



EFFECT OF ANTIBIOTICS ADMINISTRATION ON CONSUMPTION INDEX, GROWTH RATE, CONVERSION EFFICIENCY OF INGESTED AND DIGESTED FOOD OF MULBERRY SILKWORM, *Bombyx mori* L.

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Abstract: Nutrition plays a crucial role in enhancing the growth, development, health, food consumption, and conversion efficiency of silkworms (*Bombyx mori* L.). The growth of silkworms is the result of various physiological activities through which matter accumulates in their bodies. The feeding indices of silkworms are vital for converting the ingested feed into commercially valuable silk, particularly from mulberry leaves. In the present study, the bivoltine double hybrid silkworm FC1 × FC2 was raised on fortified mulberry leaves treated with different antibiotics. For this, fresh mulberry leaves were dipped in each antibiotic treatment and then air-dried for approximately ten minutes before feeding. The antibiotics were administered alongside the mulberry leaves to the silkworm larvae only once during the third, fourth, and fifth instars. Silkworms that were fed mulberry leaves treated with ceftiofur sodium (0.10%) exhibited the highest consumption index (2.01 g/g/day), growth rate (0.66 g/g/day), conversion efficiency of ingested food (32.87%), and conversion efficiency of digested food (125.22%) when compared to other treatments and the control group.

Index terms-Consumption index, growth rate, ECI and ECD.

I. INTRODUCTION

The silkworm is a significant insect and has economic significance due to the commercial value of its silk. Thus, to improve the qualitative and quantitative characteristics of silk yield, various antimicrobial agents are being used, and among these, the most frequently advocated medications in the modern scientific era are antibiotics. It has been found that feeding antibiotics with mulberry leaves increased the larval weight and production of silk (Rafiq *et al.*, 2021). In recent years, several attempts have been made to fortify leaves with different beneficial nutrients. The antibiotics have been reported to play a vital role in the improvement of disease resistance and growth enhancement in silkworms. It is also evidenced that the dietary nutritional management of silkworms directly influenced the quality and quantity of silk production (Tayade *et al.*, 1988). The nutritional performance of the mulberry silkworm is evident in the digestion and assimilation of the nutritional materials present in mulberry leaves. The amount of food consumed and the quantity digested by the silkworms have direct effects on their performance, mating success, and reproduction. The conversion rate of ingested food by the silkworm, so that we can analyze the distribution rate of mulberry intake in silkworm for various factors like growth rate, silk production, and faecal matter. The consumption indices were computed on a fresh weight basis by the gravimetric method (Waldbauer, 1968). Nutritional indices help to determine the quantity of leaf required to produce the silk. It also helps to study the amount of food consumed and digested, which directly affects the body's structure. It is glaring that ingesta, digesta, and excreta

parameters of larvae enlarge at some point of the fifth instar development, and at once affect the larval weight, cocoon weight, and shell weight that are the crucial aspects measured for the productivity of silkworm rearing (Horie and Inokuchi, 1978).

II. RESEARCH METHODOLOGY

The current study, conducted in 2023–2024 at the Agricultural Research Station in Hagari, Ballari district, under the University of Agricultural Sciences, Raichur, investigated the “Effect of Antibiotic Administration on the Growth and Development of Silkworms, *Bombyx mori* L.” In this study, standard stock solutions of six different antibiotics were prepared at two concentrations : 0.05% and 0.10%. The antibiotics used included ceftiofur sodium, enrofloxacin, oxytetracycline, chloramphenicol, streptomycin, and ampicillin. A 0.05% concentration was made by dissolving 0.05 g of the antibiotic in 100 ml of distilled water. Similarly, a 0.10% concentration was prepared by adding 0.10 g of antibiotic to 100 ml of distilled water. Fresh mulberry leaves were dipped in each treatment and allowed to air-dry for about ten minutes before feeding. The silkworm larvae were fed the antibiotic-infused mulberry leaves only once during their third, fourth, and fifth instars.

