IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 04, 2022

IMPACT OF ZINC SMELTER EFFLUENT ON THE FOOD BUDGETS AND ITS UTILIZATION IN PM, CB AND NB4D2 RACES OF SILKWORM BOMBYX MORI (L).

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Abstract: The effect of growing Morus alba, the sole food of silkworm Bombyx mori (L) with different dilutions of Zinc smelter effluent was studied. The food budget parameters considerably effected as the concentration level of Zinc smelter effluent increased from 5% to 15% concentration in the silkworm races of Pure Mysore race, NB4D2 and CB race. The test races of the silkworm Bombyx mori displayed manifold decrease in growth at each instar level. The larvae continued to feed and grow on the mulberry leaf raised on 5% concentration, 10% and 15% concentration level of Zinc smelter effluent. From the maximum weight at control the growth reduced as a function of dilution to reach minimum at 15% concentration.

Keywords: Morus alba, Bombyx mori (L), Zinc smelter effluent, PM, NB4D2, CB races

INTRODUCTION

Food and water intake and utilization provides an introduction to the study of energy transformation in an organism. It is becoming increasingly apparent that both food and water utilization information are needed to gain a deep sense of the functional properties of the animals. Food energy is the most important concept of thermodynamics.

Bioenergetics is a powerful tool to study environmental impact on organisms (Brody, 1945; Kleiber, 1961; Warren, 1971). Bioenergetics studies are made at three different levels: a) molecular level b) organisamal level (Schroeder, 1971,1973; Muthukrishnan and Delvi, 1973) and c) population and ecosystem levels (Wiegert, 1965; Lawton, 1969, 1971; Stockner, 1971; Delvi and Pandian, 1979; Palavesam and Muthukrishnan, 1992). Among invertebrates, extensive studies have been made on the Bioenergetics of insects. The contribution of Hiratsuka (1920) on Bombyx mori is by far the most complete study on food utilization carried out on insects.

Quality of mulberry leaf is one of the major factor deciding the healthy growth of silkworm and success of cocoon crop. The quality of leaf is influenced by a number of factors, such as variety, cultivation practices, incidence of pests and diseases, method of harvesting and preservation of leaves (Hassanein and Elsharway, 1962; Narayanan et al., 1967; Krishnaswamy et al., 1970; Koul et al., 1980; shastry et al., 1988). The growth and development of silkworm larvae and the economic characters of cocoons are known to be influenced by the nutritional content of mulberry leaf (Krishnaswamy et al., 1971). Quality of mulberry leaf is one of the most important factors governing the production of good cocoon crops (Ravikumar, 1988). It was

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noticed that in certain sericulture states like Karnataka, the industrial water is used for irrigating many crops including mulberry.

The present study on Bombyx mori was undertaken with the following objectives.

1) To study the rate of growth, and to estimate the rate and efficiency of utilization of food energy as function of dilution of industrial effluent (Zinc smelter-major pollutant)

2) To estimate the rates and efficiencies of food consumption and utilization in three different races of silkworm at normal conditions.

MATERIAL AND METHODS

Food intake and utilization was estimated in three different races of silkworm Bombyx mori namely Pure Mysore race (PM), NB_4D_2 (Bivoltine) and Cross Breed race (CB). Disease free laying of B. mori (three different races) were obtained from Central Silk Board, Madivala, Bangalore. After a period of 10 days freshly hatched larvae were transferred to enamel trays. The experiments were carried out in a rearing laboratory which possessed adequate number of windows, free cross ventilation and reasonably air tight to facilitate disinfections of the laboratory whenever required. The larvae were reared separately till completion of third instar. Experiments were conducted with freshly moulted larvae belonging to fourth instar and continued till pupation. The experiments were triplicated, each group consisting of 50 larvae of fourth instar. The experimental larvae of all the three races were separately kept in terraria (Enamel trays size 36×26×4 cms) and were maintained in the laboratory fed ad libitum mulberry leaf Morus alba at a room temperature of 26±2ºC and relative humidity 80±10% R.H. A paraffin paper of tray size was used to cover the beds to minimize the loss of water from the leaf. The inner edges of trays were provided with wet foam rubber strips to maintain the humidity uniformly.

