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Silkworm (*Bombyx mori*) Rearing Technology by Non-Traditional Method

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ABSTRACT

Silkworm *Bombyx mori* L. is a highly sensitive lepidopteron insect and responds sharply to changes in the feed quality. The study was carried out to explore the silkworm (*Bombyx mori*) rearing technology by non-traditional method. The research work was started on March 20, 2018, silkworm complete 4th stage and spun cocoon on April 10, 2018 and identification of male and female on April 18, 2018. Average shell weight of five male and female cocoons were taken and were cut opened and their respective cocoon shells are weighed . The average weight of single-female cocoon =0.96 g (with pupa), average weight of single female cocoon= 0.14 g (without pupa), average weight of female pupa = 0.82 g, average weight of single male cocoon = 0.81 g (with pupa), average weight of single male cocoon = 0.12 g (without pupa), average weight of female pupa=0.69 g.

Keywords Silkworm, Mulberry leaves, Non-traditional method, Rearing, Mounting.

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INTRODUCTION

Silkworm *Bombyx mori* is a typical monophagus insect and mulberry (*Morus* spp.) leaf as sole food. The quantity of the leaf intake and its quality has got direct and positive correlation with quantity and quality of cocoon produced (Trivedy and Nair 1998, Trivedy and Nair 2003). Rearing of silkworm on artificial diet containing balanced nutrition, at least during the young instar stage ensures a successful and economically viable cocoon crop production. The domesticated silkworm, *Bombyx mori* is an important economic insect for silk production. There are several types of silkworm diseases which cause grate economic losses to the sericulture industry. The practice of sericulture comprises two major activities namely cultivation of mulberry for raising the leaf production to feed the silkworm and rearing of silkworms to produce the cocoons which is the raw material for the silk reeling industry. Mulberry cultivation is agricultural in nature, the operations involved are being simple, straight and easy to be carried out. On the other hand, silkworm rearing is a quite complicated process, calling for a great management skill with due understanding of the various technical aspects involved. The silkworm which has been domesticated and evolved over many thousands of generations, to produce substantial quantities of silk in a very short span, is indeed very delicate and requires careful handling during the process of rearing. Highly productive races are still more delicate

and demanding in their ecological requirements. The first practicial artificial diet was formulated during 1972 (Horie 1972) and the first large-scale artificial diet rearing of young silkworm was initiated in 1977.

Indian sericulture in the past has been characterized by either poor cocoon crop yield or even total loss on certain occasions. Until 1970, the average yield of cocoons for 100 disease free laying (comprizing roughly about 40,000 eggs) was of the order of only 20-25 kg as against 60-65 kg in temperate regions like Japan, Korea, USSR. Further, one out of every three or four crops used to result in total loss for the sericulturist. An analysis of the poor cocoon crop results in India indicated low values for the two important components that go to make the yield, namely, the number of cocoons harvested per laying and the average weight of the cocoon. In the past, only about 50% of the hatched larvae in a laying spun the cocoons successfully and the average cocoon weight was hardly 1.00 to 1.25 g. Therefore, in a laying of about 400 eggs, only about 200 cocoons were harvested which gave a yield of 200 to 250 g. In other words, the yield was of the order of 20 to 25 kg per 100 disease free laying. If only these two components could be improved by 50% individually, the combined effect will result in the number of cocoons harvested from a laying going upto 75% or 300 cocoons and the average cocoon weight to 1.7 g. That is to say, from a laying 300 cocoons weighing in all 510 g can be obtained; i. e. 51 kg from 100 disease free laying which would mean doubling the prevailing cocoon yields. If the laying are richer and the average number of eggs present goes upto 500, the yield will also correspondingly increase from 51 kg to 63.25 kg per 100 disease free laying. It can go still higher, if the number of cocoons harvested from a laying could be stepped up further, beyond 75%. Thus, the key to bumper cocoon harvests lies in the skill of management of silkworm rearing aimed at achieving higher values for the above two components, namely, increased-number of cocoons from a laying and higher cocoon weight. Towards this end, serious research was initiated first at Central Sericultural Research Station, Berhampore and later at Central Sericultural Research and Training Institute, Mysore. Based on the results achieved, the first paper on some aspects of improved technique of rearing for mulberry silkworm was published in 'Indian Silk' in 1971. This improved technique has been since popularized on a large scale during the last seven years in South India. As a result, it has been possible for the sericulturist adoption of the new technique to step up the average yields from the earlier level of 20-25 kg to 30-40 kg at present. Also, total loss of one crop out of every 3-4 crops as experienced earlier has been considerably reduced.