2.1 The observations taken are given below

2.1.1 Consumption index (g/g/day)

$$CI = \frac{F}{TA}$$

Where,

F = Fresh weight of food eaten (g)

T = Duration of feeding (days)

A = Mean fresh weight of larvae during feeding period (g)

$$\text{Weight of larvae (g)} = \frac{\text{Initial larval body weight (g)} + \text{Larval body mean weight (g)}}{2}$$

2.1.2 Growth rate (g/g/day)

$$GR = \frac{G}{TA}$$

Where,

G = Fresh weight gain by larvae during feeding period (g)

T = Duration of feeding (days)

A = Mean fresh weight of larvae during feeding period (g)

Weight gain of larvae (g) = Larval weight after fourth or fifth instar (g) – Initial larval weight (g)

2.1.3 Efficiency of conversion of ingested food (%)

$$ECI (\%) = \frac{\text{Weight gained (g)}}{\text{Weight of food ingested (g)}} \times 100$$

$$\text{or} \\ ECI (\%) = \frac{GR}{CI} \times 100$$

2.1.4 Efficiency of conversion of digested food (%)

$$ECD (\%) = \frac{\text{Weight gained (g)}}{\text{Weight of food ingested (g)} - \text{Weight of faeces (g)}} \times 100$$

III. Results and Discussion

Two concentrations of antibiotics were tested: 0.05% and 0.10%. The results showed that food consumption indices, including the consumption index, growth rate, and efficiency of converting ingested and digested food, increased at the antibiotic concentration of 0.10%.

Data collected from third, fourth, and fifth instars of silkworms fed on mulberry leaves supplemented with 0.10% ceftiofur sodium revealed significantly higher values for the consumption index (1.32 g/g/day, 1.70 g/g/day, and 2.01 g/g/day), growth rate (0.21 g/g/day, 0.46 g/g/day, and 0.66 g/g/day), efficiency of conversion of ingested food (16.16%, 26.97%, and 32.87%), and efficiency of conversion of digested food (14.31%, 17.67%, and 25.22%) compared to the control group.

The consumption index measures the dietary efficiency of silkworms. It is the ratio of food consumed to the average body weight per day, providing insights into nutrient utilization. This index is also referred to as the feeding rate, indicating the rate at which nutrients enter the digestive system (Waldbauer, 1968). The growth rate directly impacts larval development speed and is influenced by the quality of the leaves and the physiological stages of the larvae.

The current findings are consistent with those of Moustafa and Soliman (2019), who reported that the supplementation of mulberry leaves with a combination of the probiotics *Lactobacillus rhamnosus* and *Bifidobacterium bifidum* at a concentration of 6% resulted in the highest growth rate (0.128 g/g/day) compared to the control. Antibiotics may stimulate digestive enzyme activity,

enhancing food breakdown and making nutrients more readily available for absorption, which improves the conversion efficiency of ingested food.

Mahdi et al. (2017) noted that the highest efficiency of conversion of ingested food (ECI) observed was 52.01% at a 5% dose of amoxicillin. These antibiotics can also enhance the conversion efficiency of digested food by suppressing harmful gut microbes, thereby creating a more favorable environment for digestion. This improved digestion and nutrient absorption lead to increased protein synthesis and storage, resulting in better nutrient utilization. Rani et al. (2011) reported that the maximum conversion efficiency of digested food (36.30%) compared to the control was achieved when silkworms were fed mulberry leaves fortified with 10% Amway protein.



Table 3.1: Effect of antibiotics administration on consumption index of mulberry silkworm, *Bombyx mori* L.

Treatments	Consumption index (gram/gram/day)					
	Third instar		Fourth instar		Fifth instar	
	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)
T ₁ : Cefotiofur sodium	1.214 ^a	1.324 ^a	1.536 ^a	1.709 ^a	1.987 ^a	2.014 ^a
T ₂ : Enrofloxacin	1.196 ^b	1.257 ^b	1.427 ^b	1.674 ^b	1.861 ^b	1.906 ^b
T ₃ : Oxytetracycline	1.117 ^c	1.195 ^d	1.276 ^c	1.289 ^c	1.506 ^c	1.423 ^c
T ₄ : Chloramphenicol	1.121 ^d	1.196 ^d	1.282 ^d	1.384 ^d	1.609 ^d	1.612 ^d
T ₅ : Streptomycin	1.090 ^f	1.188 ^e	1.213 ^f	1.254 ^f	1.503 ^e	1.137 ^f
T ₆ : Ampicillin	1.173 ^c	1.213 ^c	1.301 ^c	1.497 ^c	1.771 ^c	1.806 ^c
T ₇ : Water spray	0.801 ^g	0.955 ^f	0.882 ^g	0.963 ^g	1.091 ^g	1.101 ^g
T ₈ : Control	0.721 ^h	0.806 ^g	0.773 ^h	0.882 ^h	1.014 ^h	1.091 ^h
S. Em (±)	0.0073	0.0077	0.0063	0.0052	0.0079	0.0081
CD (0.01)	0.030	0.031	0.0259	0.0215	0.0326	0.0334
CV (%)	1.019	1.040	0.832	0.669	0.958	0.990

Different letters designate significant difference within column by Duncan's Multiple Range Test at P= 0.01

Table 3.2 : Effect of antibiotics administration on growth rate of mulberry silkworm, *Bombyx mori* L.

