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Effect of Antibiotics on the Rearing Performance of Silkworm *Bombyx mori* L.

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A B S T R A C T

The present investigation was carried out to assess the rearing performance of silkworm *Bombyx mori* L. on antibiotic supplemented feed at various concentrations. The study was conducted on the silkworm breed APS-45. The worms were reared upto 3rd moult by feeding on mulberry leaves without any treatment. After 3rd moult, three replications were maintained and each treatment received different concentration of antibiotics. For each antibiotic three concentrations (0.05%, 0.10% and 0.15%) were prepared and sprayed on the mulberry leaves, a separate batch was also maintained where only distilled water was sprayed and that served as a control. Among the three antibiotics evaluated ceftiofur sodium showed best results followed by oxytetracycline and enroflaxcin. It was found that improved results were obtained with an increase in concentration of an antibiotic, ceftiofur sodium (0.15%) showed significantly improved results in economic parameters like cocoon characters, cocoon yield, average filament length, raw silk percentage and filament denier. So, present investigation reflected that antibiotics have the potential to be used for enhancing the cocoon and raw silk production.

Introduction

Sericulture is a science of raising silkworm for raw silk production and incorporates the activities, which are required for the production of silk fibre (Krishnaswami *et al.*, 1973). In sericulture, the efficient productivity and quality primarily depends on the healthiness, growth of the silkworm larvae and the suitable environmental conditions. Efficient productivity in sericulture mainly depends upon health, growth of the larvae and suitable environmental conditions. Thus, the growth of larvae depends on the different physiological processes that occur in the silkworm. The economic production of sericulture generally and incredibly relies upon the metabolic regulations and molecular component of silkworm, other than its genetic composition and immunological resistance (Babu *et al.*, 2005).

Insects are one of the flourishing organisms on earth, as they do not possess antibodies however, they do develop natural immune system by eliciting cellular and humoral responses. Silkworm is a significant novel insect and has an economic significance due to commercial value of its silk. Thus improving the qualitative and quantitative characteristics of silk yield, various antimicrobial agents are being used and among those the most frequently advocated medications in modern scientific era are antibiotics. Antibiotic administration has shown attractive outcomes in reaping superior crop harvest and controlling the silkworm disease. The connection among antibiotics and silkworm is additionally supported by the current uses of silkworm in drug screening and pathogen studies systems due to its short larval period and morally acknowledged model (Venkatesh and Srivastava, 2010). The antibiotics supplemented mulberry leaves enhance the growth and development of silkworm. Oral supplementation of anti-infection agents along with mulberry leaves to sound silkworm helps in the development, fertility and silk contents and decrease the frequencies of diseases (Tayade *et al.,* 1988). To build up the body and spin cocoons, silkworm larvae receive nutrients from mulberry leaves. It has been found that feeding antibiotics with mulberry leaves increased the larval weight and production of silk. The growth, development and their other economic characteristics are also greatly improved (Murthy *et al.,* 1951). Antibiotics are commonly used as a segment of bed disinfectants and helpful applications against bacterial ailments in the sericulture industry. Antibiotic supplement to silkworms has been reported to boost the oxygen absorption of the silkworm gut, which also has a beneficial effect on the regulation of the larval intestinal flora (Shyamala and Bhatt, 1961). Antibiotic agents utilized for clinical purposes therapeutically affect silkworms infected with the microorganisms *Staphylococcus aureus* and *Candida albicans*. So, the current study was carried out with an aim out to improve the efficiency and quality of cocoon production and to evaluate the rearing performance of antibiotic administrated feed to silkworm *B. mori* L.