Rearing house

The first pre-requisite is a fairly satisfactory room or house for rearing silkworm's which should have adequate number of windows, ensuring free cross ventilation. It should also be possible to make it reasonably air tight to facilitate effective disinfection of the room/house, when required. The roof should have sufficiently high ceiling, upto 10' or so, so that wide fluctuations of temperature outside the room do not affect the conditions inside very much although such ideal requirements cannot be afforded by every sericulturist (who is normally a poor or marginal-farmer) it should be the goal to try to have a separate rearing house, satisfying the above specifications. The state departments of sericulture have drawn up special schemes to assist the sericulturist by way of subsidies and loans on easy terms in this regard and therefore, every sericulturist who does not possess a separate room or house for silkworm rearing should avail this assistance.

Environmental requirements

The atmospheric temperature and humidity have a great bearing on the growth and health of the silkworms. The ideal temperature-humidity conditions under which the silkworms thrive best are 24 to 27^{o}C and 70 to 90% relative humidity. The young age worms require higher temperature, humidity and the late age worms, lower temperature and humidity within the above range. But these are hardly obtainable in nature, particularly in the tropical zone of South India, where the temperature shoots upto over 30^{o}C in summer and drops below 20^{o}C during the rainy/winter seasons. Similarly, the humidity also fluctuates widely not only from season to season but also within the day itself during any season. Yet, it should be the

Table 1. Silkworm rearing.

		Silkworm counting every week (Monday)				
Sl. No.	Box No.	First day 20 March 2018	March 26, 2018	April, 02, 2018	April 09, 2018	Final cocoon counting on April 18, 2018
1.	A	156	146 (-10)	135 (-21)	122 (-34)	80 (-76)
2.	B	156	141 (-15)	132(-24)	120 (-36)	76 (-80)
3.	C	156	149 (-07)	136 (-20)	117(-39)	65 (-91)
4.	D	156	148 (-08)	140 (-16)	119 (-37)	79 (-77)
Total		624	584 (-40)	543 (-81)	478 (-146)	300 (-324)

endeavor of every sericulturist to bring the rearing room temperature/humidity conditions as close as possible to the ideal requirements of the silkworm. This can be achieved within reasonable limits by manipulating the ventilation within the room.

For instance, during summer, when the day temperature goes very high, all the windows should be kept open during night. This enables the room temperature to come down. Further, all the windows and doors should be opened very early in the morning so that the cooler air from outside is allowed to blow freely inside and bring down the temperature to optimum levels. Thereafter, as the sun rises and the outside temperature goes up, the doors and windows should be closed (at about 9—10 am) to keep out the heat and thereby, maintain the rearing room temperature as low as possible. Similarly, during the colder seasons, the doors and windows should kept closed during nights to keep out the cold and later in the day, as the outside temperature goes up, they should be opened to allow warm air to get in. In the same way humidity of the room also can be controlled by closing the doors and windows when it rains to keep out humidity and opening them when the rains have stopped to let in free blowing air to bring down the humidity.

During colder months, as in December—January, if the temperature falls too low necessary steps to raise the temperature to the desired level should be taken through artificial heating of the rooms with the aid of electric room heaters or smokeless charcoal fire. This is particularly necessary at the ‘‘chawki’’ (young age) stage rearing.

Table 2. Cocoon formation in number.

Sl. No.	Box No.	Number of cocoon	No. of male cocoon	No. of female cocoon
1.	A	80	56	24
2.	B	76	50	26
3.	C	65	43	22
4.	D	79	54	25
Total		300	203	97

The above steps go a long way to provide the near-ideal environmental conditions for the silkworm to grow and thrive well. It is in this context, the need for a suitable rearing room or house conforming to the bare minimum specifications described above will be found unavoidable.