EXPERIMENTAL DESIGN

Lepidopterans are the major insects primary consumer (Delvi and Pandian 1971). These larvae consume more than 97% to 98% of the total food intake during fourth and fifth instar (waldbauer,1968). Hence the effect of major pollutants on food and water utilization was estimated in the fourth and fifth instar of larvae Bombyx mori. Zinc smelter effluent was brought from a Zinc Smelter plant. The effluent was diluted to obtained desired concentrations. Atomic Absorption Spectrophotometer was used to estimate the content of the effluent. It was found to contain 0.10-0.14 mg Cadmium/liter, 0.10-0.12 mg Copper/liter and 0.12-0.18 mg Zinc/liter. Zinc smelter effluent was used in three different concentrations i.e., 5%, 10% and 15%. The concentration was prepared in the laboratory using distilled water. Three sets of mulberry Morus alba was irrigated after proper dilution.

Four sets of experiments were conducted in each race (PM, NB_4D_2 and KA). The first sets of larvae were fed with fresh leaf of mulberry irrigated with bore well water, which was maintained as control. The second set on mulberry raised with 5% diluted Zinc Smelter, the third set of

larvae were fed on mulberry irrigated with 10% diluted Zinc Smelter effluent. The irrigated schedule for bore well water and treated effluent plots was once in twelve days.

After forty five days, the mature leaf Morus alba collected from control and treated plots were fed to fourth and fifth instar larvae of Bombyx mori The mulberry leaf were cut into two halves, one half was further cut into 2 or 3 pieces with a fine razor, removing the mid rib and fed to the worms, while other half was used as control to estimate the water loss during feeding period (Waldbauer, 1968), the mass and water utilization was studied in the fourth and fifth instars of the silkworm Bombyx mori.

The experimental larvae were weighed at the initial and also at the ore moult stage in each instars. Growth of laboratory insects (Delvi, 1972) was accessed just before offering the first feed. Few larvae were randomly selected at the beginning of each instars and were weighed to record the wet weight and freeze killed and dried in a hot air oven at 100^0C, to note the dry weight (Waldbauer,1968)

The sacrifice method described by Mynard and Loosli (1962) was for accessing the growth of laboratory mammals and fishes (Gerking,1952, Menzel,1960, Pandian,1970) and insects (Delvi, 1972) was employed in the present study.

Conversion of food into body weight was estimated by subtracting the dry weight of the individuals at the beginning of the experiment. The sample individuals of the same life stage, nutritional stage and temperature represent the corresponding test individuals at the beginning and at the end of each experiment. All weights were recorded as milligram dry weight except for the growth expressed in wet weight.

The silkworm faeces, as well as the food offered were weighed on single pan balance precica 127 SCA with 0.1 mg accuracy. The food utilization budget and resource allocation of the silkworm was analyzed using modified IBP terminology (Petrusewicz and Mac Fadyen, 1970) after Scriber and Slansky (1981)

$$\mathbf{I = B + M + F}$$

Where; I = Ingested food, B = Biomass gained, M = Assimilated food metabolized, and F = Undigested food + Excretory products

$$\mathbf{B = \{I- (M+ F)\}}$$

The difference between the final weight and initial weight is the growth of insect in each instar. Food ingested was calculated by subtracting the weight of uneaten food from the weight of food offered. Necessary corrections were made for the moisture loss during the feeding period (Waldbauer).

DISCUSSION-FOOD

The effect of Zinc smelter effluent on the food utilization budgets in the silkworm *Bombyx mori* has revealed some interesting aspects of feeding behavior in Lepidopteran insects. The silkworm larvae were fed separately mulberry M5 *Morus alba* leaf raised on 5%, 10% and 15%

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 04, 2022

dilutions of Zinc smelter effluent (Zinc, copper and cadmium). Nutritional efficiency was studied during penultimate two instars as more than 97% of the food is consumed during these two instars (Delvi and Pandian, 1972; Magadum *et al.,* 1996; Kurinji, 2002).