Materials and Methods

Silkworm rearing

The present study was carried out during spring 2020 at silkworm rearing laboratory of Division of Silkworm Breeding and Genetics, College of Temperate Sericulture, SKUAST-K (Mirgund). The silkworm rearing was conducted by following the recommended package of practices Krishnaswamy (1978). The silkworm race APS-45 was selected to conduct experiment. Rearing was carried out under hygienic conditions. The laying's were incubated at 25 ± 1^{0}C temperature and relative humidity of 75-80% for about 10-12 days till hatching. The hatched larvae were brushed and reared upto 3rd moult by feeding on mulberry leaves without any treatment. After 3rd moult, three replications were maintained for each treatment with 100 silkworms of uniform age and size and each treatment received different concentration of antibiotics.

Preparation of stock solution

For preparation of standard stock solution different concentration of three antibiotics *viz*. Ceftiofur sodium, Oxytetracycline and Enroflaxcin solution were prepared in distilled water. The concentrations of the antibiotics prepared were 0.05%, 0.10% and 0.15%. The concentration 0.05% was prepared by mixing 0.05g of antibiotic in 100ml of distilled water similarly concentration of 0.10% was prepared by adding 0.10 gram of antibiotic in 100 ml of distilled water and in the same way 0.15 per

cent of concentration was prepared by putting 0.15 grams of antibiotic in 100 ml of distilled water. Fresh mulberry leaves were smeared by each treatment and were air dried for about10 minutes prior to feeding. The feeding of antibiotics along with mulberry leaves was supplemented after 3rd moult once in a day.

Experimental groups

The worms in the C_1batch received the mulberry leaves sprayed with 0.05% of antibiotic solution. The larvae in the C_2 batch received the leaves smeared with 0.10% of antibiotic solution and the larvae in C_3 batch received the mulberry leaves sprayed with 0.15% of an antibiotic solution. However, the C_4 batch served as a control as the larvae received the mulberry leaves sprayed with only distilled water.

Statistical analysis

The design of the experiment followed was completely randomized design (CRD). Data was analysed by two way analysis of variance (ANOVA).

Results and Discussion

Effects of antibiotic on the growth and development of *B. mori* L.

Larval weight is one of the important parameter which determines not only the health of the larvae, but also the quality of the cocoons spun (Ito, 1978). Present study revealed that there was significant variation in larval weight in different antibiotic treatments. The highest larval weight was recorded in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). Similarly, other treatments like treatment A_3 (Oxytetracycline) at concentration C_3 (0.15%) have shown better results in increasing the weight of the larvae as compared to control. These observations are in line with the findings of Ahmed *et al.,* (2001) who have reported that the oral supplementation of the antibiotics to 4th instar larvae resulted in significant increase in the larval weight.

Weight of silk gland plays an essential role in the cocoon yield, hence physiological and biochemical studies are considered important for this trait. Observations on the growth of silk gland revealed that the highest silk gland weight of 1.53g was obtained in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). Similarly there was increase in the silk gland weight in the other treatments. These findings are in agreement with the observations of Rahmathulla and Nayak (2017) who have studied the influence of antibiotic Norfloxacin on growth and development of silkworm larva and silk gland and reported that administration of antibiotics significantly enhanced the silk gland weight. This study is further supported by the study of Murthy *et al.,* (1953) who have reported that antibiotic administrated feed to silkworm resulted in the increase in silk gland weight. In the current study, a decreasing trend in larval duration was observed among all the treated groups with a least mean larval duration of 650.76 hrs recorded in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). Similarly the larval duration in all the treated batches was found to decrease than the control and also the higher concentration of the antibiotics reduced the larval duration significantly. These findings are in agreement with results of (Thilagavathi *et al.,* 2013) who reported that the larval and pupal duration of silkworm *B. mori* were significantly decreased due to different antibiotic application on mulberry leaves. The present findings corroborate with the findings of Mahidi *et al.,* (2017) who have reported that the larval duration in silkworm has significantly decreased as the minimum larval period was recorded at 5% dosage of amoxicillin (Table 1).