Quality of leaves

Another major factor to be taken into consideration in silkworm rearing is the quality of leaf, because growth of the silkworm very much depends on the quality and quantity of leaves fed to it. The leaves utilized are those containing more moisture, protein, sugars, carbohydrates, less ash and fiber and look both succulent and dark green in color. In about 2 to 2½ month time following pruning or last picking of leaves, the plants get covered with leaves that would have reached correct stage of maturity to be plucked and fed to the silkworms in the last instar. Therefore, commencing of rearing should be so timed that bulk of the harvest is made and utilized at the correct stage of leaf maturity, before the leaves get either over matured or turn yellow and shed.

The quality of leaf may also vary considerably from season to season, being influenced by the climatic factors. In the hot dry season, the leaves grow and mature fast, but wither quickly. Its life in the rearing bed is short necessitating upto five feeds or even six feeds per day during the hot dry months. In the rainy season, however, although the leaves grow and mature fast, they contain more moisture. Their life in the rearing bed lasts longer therefore, three to four feeds per day may be found adequate.

In the cold season, the growth of mulberry is comparatively slower and so, the leaves also mature gradually. Such leaves have better keeping quality, op-

timum moisture content and consequently better feed value. Four feeds per day may be found adequate and the leaves neither wither nor increase bed humidity, leading to normally successful crops, assisted also by favorable temperature/humidity conditions of the season as in December—January.

Inseasons, when the day/night temperature difference is high i.e., with a warm day and a cool to cold night, the leaf quality is again good, since the photosynthetic activity during day is maximum,while the assimilation of the manufactured food is minimum during night.

Growth of Silkworms

Silkworms show fantastic rate of growth, gaining in weight about 10,000 times between hatching and final spinning of cocoons in a matter of about 24 to 25 days. The spacing of the rearing bed as well as the quantity of feeds given will have to be regulated to allow for the is fast rate of growth, which will ensure full development of the larva throughout its larval period-right from the first instar to the fifth instar. The worm would then show about maximum growth, attaining a weight of 4 to 5 g. Such worms will be healthy and will not fall easy prey to diseases. Further, they will produce cocoons of 1.75 to 2.0 g and above in weight.

Mounting

On the completion of full 6 or 7 days after passing the fourth moult, the worms will cease feeding and become ripe for mounting. Ripe worms should be picked in time so that all the maturing worms are enabled to spin cocoons successfully. Worms not picked in time or unduly delayed in picking can also be mistaken for diseased worms. Similarly, worms picked much before ripening, may not also spin resulting in unnecessary crop losses at the last stage of rearing. Therefore, it is important that maturing worms as they show signs of maturity (from the translucent body color and the active raising of heads by the ripe worms) should be picked in time and mounted to get full benefits of successful rearing.

Under the improved methods of rearing suggested here, the worms will grow uniformly and therefore, will also mount uniformly completing mounting with in the shortest possible time. Majority of the worms will mount in 24 h and the total time taken for all the worms to mount will not exceed 2 days.

Advantages

A comparison of the improved technique of rearing with the conventional method of rearing will show clearly that under the improved technique, the leaf produced is most efficiently utilized since the leaf cocoon ratio works out to be 15-20 : 1 as against 20-25 : 1 or even more in the case of conventional method of rearing. Further, for producing the same quantity of cocoon crop, the seed required is just half. Also the cocoon produced is of such superior quality that a premium price of 30 to 50% more can be easily obtained in the cocoon markets for the cocoons obtained in the improved technique of rearing. Thus, the new technique helps the sericulturist to obtain both higher yield as well as higher prices for the cocoons produced.

It may also be mentioned in this connection that the sericulturist used to lose on an average one crop out of every three or four crops and crop failures are regular features under the conventional method of rearing, whereas in the case of improved technique, the crop failures are very rare and almost completely eliminated. Even if there were to be any disease infection, it does not result in the total loss of the crop and to a large extent the crop is saved. The crop is generally successful and the effective rate of rearing reaches 70-80% and above and this mainly accounts for bumper harvests.

