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Rearing of Silkworm *Bombyx mori* L. on Alternate Food Plants

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Abstract
Silkworm (*Bombyx mori* L.) larvae are commonly raised on leaves of mulberry (*Morus alba*). They can be reared successfully on leaves of peepal (*Ficus religiosa*), when fed after third instar. It was concluded that these larvae not only can consume and utilize the new food aptly but can also produce healthy cocoons as compared to those raised on mulberry and other alternate host plants.

Introduction
The common silkworm (*Bombyx mori* L.) 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. Chlorophyl can be extracted from its feces (Khurshid, 1986).
Silkworm is commonly raised on leaves of different varieties of mulberry (*Morus alba*). 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 alba* (Gopal, 1910). Samokhvalova (1976) also tried to raise silkworm on mixed feeding. He noted that, mixed feeding supported the insect better as compared to leaves of single plant species. Pan-Chuan and Da-Chuang (1988) studied the effects of leaf ages on cocoon production by the larvae. After Samokhvalova (1976) most of the research was concentrated on mulberry. No remarkable work was done on alternate hosts that could be exploited to get better silk in quality as well as quantity.
The main objective of the present study was to find out some other potential host plants for silkworm (*Bombyx mori* L.) larvae so that the production and quality of silk could be improved.

Materials and Methods
A lot of 20 plants was chosen for preliminary trials (Table 1). Out of these only six (i.e, *Lactuca sativa*, *Morus alba*, *tis vinifera*, *Pyrus malus*, *Pyrus communis* and *Citrus edica*) which could support 1st instar larvae well for a longer period were isolated for further studies. In the meantime we came to know accidentally that silkworm me could feed voraciously on young peepal (*Ficus igiosa*) leaves. So we again included it in the list of eady selected six alternates. Even though the survival period of 1st instar larvae was only 3 days on peepal haps due to the hardness of leaves (Table 1). Then the ates were seven in numbers.
The experiment was conducted under laboratory conditions, temperature 23 degree centigrade and R.H. 75 percent. The cardboard trays, each 44 cm in length and 36 cm in width were used. Each tray was subdivided into 12 squares of 10 x 10 cm. A single newly molted silkworm larva was placed in each square. The larvae were offered with weighed quantity of food plants viz. T1 (*Lactuca sativa*), T2 (*Morus alba*), T3 (*Ficus religiosa*), T4 (*Vitis vinifera*), T5 (*Pyrus malus*), T6 (*Pyrus communis*) and T7 (*Citrus medica*). Each treatment was replicated ten times. The experiment was continued unto cocoon formation. Food consumption and co-efficient of utilization for each treatment was worked out by the following formulae (Saleem and Haq, 1984).

$$F.C. = F.O - F.Un.$$

Where,
F.C. = weight of dry food consumed (gms)
F.O. = weight of dry food offered (gms.).
F.Un. = Weight of dry food left unconsumed (gms.).

$$C.F.U. = (F.C. - F.P.) / F.C. \times 100$$

Where,
C.F.U. = Coefficient of food utilized %)
F.C. = Food consumed (gms.)
F.P. = Faeces produced (gms.)

Table 1: Survival of first instar larvae *Bombyx mori* L. on selected host plants

Name of Plant	Family	Survival days
Brussonetia papyrifera	Brussonetia	3
Ficus religiosa	Brussonetia	3
Brassica olerace	Brassiceae	6
Lactuca sativa	Composite	5
Juglans regia	Juglandaceae	5
Ficus carica	Moracea	2
Mows alba	Moracae	7
Hibiscus mutabllis	Malvaceae	5
Hibicus rasa	Malvaceae	2
Populus eumericana	Populaceae	5
Zea mays	Poaceae	5
Pyrus malus	Rosaceae	5
Pyrus communis	Rosoceae	5
Citrus reticulata	Rutaceae	4
Citrus sinensis	Rutaceae	5
Citrus medica	Rutaceae	5
Citrus decumana	Rutaceae	5
Solanum tuberosum	Solanaceae	2
Lycopersicon esculentum	Solanaceae	4

The collected cocoons were weighed for each treatment at the end of experiment. A multiple comparison of the mean values for the cocoon produced by *Bombyx mori* L. larvae raised on different host plants with those of the amount of their leaves consumed, coefficient of food utilized, dry weight of food offered, dry weight of leaves left un-consumed and dry weight of excreta was calculated (Table 2).

A correlation of cocoon production to food consumption and utilization was calculated along with various BRF statistics (Table 3). The magnitude of changes in correlated factors and their mathematical relationship with cocoon production was expressed by regression line drawn through the data tested with the help of chi-square values (Table 4). The exception in the cocoon produced by silkworm larvae was further exposed to Durban Watson Test to see the auto correlation in the data collected.

