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Comparative Study on the Feeding Activity of *Bombyx Mori* with Host Plant Morus Nigra (Mulberry) and Alternative Plant Ricinus Communis (Castor Plant)

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Abstract: *In the present study, two different host plant leaves were used to analyse the feeding activity of Bomby mori. In the host plant Ricinus communis the larvae tried to feed on the host plant but in a meagre quantity. The feeding rate was 25-50 gms only. 350-700 gms of third and fourth glossy young mulberry leaves were fed by the larvae. In the case of worms fed with Ricinus communis shown wriggling movement and moved towards the corners of the tray. Sign of inconvenience and weakness was observed. Followed by various symptoms the larvae starved to death due to in availability of their regular host plant Morus nigra. During the third stage, the worms become highly voracious feeders in which case of silkworms consumed almost 2 to 3 kgs, of mulberry leaves. The feeding rate increased tremendously to enormous volume of 12 to 40 kgs during fourth instars. The quantity of leaves uptake was in the following manner such as 20 kg-100 kg up to 28th day. But at 29th day the feed up take was dropped suddenly to 50 kgs.*
Keywords – *Bombyx mori, Morus nigra, Mulberry leaves, Riccinus communis, Silkworm*

I. Introduction

Sericulture refers to the conscious mass scale rearing of silk producing organisms in order to obtain silk from them. It is an ideal cottage industry requiring low initial investment, village made simple appliances for rearing and reeling. Hence in recent years maximum attention has been given for the improvement of mulberry in terms of both quality and quantity. In India, major silk producing states include Karnataka, Tamil Nadu, Andhra Pradesh and West Bengal where silk worms are reared four to six times in a year. It is a remunerative enterprise to Indian farmers.

1.1 Life Cycle of Bombyx Mori

Bombyx mori undergoes complete metamorphosis and has four stages in its life cycle - egg, larva, pupa and adult. The duration of each stage varies according to its inherited characters of the race and according to the environmental conditions like climate during rearing and the quality of food. Based on the number of generations the race undergoes in a year it is called univoltine, bivoltine and multivoltine. The duration of each stage of the life cycle is longer in the uni and bivoltines than in the multivoltine.

The duration of life cycle spent in the egg stage varies depending upon whether it is a diapausing or a non-diapausing egg. Diapausing or hibernating eggs are called as kurodane eggs and non-diapausing eggs are known as nomadane eggs in Japan. Diapausing eggs under natural conditions remain dormant for months together till the spring season in the next year. Diapause can be broken artificially by acid treatment. After this, the eggs have to be incubated at a constant temperature for another eleven to fourteen days for embryonic development to take place and for the larva to hatch out. Duration of embryonic development varies depending on the race, season and nutrition during the larval stage of the mother. Non-Diapausing eggs normally complete their embryonic development in nine to twelve days and hatch into larvae. The larva moults three, four or five times and has four, five or six larval instars respectively. Most of the races are tetra-moulters and have five larval instars. The final instar larva, after full growth, empties its gut, stops feeding and spins the cocoon of silk around itself. At this stage it is called a prepupa. After spinning, it moults into the pupa inside the cocoon. The pupa is a non- feeding and inactive stage. The larval structures are histolysed and adult structures are differentiated during this stage. The differentiated adult or imago breaks open the cocoon by secreting a mild protease and emerges out. They are non-feeding and live only for a short duration. During this period they mate and the female lays the eggs.

The common silkworm *Bombyx mori* is an important commercial insect. It produces natural silk that is well known for its water absorbency, dying affinity thermo tolerance and insulation properties. Its pupae are used as a raw material to make vitamin E and K.

The silkworm *Bombyx mori* is essentially a monophagous and survives solely on mulberry leaves (Morus sp) which plays an important role in the nutrition of the silkworm and in turn cocoon and silk production [1]. The nutritional elements of mulberry leaves determine the growth and development of the larvae and

cocoon production [2]. The quality of the leaves has a profound effect on the superiority of silk produced by the *Bombyx mori.* In this regard, the production of good cocoon crop is totally dependent on the quality of leaves. Leaves of superior quality enhance the chances by good cocoon crop. It has also been demonstrated that the dietary nutritional management has a direct influence on quality and quantity of silk production in *Bombyx mori* [3].

Nutrition plays an important role in improving the growth and development of the silkworm, *Bombyx mori.* Legay [4] has stated that silk production is dependent on the larval nutrition and nutritive value of mulberry leaves plays a very effective role in producing good quality cocoons. Seki and Oshikane [5] have observed better growth and development of silkworm larvae as well as good quality cocoons when fed on nutritionally enriched leaves.