The present study on the effect of major pollutants on food utilization budgets in different races of silkworm Bombyx mori L. (PM, NB_4D_2 and PM races) reveals the following interesting findings.

1. The test races of the silkworm Bombyx mori displayed manifold decrease in growth at each instar level. The larvae continued to feed and grow on the mulberry leaf raised on 5%, 10% and 15% diluted industrial effluent (with zinc, copper and cadmium as major pollutant). From the maximum weight at control the growth reduced as a function of dilution to reach minimum at 15% dilution.
2. The food consumption was race specific at all the feeding level. Food intake decreased as function of dilution. The PM race consumed 18.6% less food, at 5% dilution, 39.3% less food at 10% dilution and 44.1% less food at 15% dilution than at control. The decrease in food intake was found in CB and NB_4D_2 races which ranged from 23.4% to 47.0%.
3. The feeding rate decreased as function of dilution of industrial effluent in all the test races. The rate in PM race decreased by 5.6% at 5% dilution, 13.3% at 10% dilution and 16.0% at 15% dilution. Similar decrease in rate was found in CB and NB_4D_2 race which ranged from 13.2% to 21.4%.
4. Total food assimilated increased in the test races as function of life stage and dilution of the industrial effluent. It was maximum during final instar which may be due to maximum food assimilation that takes place in Lepidopteran insects.
5. Assimilation decreased significantly from its respective maximum at control to the minimum at 15% dilution.
6. The assimilation efficiency changes a little as function of either life stage of dilution of industrial effluent (Zinc, Copper and Cadmium as major pollutants) in all the test races. There exists a negative correlation between food assimilation and assimilation efficiency. The regression coefficients and correlation coefficient for the relation between food assimilation and assimilation efficiency are reported.
7. Conversion of food into body substance differed considerably depending on larval period and race. Maximum amount of food was converted by CB race during the penultimate two instars at control. PM race larvae converted significantly less food into body substance which amounted to 60% less than the conversion in CB race at control. The conversion decreased as function of dilution of the industrial effluent (zinc, copper and cadmium as major pollutants) irrespective of race. The decrease in conversion as function of larval stage and dilution of effluent may be due to the influence of the industrial effluent used for raising the mulberry leaf. The plant must have accumulated the pollutants (Heavy metals like zinc copper and cadmium) in the leaf which must have acted as deterrent to the larvae during feeding.
8. Decrease in feeding and assimilation rate resulted in decrease metabolic rate. The conversion rate decreased as a function of dilution of industrial effluent. There exists a linear and positive or

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negative relation between food converted Vs conversion rate, and also between food assimilation and assimilation rate.

9. The gross conversion efficiency increased as function of life stage and also as function of dilution of industrial effluent. However, variations were found in the net conversion efficiency among the test races.

10 The present study has clearly established that feeding mulberry leaf Morus alba raised on industrial effluent (major pollutants like zinc, copper and cadmium) effects all the parameters of food intake and utilization in the silkworm Bombyx mori. It may be due to low nutrient content of the leaf or accumulation of the heavy metals in the leaf which in turn effect the Bombyx mori larvae. The conclusions are significant for the sericulture practices. Further work is required on qualitative analysis.

Table : Effect of different concentrations of Zinc smelter effluent (Zinc, Copper and Cadmium) on Growth in *Bombyx mori* L fed *ad libitum Morus alba* at 26±2ºC and 80±10% R.H. The values are expressed in mg wet weight/insect.

DILUTION	IV INSTAR AFTER 3RD MOULT	V INSTAR AFTER 4TH MOULT	PRIOR TO PUPATION
PM			
CONTROL	38.42 ± 0.3534	248.54 ± 0.7410	1659.44 ± 0.9395
5%	37.70 ± 0.4044	202.47 ± 0.4596	1299.09 ± 0.3005
10%	37.75 ± 0.3928	172.13 ± 0.6557	1187.15 ± 0.6735
15%	37.22 ± 0.6557	168.32 ± 2.0297	1177.65 ± 0.7155
NB_4D_2			
CONTROL	130.79 ± 0.9020	682.19 ± 1.0953	2852.49 ± 1.6168
5%	131.84 ± 0.8681	554.70 ± 2.1357	2540.89 ± 2.5512
10%	130.77 ± 0.7279	550.23 ± 1.0137	2418.24 ± 3.2416
15%	130.82 ± 1.2250	535.39 ± 1.0717	2321.79 ± 0.9959