Table.1 Influence of antibiotics at different concentration levels on larval weight, silk gland weight, SGTSI, 5th age larval duration and total larval duration (hrs) in silkworm *B. mori*

Antibiotics	Concentration (%)	Larval weight (g)	Silk gland weight (g)	SGTSI (%)	5th age larval duration (hrs)	Total larval duration (hrs)
A_1 (Ceftiofur sodium)	C_1 (0.05)	40.93	1.40	34.36	196.08	653.44
	C_2 (0.10)	41.72	1.44	34.82	197.28	652.28
	C_3 (0.15)	43.94	1.53	35.25	193.68	650.76
	C_4 (control)	38.87	1.32	34.45	196.56	678.02
Mean		41.38	1.42	34.40	190.02	658.62
A_2 (Enroflaxcin)	C_1 (0.05)	39.58	1.36	34.96	195.60	677.28
	C_2 (0.10)	40.33	1.39	35.47	194.64	673.65
	C_3 (0.15)	40.38	1.42	34.87	191.76	660.00
	C_4 (control)	37.63	1.29	33.59	196.80	679.73
Mean		39.48	1.37	35.00	195.90	672.67
A_3 (Oxytetracycline)	C_1 (0.05)	39.18	1.37	34.96	195.60	672.72
	C_2 (0.10)	39.78	1.41	35.47	194.64	664.89
	C_3 (0.15)	41.87	1.46	34.87	191.76	651.39
	C_4 (control)	38.72	1.30	33.59	196.80	679.56
Mean		39.89	1.39	34.72	194.70	667.14
C.D ($p \leq 0.05$) (Antibiotic Mean)		**0.626**	**0.007**	**0.153**	**1.17**	**0.490**

Table.2 Influence of antibiotics at different concentration levels on cocoon weight, shell weight, shell ratio and cocoon yield in silkworm *B. mori*

Antibiotics	Concentration (%)	Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)	ERR by number	ERR by weight (kg)
A_1 (Ceftiofur sodium)	C_1 (0.05)	1.78	0.31	19.67	8511.0	15.26
	C_2 (0.10)	1.82	0.36	20.51	8605.3	15.57
	C_3 (0.15)	1.87	0.39	21.27	8740.0	16.67
	C_4 (control)	1.71	0.31	18.63	7920.0	13.37
Mean		1.80	0.35	20.02	8444.1	15.22
A_2 (Enroflaxcin)	C_1 (0.05)	1.74	0.33	18.28	7935.0	13.94
	C_2 (0.10)	1.77	0.33	18.65	7963.0	14.01
	C_3 (0.15)	1.79	0.33	19.16	8164.0	14.32
	C_4 (control)	1.69	0.31	18.25	7951.3	13.65
Mean		1.75	0.33	18.59	8003.3	13.98
A_3 (Oxytetracycline)	C_1 (0.05)	1.80	0.35	19.77	8040.0	14.69
	C_2 (0.10)	1.83	0.36	19.96	8196.3	15.03
	C_3 (0.15)	1.86	0.37	20.38	8674.3	16.02
	C_4 (control)	1.75	0.32	18.54	7945.0	13.68
Mean		1.81	0.35	19.67	8214.0	14.86
C.D ($p \leq 0.05$) (Antibiotic Mean)		**1.010**	**0.008**	**NS**	**88.42**	**0.200**

Table.3 Influence of antibiotics at different concentration levels on average filament length, denier and raw silk percentage in silkworm *B. mori*

Antibiotics	Concentration (%)	Average filament length (m)	Denier	Raw silk (%)
A_1 (Ceftiofur sodium)	C_1 (0.05)	914	2.23	15.32
	C_2 (0.10)	998.3	2.16	15.81
	C_3 (0.15)	1020	2.15	15.85
	C_4 (control)	837	2.32	15.01
Mean		942.3	2.21	15.50
A_2 (Enroflaxcin)	C_1 (0.05)	882	2.28	15.06
	C_2 (0.10)	919	2.26	15.21
	C_3 (0.15)	972.7	2.16	15.69
	C_4 (control)	860	2.37	14.63
Mean		908.4	2.27	15.15
A_3 (Oxytetracycline)	C_1 (0.05)	935.7	2.25	15.15
	C_2 (0.10)	962	2.18	15.49
	C_3 (0.15)	992.3	2.20	15.75
	C_4 (control)	895.7	2.35	14.59
Mean		946.4	2.25	15.24
C.D ($p \leq 0.05$) (Antibiotic Mean)		**16.13**	**0.010**	**0.084**

Effects of antibiotic on the cocoon characters of *B. mori* L.