1.2. Description of The Host Plants:

1) Mulberry Plant:

Mulberry silkworm is a monophagous insect, which feeds only on mulberry leaves. Mulberry includes a number of species and varieties. They differ in their suitability for silkworm rearing because of their varying nutritious value and palatability for the worm.

Mulberry belongs to the family moraceae. The characteristic feature of this family is the presence of idioblasts. These are long cells in the upper epidermis of the leaves contain a cystolith of non-crystalline line. Mulberry is a deep-rooted perennial plant with highly branching root and shoot systems with primary, secondary and tertiary branches. Normally, it grows into a tree, but in cultivation it is raised as a middling or bush by pruning. The color of the bark of the stem varies from green, grey to pink or brown and has a number of lenticels which are important for classification purposes.

2) Ricinus Communis - Castor Plant:

The castor plant *Ricinus communis* is a plant species of the family Euphorbiaceae and the sole member of the genus Ricinus and of the subtribe ricininae. It is essentially a warm season crop, cultivated in tropical, subtropical and temperate regions. It grows in tropical and subtropical regions as a perennial plant and in temperate climate as an annual plant. A moderate temperature of 20-26ºC is highly favourable during crop period for obtaining higher yields. A low temperature (less then 15ºC) into seed bed prolongs the emergence of seedlings and makes the seed more liable to attack by fungal diseases and insects. Castor being a deep rooted crop is fairly resistant to drought.

Castor plant is indigenous to many parts of India and Africa; now it has spread out over all tropical and sub tropical countries. In India the plant is found throughout the hotter parts of the country, cultivated in the fields and garden, also frequently found wild near habitation, roadside and on waste lands.

Silkworm is commonly raised on leaves of different varieties of mulberry (*Morus* sps) There had always been a search for alternate host plant which can raise silkworm larvae to produce better silk in quality and quantity like *Morus nigra* Gopal [6], Samokhvalova [7] also tired to raise silkworm on mixed feeding. He noted that mixed feeding supported the insect better as compared to leaves of single plant species [7]. Most of the research was concentrated on mulberry plant. No remarkable work was done on alternate hosts that could be exploited to get better silk in quality and as well as quantity.

South Indian farmers choose only mulberry for feeding *Bombyx mori*. Alternative to this feed there are other several commonly available host plants which can also be used feeding the silkworm *Bombyx mori*.

In the present study an attempt has been made to evaluate the substitute for mulberry as a sole diet for silk worm *Bombyx mori*. More studies are done only with mulberry as a feed for silkworm. So the present study is to analyse a better feed for silkworm. Moreover the *Ricinus communis* plant is perennial, easily cultivable in different soil types. It is comparatively resistant to environmental fluctuations and is relatively free from pests and diseases. In the present project the perennial plant *Ricinus communis* (Castor plant) is selected as an alternate diet for the silkworm *Bombyx mori*

II. Materials And Methods

2.1 Study Site:

The project is conducted in the college campus (Vellalar College for women, Erode). The experimental plants are mulberry plant (*Morus nigra*) and castor plant (*Ricinus communis*) The mulberry leaves were procured from Sekar Serifarm Athani, Erode. Castor leaves were procured from Agricultural field, Kodumudi village, Erode. The egg patch of silk worm (*Bombyx mori*) were collected from sericulture training centre located at Krishnagiri, Tamil Nadu.

2.2 Rearing Operations

Silk worm larvae are highly sensitive to environmental conditions. Temperature, humidity, light, chemical noise pollution etc., will influence the growth and development of larvae as well as spinning by the grown up the larvae. In particular, each instars requires a specific temperature and humidity.

2.3 Experimental method:

Experiment was conducted under laboratory conditions (Temperature, 23° centigrade R.H 75%). Metal and cardboard trays, each 44 cm in length and 36 cm width were used. Eggs of *Bombyx mori* were placed in a metal tray for hatching. The larval life consists of five larval stages. The larvae feed voraciously upon the mulberry leaves and grow very quickly. They stopped feeding became inactive after four to five days I moulting took place. The eggs of *Bombyx mori* larvae were offered with finely chopped tender mulberry leaves. After hatching larvae were isolated. The larvae were reared in cardboard boxes covered with polythene sheet and placed in an iron stand with ant wells. Larval period consists of 25 to 30 days. Fresh tender mulberry leaves are spread and the experiment was continued until III, IV and V instars larval duration.