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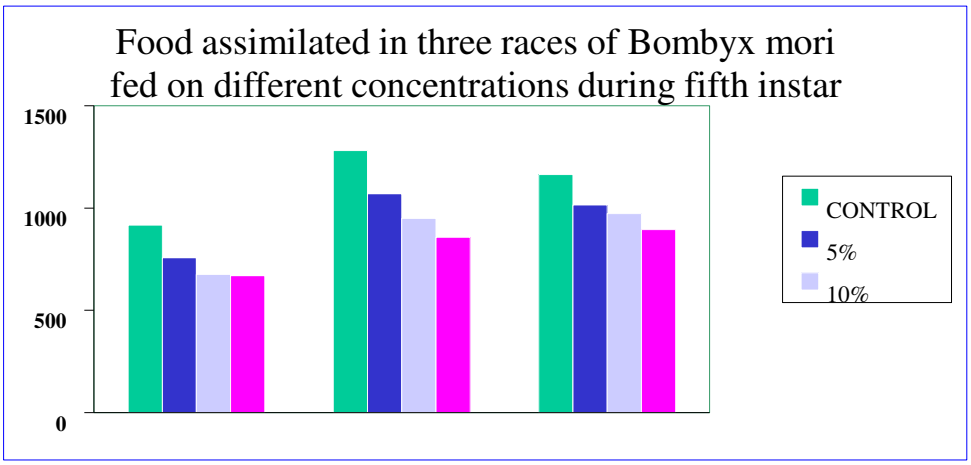
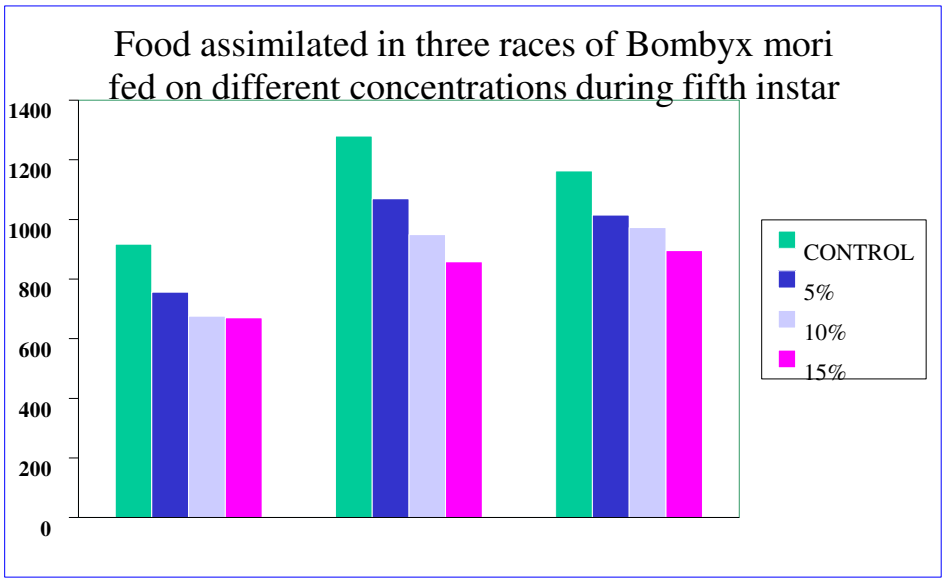
CB			
CONTROL	100.22 ± 1.5469	451.21 ± 0.2406	2575.99 ± 3.6662
5%	100.72 ± 1.91	304.19 ± 0.7435	2011.24 ± 0.6946
10%	101.67 ± 1.28	290.55 ± 2.1985	1918.44 ± 1.7252
15%	99.21 ± 1.34	277.19 ± 1.1760	1868.15 ± 2.2891





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