Results and Discussion

The multiple comparison of mean values for the weight of cocoons produced, amount of food consumed shown in Table 2 respectively and co-efficient of food utilized in Table 2.

The weight of cocoons produced was maximum against 72 (*Morus alba*) and T3 (*Ficus religiosa*) leaves (Table 2). The data on food consumption (Table 2) and its co-efficient of utilization (Table 2) revealed that the consumption and utilization had direct effect on cocoon weight (Table 2), as reported by Saleem and Haq (1984). The cocoon production was positively correlated with nutritive qualities of the host plants tested. The higher cocoon production by the larvae fed on peepal and mulberry indicated a better nutritive quality of the host plants.

Correlation matrix in Table 3 revealed that the correlation in changes of the amount of different test plants consumed

Table 2: Multiple comparison of mean values of various estimates.

Treatment	A Cocoon Wt. (gins)	B L.consumed (gms)	C Food utilization (%)	D L.offered (gms)	E Unconsumed Leaves (gms)	F Excreta (gms)
T3	0.33**a	0.32**a	58.40* *a	1.83	1.51	0.13
T2	0.32a	0.19 b	57.40 a	1.54	1.35	0.08
T5	0.16 b	0.06 cd	33.20 b	0.8	0.74	0.04
T6	0.14 b	0.08 cd	25.40 bc	0.55	0.47	0.06
T1	0.07 bc	0.06 cd	22.30 c	1.92	1.87	0.05
T4	0.04 c	0.05 d	32.80 b	1.75	1.7	0.03
T7	0.03 c	0.10 c	29.40 bc	1.3	1.2	0.07

Table 3: Correlation matrix

Character	1	2	3	4	5	6
Cocoon wt.	1.00000					
Consumption	0.64758**	1.00000				
Utilization	0.75573**	0.73953**	1.00000			
Offered leaves (dry wt. gms.)	0.09136**	0.32915**	0.30433**	1.00000		
Unconsumed (dry wt.gms)	-0.03694**	0.14172**	0.16789***	0.98109**	1.00000	
Excreta (dry wt.gms)	0.47567**	0.92467**	0.16789**	0.22809**	0.04996**	1.000

Table 4: A statistical impact of different characters on the cocoon produced.

Parameters	Variables	B-value	F-value	Req-change
Cocoon wt.	Y	0.2379	0.026 n.s.	0.0004
Food Consumption	X1	0.0052	3.509 n.s.	0.5711
Food utilization	X2	0.3263	0.057 n.s.	0.019
Leaves offered	X3	-0.3771	0.076 n.s.	0.0276
Leaves unconsumed	X4	-0.6029	0.076 n.s.	0.0006
Excreta	X5			
Overall			9.410**	0.6187
CHI-Sq. Value		5.59 n.s.		
Durbin-watson value		1.5403		

Significant at one percent level; n.s. = Non significant

Table 5: Chemical Analysis

Elements	Mulberry Leaves	Peepal Leaves	Peepal Fruit
Crude Fiber	361.80	312.30	335.00
Protein	162.50	125.00	75.00
Oil Contents	137.40	123.00	113.00
Mineral Matters	76.10	89.20	105.00
Nitrogen	2.60	0.00	12.00
Potash	24.40	34.80	41.60
Magnesium	16.50	14.80	11.00
Calcium	6.80	2.20	1.70
Phosphorus	5.40	5.80	7.00
Iron	1.48	0.58	0.18
Copper	0.20	0.20	0.19
Manganese	0.15	0.05	0.04
Zinc	0.10	0.90	0.07

(Table 3), food utilized by *Bombyx mori* L., dry weight of leaves offered, dry weight of unconsumed leaves and of those dry weight of excreta with their cocoon production was highly significant and positive in all cases except dry weight of unconsumed leaves.

The overall F-value (9.41) was a highly significant and suggested that the changes in cocoon production were very much influenced by the overall changes in food consumption and utilization. The insignificant change in the individual F-Values against various characters showed that each of them did not effect the cocoon production. A high f-ratio against X2 further suggested that change in cocoon production in relation to food utilization is quite greater than others. Overall determination co-efficient showed that food consumed had 61.87 percent impact on cocoon production. A complete view of Table 4 suggested no significant difference in observed and estimated values for the change in cocoon production.

Efforts were also made to analyze the leaves of both potential plants along with peepal fruit (Table 5). The chemical analysis of the leaves of both potential plants and fruits of peepl will further help the adepts in preparation of artificial diets for silkworm.

The climatic conditions of Pakistan are quite supportive for multivoltine strains of silkworm (Ahmad and Park, 1988). So second generation can easily be raised by providing Peeple only or a combination of both mulberry and peeple leaves, that resulted in better cocoon production.

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