Treatments	Growth rate (gram/gram/day)					
	Third instar		Fourth instar		Fifth instar	
	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)
T ₁ : Cefotiofur sodium	0.189 ^a	0.214 ^a	0.386 ^a	0.461 ^a	0.597 ^a	0.662 ^a
T ₂ : Enrofloxacin	0.167 ^b	0.198 ^b	0.337 ^b	0.412 ^b	0.526 ^b	0.581 ^b
T ₃ : Oxytetracycline	0.122 ^c	0.152 ^c	0.254 ^c	0.287 ^c	0.384 ^c	0.359 ^c
T ₄ : Chloramphenicol	0.132 ^d	0.166 ^d	0.279 ^d	0.331 ^d	0.423 ^d	0.446 ^d
T ₅ : Streptomycin	0.113 ^f	0.136 ^f	0.221 ^f	0.251 ^f	0.346 ^f	0.264 ^f
T ₆ : Ampicillin	0.148 ^c	0.174 ^c	0.291 ^c	0.364 ^c	0.487 ^c	0.513 ^c
T ₇ : Water spray	0.075 ^g	0.092 ^g	0.142 ^g	0.174 ^g	0.189 ^g	0.213 ^g
T ₈ : Control	0.055 ^h	0.069 ^h	0.114 ^h	0.145 ^h	0.171 ^h	0.185 ^h
S. Em (±)	0.0013	0.0010	0.0015	0.0019	0.0039	0.0041
CD (0.01)	0.0053	0.0043	0.0064	0.0079	0.0159	0.0168
CV (%)	0.280	0.222	0.307	0.368	0.709	0.745

Different letters designate significant difference within column by Duncan's Multiple Range Test at P= 0.01

Table 3.3: Effect of antibiotics administration on conversion efficiency of ingested food of mulberry silkworm, *Bombyx mori* L.

Treatments	Conversion efficiency of ingested food (%)					
	Third instar		Fourth instar		Fifth instar	
	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)
T₁: Ceftiofur sodium	15.568 (23.24) ^a	16.163 (23.71) ^a	25.130 (30.09) ^a	26.975 (31.29) ^a	30.045 (33.24) ^a	32.870 (34.98) ^a
T₂: Enrofloxacin	13.963 (21.94) ^b	15.752 (23.38) ^b	23.616 (29.08) ^b	24.612 (29.74) ^b	28.264 (32.12) ^b	30.483 (33.51) ^b
T₃: Oxytetracycline	10.922 (19.30) ^c	12.795 (20.96) ^c	19.906 (26.50) ^c	22.265 (28.15) ^d	25.228 (30.15) ^c	25.498 (30.33) ^c
T₄: Chloramphenicol	11.775 (20.07) ^d	13.880 (21.87) ^d	21.763 (27.81) ^d	23.916 (29.28) ^c	26.290 (30.85) ^d	27.667 (31.74) ^d
T₅: Streptomycin	10.367 (18.78) ^e	11.381 (19.72) ^f	18.219 (25.27) ^f	20.016 (26.58) ^e	23.021 (28.67) ^f	23.219 (28.81) ^f
T₆: Ampicillin	12.617 (20.81) ^e	14.345 (22.26) ^c	22.367 (28.23) ^c	24.315 (29.54) ^b	27.499 (31.63) ^c	28.405 (32.21) ^c
T₇: Water spray	9.363 (17.82) ^f	9.634 (18.08) ^g	16.100 (23.66) ^g	18.069 (25.16) ^f	17.324 (24.60) ^g	19.346 (26.09) ^g
T₈: Control	7.628 (16.03) ^g	8.561 (17.01) ^h	14.748 (22.58) ^h	16.440 (23.92) ^g	16.864 (24.25) ^h	16.957 (24.32) ^h
S. Em (±)	0.028	0.021	0.029	0.034	0.041	0.036
CD (0.01)	0.116	0.090	0.123	0.141	0.169	0.148
CV (%)	1.417	1.047	1.140	1.255	1.431	1.228

*Figures in parentheses are arcsine transformed value

Different letters designate significant difference within column by Duncan's Multiple Range Test at P= 0.01

Table 3.4 : Effect of antibiotics administration on conversion efficiency of digested food of mulberry silkworm, *Bombyx mori* L.

