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Shell Ratio Changes under Magnetic Exposure of Eggs in *Bombyx mori*: A Mulivoltine Mulberry Silkworm

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Abstract: Effect of magnetization of eggs on the shell ratio of *Bombyx mori* was study. The eggs were magnetized in 1000, 2000, 3000 and 4000 Gauss magnetic field for 24, 48 and 96 hours with each strength while, in control study the eggs were not magnetized. Per cent shell ratio of *Bombyx mori* was significantly ($P<0.01$) influenced due to variation in the strength of static magnetic field and exposure duration of eggs. Maximum per cent of shell ratio was recorded to be 14.50±0.04 in case of the eggs magnetized in 3000 Gauss magnetic field for 96 hour exposure, while the per cent of shell ratio was minimum (11.24±0.13) in control study. Thus, magnetization of *Bombyx mori* eggs may open a new biotechnological tool for sericulture industry to improve economic characters due to increase in production of cocoon and quality raw silk.

Key words: Magnetization · Silk · Exposure duration

INTRODUCTION

India is the unique being only country producing all the four commercial variety of silk namely mulberry, tasar, eri and munga, but Indian sericulture industry mainly depend on the multivoltine mulberry race (*Bombyx mor*). The race *nistari* is a resistant variety of multivoltine mulberry silkworm which contributes up to great extent in the commercial production of silk. In order to increase the production of silk, efforts have been mad to study the effect of temperature [1], relative humidity [2], photoperiod [3], artificial diet [4], X-ray [5] etc on the performance of silkworm. Magnetization of larvae influences the performance of silkworm [6]. Magnetic field influences morphological, physiological and biochemical characteristic of biological system [7]. Magnetic field affects larval behaviors of silkworm [8], hormone level [9] and acid phosphatase activity [10] in mouse and germination of seed [11]. Its positive effects include cell viability [12], nerve regeneration [13] and bone healing in guinea pig [14]. Magnetization of eggs influences incubation period [15] and protein content in the larvae and pupae [16] of *Bombyx mori*.

Keeping this in view, an attempt has been made to investigate the influence of magnetic field on the per cent shell ratio of multivoltine mulberry silkworm (*Bombyx mori*).

MATERIALS AND METHODS

Seed Cocoon: The seed cocoon (pupa inclosed in silken case) of multivoltine mulberry silkworm (*Bombyx mori nistari*), a native of West Bengal in India, were obtained from the silkworm grainage Behraich, Directerate of sericulture, Uttar Pradesh, India and were maintained in plywood trays (23X20X5cm) under the ideal rearing conditions [17] in the silkworm laboratory Department of Zoology, DDU Gorakhpur University, Gorakhpur. The temperature and relative humidity were maintained at 26±1°C and 75±5% respectively till the emergence of moths from the seed cocoons. The moths emerged generally in the morning at around '4' am. The trays in which seed cocoon were kept was suddenly illuminated by light in the morning at 4,O Clock on 9th and 10th days of spinning. The newly emerged moths, from seed cocoon, were quickly picked up and kept sex-wise in separate trays to avoid copulation.

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The male moths were smaller in size but more active than the female moths which were comparatively larger and less active.

Copulation: Silkworm moths have a tendency to copulate immediately after the emergence thus, allowed with their opposite sex for copulation. 360 pairs each containing one male and one female from newly emerged moths, were allowed to mate at 26± 1°C temperature and 75±5% relative humidity in 12 hours/day dim light condition. After four hour of mating, the paired moths were separated manually. The male moths were discarded while the female moths were allowed to eggs laying.

Oviposition: Just after separation, the gravid females were kept under plastic cellules on the sheet of paper for eggs laying in dark condition at 26±1°C temperature and 75±5% relative humidity maintained in BOD incubator. After 24 hours of eggs laying, the female moths were individually examined for their disease freeness. The females were crushed individually in mortar with pestles and blood smears were examined by microscope under 15 X 45 magnifications for the detection of bacterial and protozoan pathogens.