Moulting test conducted up to pupal stage following standard rearing method. Healthy tender chopped mulberry leaves were fed to young silk worm . Daily three feeding were given at 7 am, 2 pm and 8 pm. First appearance of one larva out of moult was considered as commencement of moulting.

Young age larvae were fed with tender, succulent and nutritious leaves known to favour growth and development of chawki silk worm, while mature and coarse leaves were fed to late age silk worm till ripening. They ate voraciously for next seven days then moulting took place and third stage larvae were formed. The maturity is attained at about 30 days from the time of hatching, then the larvae passes on to the next stage the pupa. The findings of the present study with respect to the host plant *Morus nigra* verses *Bombyx mori* is presented in TABLE I

2.4 Silk worm rearing with the host plant *Ricinus communis*:

Similar study has been carried out with the host plant Ricinus commuins (castor plant) as a trial to find out the alternative feed for the silk worm bambyx mori . The same methodology was carried out with *Ricinus communis* against the silk worm *Bombyx mori*.

The egg patch of *Bombyx mori* were placed in a metal tray for hatching. The hatching out within three to four days. The larvae were offered with tender finely chopped castor leaves. All the necessary environmental and standard condition was maintained. (such as temperature, humidity). The newly hatched larvae tried to feed on the tender castor leaves but they didn't feed. They show regressive movement to castor leaves. The newly hatched larvae moved to the corners of the rearing tray and avoided the new feed.

III. Results

The significance of the different host plant leaves on the feeding activity of *Bombyx mori* were analysed in this study.

3.1 Assessment of feeding activity of *Bombyx mori* :

Silk worm undergoes four moultings (instars) in the larval stage and are fed according to this instars

I stage (I instar):

i) Approximately 150-200 gms of finely chopped second and third young mulberry leaves were fed to the worms during each day of the first instar. After the fourth day the worms enter in to the moult stage. Moulting takes place for about 18-24 hours and the worms should not be fed during this period

ii) Simultaneously, the above method was adopted with the host plant *Ricinus communis*. The larvae tried to feed on the host plant but in a meagre quantity. The feeding rate was 25-50 gms only. That too only some larvae fed those new host plant leaves

II stage (II instar):

i) From sixth to ninth day will be the larval duration of second instar larvae. 350-700 gms of third and fourth glossy young mulberry leaves were fed by the larvae. At tenth day the larvae entered into second moulting stage

ii) In the case of worms fed with *Ricinus communis* shown woriggling movement and moved towards the corners of the tray. Sign of inconvenience and weakness was observed. Followed by various symptoms the larvae starved to death due to in availability of their regular host plant *Morus nigra*

III stage (III instar):

During the third stage, the worms becomes highly voracious feeders in which case of worms consumed almost 2 to 3 kgs, of mulberry leaves. Even the green part of the stem and shoot were also fed by them. The larval duration of third instar larvae is third days i.e 11^{th} to 13^{th} day. After 13^{th} day the third stage larvae enters into the third moulting.

IV stage (IV instar):
After moulting the larvae turned into fourth instar which are fed with whole shoot for feeding. The feeding rate increased tremendously to enormous volume of 12 to 40 kgs. The shoot length measures about 1 to1.5 metres.
V stage (V instar):
This is the important stage of silk worm during which certain interesting gradual raise in feeding activity was recorded. The study shows that the quantity of leaves uptake was in the following manner such as 20 kg-100 kg up to 28th day. But at 29th day the feed up take was dropped suddenly to 50 kgs. 30th day the larvae stops feeding and start cocooning.

Table – I: Quantity of leaf requirement for rearing of one case silkworm *Bombyx mori* fed with *Morus nigra* (Mulberry plant)

STAGE	AGE / DAY	LEAF WEIGHT	LEAF / SHOOT REMARKS PER DAY
First	1 1st	150 g	
	2 2nd	175 g	
	3 3rd	200 g	Second and Third young leaves
	4 4th	150 g	
	5 5th	Moulting	
Second	6 1st	350 g	
	7 2nd	425 g	
	8 3rd	625 g	Third and Fourth leaves
	9 4th	700 g	
	10 5th	Moulting	
Third	11 1st	2 kg	
	12 2nd	2.5 kg	Green part of young shoot
	13 3rd	3 kg	
	14 4th	Moulting	
Fourth	15 1st	12 kg	
	16 2nd	15 kg	
	17 3rd	25 kg	
	18 4th	30 kg	Good shoot (1-1 ½m) meters long
	19 5th	40 kg	
	20 6th	Moulting	
	21 7th	Moulting	
Fifth	22 1st	20 kg	
	23 2nd	25 kg	
	24 3rd	30 kg	
	25 4th	50 kg	
	26 5th	60 kg	Whole shoot
	27 6th	70 kg	
	28 7th	100 kg	
	29 8th	50 kg	
	30 9th	Start cocooning	