Cocoon weight, shell ratio and filament length are highly heritable traits and are significantly important as these determine the quality, quantity and efficiency of the reeling process. All the treatments showed significant increase in cocoon weight than control and the better performance were recorded with the increase of antibiotic concentrations (Table 2 and 3).

The results of the present finding were in conformity with the findings of Thilagavathi *et al.,* (2013) who have reported significant increase in cocoon parameters (length, width and weight respectively) with supplementation of Amoxicillin (5% concentration). Tayade *et al.,* (1988) who reported significant increase in cocoon weight, while using Chloramphenicol as feed supplementation to silkworm *B.mori*. Cocoon shell weight is an important character in determining the silk weight. The results from the present study revealed that among all the treated groups, the highest shell weight of 0.39g was recorded in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). The improvement in shell weight was also recorded in the other treatments. The findings of present study are in agreement with the findings of Rahmathulla *et al.,* (2003) who have reported that administration of antibiotic Norfloxacin has resulted in significant increase in the shell weight.

While accessing the oral antibiotic administration to silkworm with different concentrations Radha *et al.,* (1980) reported significant increase in the single shell weight and shell ratio. The results of present study showed that antibiotic supplementation have shown significant effect towards the shell ratio in all the treatments. Also, the findings of Rahmathulla *et al.,* (2003) reported that impact of antibiotic administration Norfloxacin resulted in increased shell ratio percentage.

Higher values of effective rate of rearing are indicative of higher silk productivity and a good cocoon crop. Among, all the treated groups, the highest effective rate of rearing (ERR) by no. and by weight was achieved in the silkworm batches treated with treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%).

In support of the findings of present study similar results were obtained by Krishnaswami *et al.,* (1981) who have reported that oral administration of chloramphenicol acts as growth promoter and significantly improved the cocoon yield by weight. Similar types of result have been reported by Baig *et al.,* (1990) that are in conformity with the results of present study.

Effects of antibiotic on the reeling characters of *B. mori* L.

Average filament length denotes length of the have contained in the cocoon shell. The results of the present investigation indicated that antibiotic supplementation causes increase in the length of silk filament with increase in the concentration levels. Present findings are well supported by Tayade *et al.,* (1988) who have reported that oral feeding of antibiotics along with mulberry leaves resulted in improved silk content. The results of the present study are also in line with the observations of Rahmathulla *et al.,* (2003) who have reported that antibiotic Norfloxacin causes an increase in average filament length with an increase in concentration levels.

In the current study the least denier of 2.15 was recorded in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). Similarly, all the other treatments have shown decreasing trend in filament denier other than the control. The results from the present investigation revealed that the administration of antibiotics have a decreasing impact on the filament denier. The results of the present finding are contradictory to the findings of Radha *et al.,* (1980) who observed that antibiotic administration with different concentration significantly improved denier, and better performance were recorded with the increase in antibiotic concentration.

In the current investigation the highest raw silk percentage of 15.85% was recorded in treatment A_1 (Ceftiofur sodium) at concentration C_3 (0.15%). Moreover, the raw silk percentage evaluated was relatively higher in all the treatments as compared to control. These results are in line with the observations of Rahmathulla *et al.,* (2003) who have reported that antibiotic Norfloxacin and its increase in concentration significantly improved the raw silk percentage. In light of the present findings Sharada *et al.,* (1956) have reported that chloromycetin supplementation individually and in combination with glycine yielded about 6% more silk than the control.

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Competing interest

The authors declare no conflict of interest in the publication of this manuscript.

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