The disease free laying (DFLs), thus prepared on paper sheet, were treated with 2% formaline for 15 minutes to increase the adhesiveness of eggs on the paper sheet and surface disinfection. Thereafter, the eggs sheets with eggs laying, were thoroughly washed with running water to remove formalin and eggs were dried in shade. The dried eggs thus obtained, were taken for magnetization under various experimental conditions.

Experimental Design: To observe, the influence of magnetic field on the per cent shell ratio of *Bombyx mori*, the DFLs, thus obtained were kept in the static magnetic field of 1000, 2000, 3000 and 4000 Gauss separately for the magnetization. The DFLs were magnetized for 24, 48 and 96 hours separately with the magnet of separate strength. The DFLs were kept for magnetization just after the laying and primarily processing of newly laid eggs. For the magnetization, 90 DFLs were kept in 1000 Gauss magnetic field, of which 30 DFLs were released after 24 hours of magnetic exposure. Further 30 DFLs were released each after 48 and 96 hours of magnetic exposure of eggs. The treated DFLs were transferred chronologically in separate groups of BOD incubator maintained at 26±1°C temperature, 75±5% relative humidity and 12±1 hour photoperiod in a day. The incubation of exposed eggs and further rearing of different stages was performed in the same BOD incubator. Same experiments were performed with 2000, 3000 and 4000 Gauss magnetic strength separately. A control set (eggs not treated) of experiment was also performed simultaneously for comparative study.

Shell Ratio per Cent: To determine shell ratio, the weight of 20 good cocoons and 20 cocoon shell from each batch of experiment were recorded separately on the fifth days of spinning. Per cent shell ratio was calculated as given bellow and based on at least 20 cocoons and 20 cocoon shells taken at random from good lot.

$$\text{Shell ratio (\%)} = \frac{\text{Weight of cocoon shell}}{\text{Weight of cocoon [18]}} \text{X } 100$$

Statistical analysis: Three replicates of each experiment were made. The data obtained were analyzed statistically by two-way ANOVA, regression and correlation coefficient.

RSULTS

It is clear from the data (Table 1 and Figure 1) that variation in the strength of static magnetic field and exposure duration of *Bombyx mori* eggs caused considerable changes in the per cent shell ratio. Due to increase in exposure duration of eggs up to 96 hours, the shell ratio per cent was increased in case of 1000, 2000 and 3000 Gauss magnetic field, while in 4000 Gauss magnetic field the per cent shell ratio was increased up to 48 hours magnetic exposure of eggs and further increase in exposure duration caused decline in per cent shell ratio. In case of eggs magnetized in 1000 Gauss magnetic field, the per cent shell ratio was increased slowly and slowly with increase in exposure duration of eggs and recorded to be 12.59±0.05 in 96 hours magnetic exposure of eggs. In 2000 Gauss magnetized eggs, a steep rise in the per cent shell ratio was noticed in 24 hours magnetic exposure, while further increase in exposure duration up to 96 hours caused slow increase in the shell ratio which was reached to level of 12.93±0.03 in case of 96 hours exposed eggs. In case of 3000 Gauss magnetized eggs, the per cent shell ratio was increased steeply up to 24 hours exposure of eggs and reached to the highest level of 14.50±0.04 in case of 96 hours magnetic exposure of eggs.

