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Influence of Artificial Diet on Larvae of Eri Silkworm, *Samia cynthia ricini* Boisduval

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An Artificial Diet composed of castor leaf powder (11.5 g), parched soybean powder (1.0 g), sucrose (1.0 g), agar-agar (1.5 g), inhibitor solution (5 ml) and water (20 ml) was evaluated against eri silkworm larvae. Castor fed eri silkworms were maintained as control for comparison. Larval weight was significantly maximum in eri silkworms fed with artificial diet upto first instar which was followed by feeding of eri silkworms on artificial diet upto second instar + castor leaves from upto fifth instar and feeding of eri silkworm on artificial diet upto third instar + castor during remaining instars. Whereas, the larval mortality was minimum in eri silkworms reared on artificial diet upto first instar followed by artificial diet upto second and third instars + castor during remaining instars, whereas, they were higher in eri silkworms fed on artificial diet upto fourth and fifth instars + castor during remaining instars.

Key words: Artificial diet, eri silkworm, larval parameters.

Sericulture is broadly classified into two distinct sectors as Mulberry and Non-mulberry. Mulberry silk is produced on large scale around the World. India ranks second in the World with respect to raw silk production and has unique distinction of producing all the four popular kinds on natural silks *viz*., Mulberry, Tasar, Eri and Muga.

Among the commercially exploited non-mulberry silkworms, the eri silkworm, *Samia cynthia ricini* Boisduval is the only species domesticated completely and adapted to indoor rearing all through the year (Reddy, 2000).

Rearing silkworms on leaves require more labour. The leaves used must be fresh enough to meet the preferences of silkworm; therefore, it has to be given to the silkworm three to four times a day. The year-round rearing of eri silkworm on fresh leaves is not convenient, because the food plants, *Ricinus communis* and *Ailanthus glandulosa* shed their leaves. The low quality of the leaf fed to early instars of silkworms and the risk of infection in chawki are the major constraints. A system of rearing with artificial diet may solve the above problems. Rearing on artificial diet allows complete prevention of various pathogenic microorganisms infecting through food source. Farmers who rear silkworms can buy the diet instead of cultivating and need not have a field for themselves.

Raising of insects on artificial food has been successful in a few cases, but raising of insects, on artificial food is not so easy and there are very few successful cases.

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Rearing, *B. mori* L. entirely on an artificial diet was also achieved (Fukuda *et al*., 1960b; Ito and Tanaka, 1960; Yoshida *et al*., 1960). The composition of diet used by Fukuda *et al.* (1960b) is entirely the same as that devised by Yoshida *et al*. (1960) but that employed by Ito and Tanaka (1960) is slightly modified. Main constituents of these diets are starch, sucrose, soybean powder and mulberry leaf powder. Growth was suboptimal on all these diets.

In this context, the influence of an artificial diet on larval parameters was studied in comparison with natural diet in *S.c. ricini*.

Materials and Methods

Studies on economic parameters and consumption indices of eri silkworm, *Samia cynthia ricini* Boisduval on artificial diet were carried out in the Department of Sericulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore. Three consecutive rearings were conducted.

Preparation of Rearing Room and Equipment

Prior to commencement of rearing, the rearing room with rearing stands were cleaned, washed thoroughly and properly disinfected with 4 per cent formalin solution using a foot pump as adopted by Dandin *et al.* (2003). After spraying, the room was kept closed for 48 hours for effective disinfection. After 24 hours of disinfection, the doors and windows were kept open to allow the fresh air into the rearing room.

Preparation of eggs

The eggs of plain white eri silkworm breeds were prepared as per the procedure outlined by Reddy *et al.* (2000). The eggs laid in a span of 24 hours were collected, surface disinfected with 2 per cent formalin solution for 5 minutes, washed with tap water, shade dried and incubated at ambient room temperature.

Preparation of artificial diet

Leaves picked from castor plant were dried (not higher than 40°C) under air-blast and then powdered to pass through 80-mesh sieve. The inhibitor solution was prepared by dissolving 0.1g of Vitamin K_3, 0.2g of sodium dehydroacetate and 0.2g sodium sorbate in 100ml of distilled water by heat. To the hot mixture containing agar-agar, sucrose, inhibitor solution and water, powdered leaves and parched soybean were added. The mixture was stirred well and was hardened at room temperature. The composition of artificial diet is given in Table 1.

Table 1. Composition of Artificial Diet

Composition	Weight / Volume
Castor leaf powder	11.5g
Powder of parched soybean	1.0g
Sucrose	1.0g
Agar-agar	1.5g
Inhibitor solution	5ml
Water	20ml

With this artificial diet, castor leaves were supplemented in different larval instars as below and larval growth parameters were recorded.