Thus, it may be seen that the adoption of the improved technique of rearing as recommended by the institute is an essential step in sericulture practice which would ensure sustained production of bumper crops.

MATERIALS AND METHODS

The present study was carried out at Uttaranchal PG College of Bio-Medical Sciences and Hospital

Table 3. Harvested female cocoon detail.

Sl. No.	Box No.	Weight of single female cocoon (with pupa) g average 5 cocoons	Weight of single female cocoon (without pupa) g average 5 cocoons	Weight of female pupa (g) average 5 pupa
1.	A	0.99	0.14	0.85
2.	B	0.97	0.13	0.84
3.	C	0.93	0.14	0.79
4.	D	0.95	0.15	0.81
Average		0.96	0.14	0.82

Table 4. Harvested male cocoon detail.

Sl. No.	Box No.	Weight of single male cocoon (with pupa) g average 5 cocoons	Weight of single male cocoon (without pupa) g average 5 cocoons	Weight of male pupa (g) average 5 pupa
1	A	0.80	0.12	0.68
2.	B	0.82	0.13	0.69
3.	C	0.80	0.13	0.67
4.	D	0.81	0.11	0.70
Average		0.81	0.12	0.69

(UCBMSH), Dehradun by non-traditional method.

Non-traditional method used articles were : Silkworm rearing conducted in cartoon box and plastic tray under normal atmosphere condition. Silkworm were fed with road side mulberry plantation leaf. Mountage were used with local material. Rearing was conducted under disinfected condition. There was no maintenance of hygienic during rearing period. As there conditions are contrary to advanced rearing technology.

RESULTS AND DISCUSSION

Research work was started on March 20, 2018, silkworm complete 4th stage and spun cocoon on April 10, 2018 and identification of male and female on April 18, 2018.

Larval duration

The larval duration of silkworm was studied by counting the days and hours from the time of brushing up to spinning . Instar duration also calculated by considering the day and time of moult out larvae to the day and time of entering into the next moult or spinning.

Cocoon parameters

Pupation is an important rearing parameter which indicate the quality of cocoons. Dandin et al. (2005) recorded various characters for CSR2 × CSR4 viz., pupation rate (ranged from 95-97%), cocoon shell ratio (23-24%), filament length (1000-1150 m), filament size (2.9—3.2d), raw silk percentage (19-20%), neatness (93–95 points), reelability (80-85%) and renditta (5.0-5.5). Total no. of cocoon = 300.

Average cocoon weight 5 male and 5 female cocoons were taken from each treatment and were weighed. The weight of average cocoon was calculated. Average weight of single female cocoon=0.96 g (with pupa). Average weight of single female cocoon = 0.14 g (without pupa). Average weight of female pupa = 0.82 g. Average weight of single male cocoon =0.81 g (with pupa). Average weight of single male cocoon =0.12 g (without pupa). Average weight of female pupa = 0.69 g.

Average shell weight

Five male and female cocoons were taken and were cut opened and their respective cocoon shells are weighed.

Shell ratio

The value of shell ratio is expressed in percentage. It

Table 5. Silkworm rearing detail.

		Silkworm rearing every week (Monday)				
Sl. No.	Box No.	First day no. of larva on March 20, 2018	Missing larva	Dead larva	No. of of single cocoon	No. of double cocoon
1.	A	156	20	56	76	4
2.	B	156	34	46	70	6
3.	C	156	26	65	63	2
4.	D	156	23	54	76	3
Total		624	103	221	285	15

is assessed by using the formula.

$$\text{Shell ratio} = \frac{\text{Average shell weight}}{\text{Average cocoon weight}} \times 100$$

No. of double cocoons =15. No. of single cocoons = 285. No. of missing larva = 103. No. of dead larva = 221. Selected 100 cocoon i. Artificial 50 cocoons cut, ii. Natural Condition 50 cocoons without cut. Boil 200 cocoons.

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