Table – II: Quantity of leaf requirement for rearing of one case silkworm *Bombyx mori* fed with *Ricinus communis* (Castor plant)

STAGE	AGE / DAY	LEAF WEIGHT	LEAF / SHOOT REMARKS PER DAY
First	1 1st	25 g	
	2 2nd	28 g	
	3 3rd	30 g	
	4 4th	35 g	Second and Third young leaves
	5 5th	Moulting	
Second	6 1st	20 g	
	7 2nd	15 g	
	8 3rd	10 g	
	9 4th	5 g	Third and Fourth leaves
	10 5th	Death	

IV. Discussion

In spite of newer technologies still there existed a wide gap between the potential yield and yields obtained by farmers. The general problems faced by the Indian sericulture industry include, low productivity, poor silk quality, non-availability of region, specific silkworm races, need to timely supply of good quality silkworm eggs, non-availability of planting materials of improved varieties reeling efficiency, poor marketing facilities, price fluctuation and crop losses due various factors including diseases [8].

South Indian farmers select only mulberry leaves for feeding *Bombyx mori*. Alternative to this feed there are other several commonly available host plants which can also be used for feeding the silk worm *Bombyx mori*. In the present study an attempt has been made to evaluate the substitute for mulberry as sole diet

for silk worm *Bombyx mori*. So, the perennial plant *Ricinus communis* (castor plant) is selected as an alternative feed for the silk worm *Bombyx mori* .

Assessment of feeding activity of *Bombyx mori* fed with *Morus nigra* (mulberry plant) and *Ricinus communis*(castor plant)

On the basis of results obtained we can say that our findings as in resemblances to the findings of other scientists of different parts of the country. The food plant of different species influences the larval growth, larval duration, cocoon weight, pupal weight, shell weight and fecundity [9].

Studies on the influence of different mulberry varieties on silk worms behaviour and cocoon traits were studied in tropical conditions of India [10] [11] [12]. It was also emphasized that mulberry leaf quality has direct effect on food consumption ratio, larval growth, digestive co- efficient and food absorption [13].Significant differences were observed in food consumption. Silk worm fed with *Morus nigra* (mulberry plant) leaves revealed increased food consumption in all the larval stages as compared to that of the silk worm fed *Ricinus communis* (castor plant)The quantity of food digested increases along with progress in larval growth and the percentage of digestion gradually decreases along with the progress of larval growth.

The observed increased food consumption exhibited by silk worm *Bombyx mori* fed on *Morus nigra* (mulberry plant) may be due to the high rate of food ingestion and food assimilation activity. However, [14] reported that in silk worm *Bombyx mori* the food consumption has a direct influence on the weight of larvae, cocoon and shell.

The food consumption was significantly higher in silk worms reared on *Morus nigra* (mulberry plant)and lower was recorded silkworms reared on *Ricinus communis* is(castor plant).The higher food consumption by the larvae fed on *Morus nigra* (Mulberry plant)indicated a better nutritive quality of host plants [15].

V. Conclusion

150-200 gms of finely chopped second and third young mulberry leaves were fed to the worms during each day of the first instar. In the host plant *Ricinus communis* the larvae tried to feed on the host plant but in a meagre quantity. The feeding rate was 25-50 gms only. 350-700 gms of third and fourth glossy young mulberry leaves were fed by the larvae. In the case of worms fed with *Ricinus communis* shown wriggling movement and moved towards the corners of the tray. Sign of inconvenience and weakness was observed. Followed by various symptoms the larvae starved to death due to in availability of their regular host plant *Morus nigra*. During the third stage, the worms become highly voracious feeders in which case of worms consumed almost 2 to 3 kgs, of mulberry leaves. The feeding rate increased tremendously to enormous volume of 12 to 40 kgs during fourth instar. The quantity of leaves uptake was in the following manner such as 20 kg-100 kg up to 28^{th} day. But at 29^{th} day the feed up take was dropped suddenly to 50 kgs.

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