Treatment details

T_1 : Feeding eri silkworms on artificial diet upto first instar + further feeding on castor leaves from second to fifth instar.

T_2 : Feeding eri silkworms on artificial diet upto second instar + further feeding on castor leaves from third to fifth instar.

T_3 : Feeding eri silkworms on artificial diet upto third instar + further feeding on castor leaves from fourth to fifth instar.

T_4 : Feeding eri silkworms on artificial diet up to fourth instar + castor during fifth instar.

T_5 : Feeding eri silkworms on artificial diet up to spinning.

T_6 (Control): Feeding eri silkworms on castor leaves throughout the larval period.

The observations on larval weight, larval duration, moulting duration and larval mortality were recorded and analyzed using completely randomized design (Cochran and Cox, 2000).

Results and Discussion

Larval weight

The larval weight was 370.97, 369.97 and 360.86 g / 50 larvae when larvae were fed with artificial diet for first, second and third instars + castor for remaining instars, respectively. Whereas, larval weight was 375.75 when silkworms were fed with castor throughout the larval duration (Table 2). The

Table 2. Larval weight of *S. c. ricini* in different instars as influenced by feeding on artificial diet

Treatment	Mature Larval weight (g/ 50 larvae)	Total larval duration
T_1	370.97	21.76
T_2	369.97	21.34
T_3	360.86	22.51
T_4	-	10.67
T_5	-	11.01
T_6 (Control)	375.75	20.78
F- Test	*	*
S.Em ±	0.102	0.006
CD at 5%	0.302	0.060

*Significant at 5%

variation in larval weight may be due to the difference in nutritional composition of the artificial diet and leaf. There was a gradual increase in larval weight from first to fourth instar and steep increase during fifth instar. This may be due to maximum food consumption and growth rate during fifth instar. The present results are comparable to the findings of Fukuda *et al*. (1960a), who opined that the growth of eri silkworms reared on artificial food were almost same as those in case of the eri silkworms reared on fresh leaves of castor. Chen *et al*. (1992) reported that larval growth of silkworms reared on artificial diet was satisfactory. Sumida *et al*. (1995) reported that the weight of silkworm reared on low-cost artificial diet containing a residue byproduct of soybean crude as principal ingredients was satisfactory. However, Choudhuri (2000) reported that higher larval weight with artificial diet fed eri silkworms had lesser disease incidence compared to castor leaves fed batch.

Larval duration

The total larval duration was significantly shorter (20.78 days) when eri silkworms were reared on castor leaves during the entire larval period. The total larval duration was longer in case of artificial diet fed eri silkworms upto third instar + castor from fourth to fifth instar (22.51 days) followed by the larval duration of 21.76 and 21.34 days in eri silkworms provided with artificial diet during first and second instars, respectively + castor during remaining instars. There was no significant difference between the treatments and control with respect to larval duration during first three instars, but significant

differences were noticed during latter two instars (Table 2). These results are in close agreement with the findings of Choudhuri (2000), who reported that the eri silkworms reared on artificial diet containing castor leaf powder recorded longer larval duration over natural food plant, where the duration was slightly less.

Moulting duration

There was no significant difference between the treatments and control in respect of first moult duration. It was minimum in eri silkworms which received artificial diet upto third instar + castor from fourth to fifth instar (48.31hours) followed by the moulting duration of 48.63 and 48.69 hours in eri silkworms reared on artificial diet upto second and first instars, respectively + castor during remaining instars. The first moult duration in eri silkworms fed with castor was 48.25 hours. The second moult duration was significantly minimum (24.25 hours) in individuals reared on castor upto fifth instar, whereas, it was significantly maximum (120.69 hours) in eri silkworms reared on artificial diet upto first instar + castor upto fifth instar followed by the moulting duration of 96.63 in eri silkworms which received artificial diet upto second and third instars, respectively + castor during remaining instars. The third moult duration was significantly minimum (24.31 hours) in eri silkworms reared on artificial diet upto first instar + castor from second to fifth instar, while it was significantly maximum (120.31 hours) in eri silkworms reared on artificial diet upto third instar + castor from fourth to fifth instar followed by the moulting duration of eri silkworms fed on artificial diet upto second instar + castor upto fifth instar (72.38 hours). The third moult duration of eri silkworms fed with castor throughout the larval period was 24.25 hours, whereas, fourth moult duration was found to be significantly minimum (24.19 hours) in eri silkworms reared on artificial diet upto second instar + castor leaves upto fifth instar followed by the moulting duration of 24.38 and 24.63 hours in eri silkworms provided with artificial diet upto first and third instars, respectively

+ castor during remaining larval period. However, the fourth moult duration of castor fed eri silkworms was 24.19 hours (Table 3).