Treatments	Conversion efficiency of digested food (%)					
	Third instar		Fourth instar		Fifth instar	
	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)	C1 (0.05%)	C2 (0.10%)
T₁: Ceftiofur sodium	13.359 (21.44) ^a	14.318 (22.23) ^a	16.610 (24.05) ^a	17.675 (24.86) ^a	23.243 (28.82) ^a	25.222 (30.15) ^a
T₂: Enrofloxacin	12.587 (20.78) ^b	13.845 (21.84) ^b	15.597 (23.26) ^b	16.871 (24.25) ^b	22.921 (28.60) ^b	23.676 (29.12) ^b
T₃: Oxytetracycline	10.421 (18.83) ^d	11.226 (19.58) ^d	13.672 (21.70) ^d	14.788 (22.62) ^d	19.746 (26.38) ^d	19.916 (26.50) ^c
T₄: Chloramphenicol	10.974 (19.35) ^d	11.327 (19.67) ^d	14.910 (22.71) ^c	15.430 (23.13) ^c	20.731 (27.09) ^c	21.097 (27.34) ^d
T₅: Streptomycin	9.828 (18.27) ^e	10.943 (19.32) ^e	12.627 (20.81) ^e	13.678 (21.71) ^e	17.787 (24.94) ^e	18.146 (25.21) ^f
T₆: Ampicillin	11.673 (19.98) ^c	12.528 (20.73) ^c	15.313 (23.04) ^b	16.140 (23.69) ^b	22.496 (28.31) ^b	22.702 (28.45) ^c
T₇: Water spray	8.032 (16.46) ^f	9.615 (18.06) ^f	11.202 (19.55) ^f	11.523 (19.84) ^f	15.940 (23.53) ^f	16.782 (24.18) ^g
T₈: Control	6.961 (15.30) ^g	8.889 (17.35) ^g	10.415 (18.83) ^g	11.106 (19.47) ^f	15.558 (23.23) ^f	16.090 (23.65) ^g
S. Em (±)	0.023	0.030	0.027	0.035	0.041	0.024
CD (0.01)	0.098	0.125	0.112	0.145	0.169	0.101
CV (%)	1.246	1.519	1.247	1.576	1.585	0.932

*Figures in parentheses are arcsine transformed value

Different letters designate significant difference within column by Duncan's Multiple Range Test at P= 0.01

IV. CONCLUSION

These antibiotics enhance the activity of digestive enzymes, improve food breakdown, and suppress harmful microbes, thereby optimizing nutrient absorption. The consumption index measures the dietary efficiency of silkworms by calculating the ratio of food consumed to their average body weight, reflecting how well they utilize nutrients. The growth rate of silkworms depends on the quality of the leaves they consume and their larval physiology, both of which influence their development speed. This process boosts protein synthesis and storage, thereby enhancing food conversion efficiency.

REFERENCES

1. Horie, Y. and Inokuchi, T., 1978, Protein synthesis and uric acid excretion in the absence of essential amino acids in the silkworm, *Bombyx mori* L. *Insect. Biochem.*, 8(4): 251-254.
2. Mahdi, H. A., Rokonzaman, M. D., Aftab, M. D. and Kamrul, M. D., 2017, The effect of amoxicillin, oxytetracycline and doxycycline on the growth and development of silkworm, *Bombyx mori* L. *J. Entomol. Zool. Stud.*, 5(6): 1316-1321.
3. Moustafa, M. N. and Soliman, S. A., 2019, Nutritional efficiency and economic traits of silkworm, *Bombyx mori* L. reared on mulberry leaves fortified with synbiotic. *J. Plant Prot. & Pathol.*, 10(12): 671-675.
4. Rafiq, I., Buhroo, Z. I., Sahaf, K. A., Padder, B. A., Ganie, N. A., Mir, S. A., Baqual, M. F., Nagoor, S. A. and Ashraf, S., 2021, Effect of antibiotics on the rearing performance of silkworm *Bombyx mori* L. *Int. J. Curr. Microbiol. App. Sci.*, 10(1): 1-7.
5. Rani, G. A., Padmalatha, C., Raj, R. S. and Singh, A. R., 2011, Impact of supplementation of Amway protein on the economic characters and energy budget of silkworm, *Bombyx mori* L. *Asian J. Anim. Sci.*, 5(3): 190-195.
6. Tayade, D., S. Jawale, M., D. and Unchegaonkar, P. K., 1988, Effect of antibiotics on the growth of silkworm *Bombyx mori* L. *Indian J. Seric.*, 27(2): 69-72.
7. Waldbauer, G. P., 1968, The consumption and utilization of food by insects. *Adv. Ins. Physiol.*, 5: 229-288.

