation and accumulation of magnetically active microelements in cell and organ system (Mericle *et al*., 1964). Low field strength is responsible for no effect or stimulatory ones, whereas, the higher field strengths result in inhibitory effects (Mulay and Mulay, 1964). Singh *et al*. (2003) and Elbaz and Ghonimi (2015), observed various histological changes in tissues of rats exposed to magnetic field. The electromagnetic energy and body of organisms has a valid and important relationship. Applications of magnetized water result in hyperplasia and DNA synthesis (Singh *et al*., 2003). Instead of such hyperplasia, there may be enhancements of hypoploidy of silk gland in magnetized larvae than that of control larvae. Buntrock *et al*. (2012) have reported the small and more or less spherical nuclei in the silk glands of *Ephestia kuehniella*. However, nuclei of the late instar are irregular in shape and branched in nature. According to them, it is compensatory adaptation to improve molecular traffic between cytoplasm by enlarging surface to volume ratio of these nuclei. On this line in present studies, the magnetic field may have influenced the histological structures of silk gland and have resulted in more silk synthesis and secretion. Exposure of silkworm resulted in increase in diameter of its silk gland/ lumen of silk gland/space occupied by secretory



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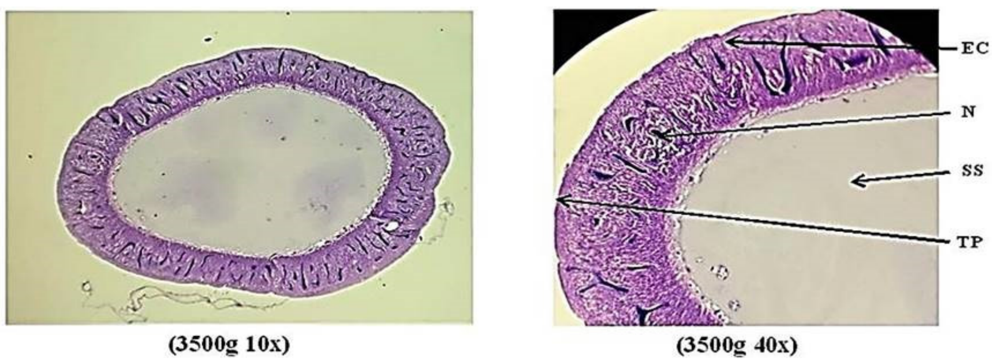

3500G Magnetization

4000G Magnetization

Fig. 1 T.S. of posterior region of silk gland of V instar silkworm
N: Nucleus, SS: Secretory Substances, Lu: Lumen, EC: Epithelial cells, TP: Tunica Propria

substance (silk protein- fibroin). This is favorable for sericulture.

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