In general, moulting duration was found to be higher when eri silkworms were reared on artificial diet and transferred to castor leaves. This may be due to sudden change in feeding habit, which may take some time for acclimatization for the larvae when they were transferred from artificial diet to leaves. The larval duration was maximum in artificial diet fed eri silkworms compared to those fed on castor leaves because of increased moulting duration, so they were unable to moult simultaneously and were lagging behind. These results conform to the results of Okauchi (1969), who reported that the larvae reared on artificial diet were lagging behind in growth, which can be made uniform by adding few

Table 3. Larval duration of different moults in *S. c. ricini* as influenced by feeding on artificial diet

Treatment	Moulting duration (hours)			
	I Moult	II Moult	III Moult	IV Moult
T_1	48.69	120.69	24.31	24.38
T_2	48.63	96.63	72.38	24.19
T_3	48.31	96.63	120.31	24.63
T_4	48.25	96.81	48.75	-
T_5	48.50	96.63	48.38	-
T_6 (Control)	48.25	24.25	24.25	24.19
F- Test	NS	*	*	*
S.Em ±	-	0.157	0.149	0.116
CD at 5%	-	0.467	0.442	0.345

*: Significant at 5% NS: Non-Significant

drops of ecdysone to the diet. Choudhuri (2000) also reported that eri silkworms reared on artificial diet containing castor leaf powder recorded longer larval duration over eri silkworms reared on natural food plant, where the duration was slightly less.

Larval mortality

The larval mortality was significantly low (2.56 and 1.88 per cent during first and second instar, respectively) in eri silkworms fed on artificial diet upto first instar + castor from second to fifth instar followed by eri silkworms fed on artificial diet upto second instar + castor from third to fifth instar (2.50, 1.93 and 1.38 per cent during first, second and third instar, respectively). The eri silkworms fed on artificial diet upto third instar + castor upto fifth instar had significantly higher mortality (2.43, 2.81, 4.88 and 1.55 per cent during first, second, third and fourth instar, respectively) (Table 4). However, there was no mortality in castor fed eri silkworms during all the instars. There was maximum mortality when eri silkworms were provided with artificial diet and when they were transferred to castor leaves the mortality was reduced and there was no mortality during subsequent instars. But the mortality was maximum when eri silkworms were fed on artificial diet upto fourth instar. There was severe mortality during fourth instar *i.e.,* immediately after third moult. So the worms in the treatments provided with artificial diet upto fourth instar + castor during fifth instar and artificial diet throughout the larval period were unable to reach fifth instar and spin cocoons. These results are in conformity with Hamamura (2001), who reported that when silkworms reared on artificial diet, mortality was observed twice during the larval period, once during the early instar or during the first moulting and again at the end of fifth instar. Yanagawa *et al*. (1991) also reported that the rate of survival was slightly lower when larvae were reared on artificial diet. The reason for the mortality of the larvae during first instar (when reared on artificial diet) is attributed to the composition of the diet. In most of the cases it is due to the factor preventing the feeding or the presence of growth inhibitor in the diet.

Table 4. Larval mortality in *S. c. ricini* in different instars as influenced by feeding on artificial diet

Treatment	Larval mortality (%)				
	I Instar	II Instar	III Instar	IV Instar	V Instar
T_1	2.56	1.18	-	-	-
T_2	2.50	1.93	1.38	-	-
T_3	2.43	2.81	4.88	1.55	-
T_4	2.63	2.38	4.88	89.76	-
T_5	2.49	2.69	4.48	90.00	-
T_6 (Control)	-	-	-	-	-
F- Test	*	*	*	*	-
S.Em ±	0.187	0.235	0.176	0.159	-
CD at 5%	0.556	0.697	0.522	0.474	

*: Significant at 5% NS: Non-Significant

As reported by Sengupta (1990), artificial diet for silkworm is restricted to the first and second instars only, covering chawki rearing. Limitation for their bulk use during the later stages is mainly due to difficulty in preservation and use *i.e.,* maintenance of aseptic condition, besides the correct temperature and humidity to prevent the physical and chemical degradation of the diet.

In general, eri silkworms fed on castor during first instar + castor from second to fifth instar were able to consume and digest more food which in turn led to increased larval growth. Eri silkworms provided with artificial diet upto fourth and fifth instars failed to complete their larval life, which might be attributed to the diet composition. The nutrition plays a vital role during last two instars, as the silkworms consume about 90 per cent of food during fourth and fifth instars to increase their body size and to synthesize silk.

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