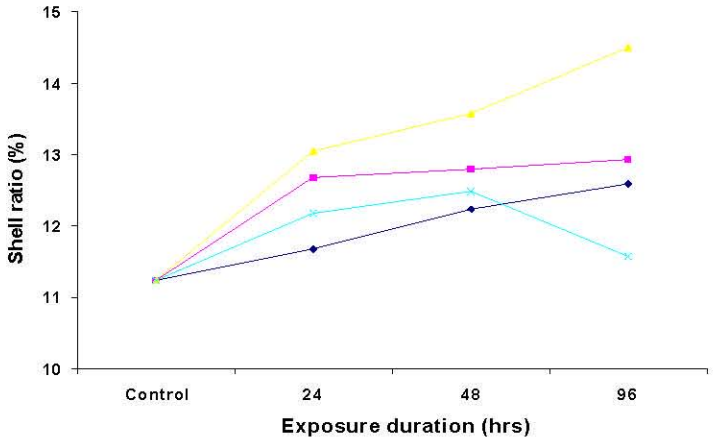

Fig. 1: Effect of magnetic field on the per cent shell ratio of *Bombyx mori*.

Table 1: Effect of magnetic field on the per cent shell ratio of *Bombyx mori*

	Magnetic power (Gauss)					
						F_1-ratio
Exposure Duration (hrs)	Control	1000	2000	3000	4000	$n_1 = 4$
24	11.24±0.13	11.68±0.26	12.67±0.04	13.05±0.05	12.18±0.06	
48	11.24±0.13	12.24±0.03	12.79±0.06	13.57±0.05	12.49±0.07	135.3*
96	11.24±0.13	12.59±0.05	12.93±0.03	14.50±0.04	11.58±0.05	
F_2-ratio = 158.6*	$n_2 = 2$					
$P_1 < 0.01$	$P_2 < 0.01$					

Each value represents mean ± SE of three replicates

The two-way ANOVA indicates that variation in the strength of static magnetic field and exposure duration of eggs significantly ($P<0.01$) influenced the shell ratio per cent of *Bombyx mori*. The regression in between independent variable [X] i.e. exposure duration of eggs and dependent variable [Y] i.e. shell ratio per cent yielded significant and positive correlation i.e. $Y_1=11.346+0.041X$ and $r_1=0.9665$, $Y_2=11.744+0.0150X$ and $r_2=0.8030$, $Y_3=11.95+0.0333X$ and $r_3=0.8812$, while negative correlation was obtained i.e. $Y_4=12.05-0.0047X$ and $r_4=-0.0263$, where Y_1, Y_2, Y_3 and Y_4 are regression and r_1, r_2, r_3 and r_4 are correlation coefficient of eggs treated in 1000, 2000, 3000 and 4000 Gauss magnetic field respectively.

DISCUSSION

Variation in the strength of static magnetic field and exposure duration of eggs caused considerable impact on the per cent shell ratio of *Bombyx mori*. The exposure of silkworm larvae in the magnetic field of 3500 Gauss caused an increase in the silk yield due to increased protein level in the silk gland [6]. Magnetization caused change in cotton fiber's characters [19] and changes in morphological, physiological and biochemical parameters has been reported in *Drosophila* after an exposure in the magnetic field [7]. The low magnetic field caused stimulatory effect, while higher magnetic field caused inhibitory effect [20]. Magnetization of eggs influenced incubation period [15] and protein content in the larvae and pupae of *Bombyx mori* [16]. Magnetization of *Bombyx mori* larvae caused an increase in acid phosphatase activity in the silk gland resulting increased in silk protein synthesis [21] and magnetic exposure on eggs up to 3000 Gauss caused increase in weight of cocoon of *Bombyx mori* [22]. Magnetization of larvae increased weight of silk gland and cocoon in *Bombyx mori* [23].

In present investigation, the per cent shell ratio is increased from 1000 to 3000 Gauss magnetized eggs which may be due to enhanced in the cytochrome activities resulting an increased in the metabolic rate causing heavy synthesis of silk protein, while higher strength of magnetic field (4000 Gauss) may caused inhibitory effect in the cytochrome system as result the synthesis of silk protein to be reduced and cause declined in the per cent shell ratio. The beneficial effect of the magnetization of eggs on the silk producing potential may open new biotechnological approach for the heavy production of good quality cocoon in future which may be prove to be boon for sericulture industry.

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