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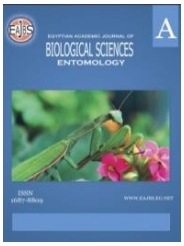

Comparison Between Some Mulberry Varieties on Silkworm, *Bombyxmori* L Economic Traits

Ghada M. Ahmed
Sericulture Research Department, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt
E.mail: ghadahamadarc@gmail.com

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ABSTRACT

Five mulberry varieties were used for tests. These varieties were *Morus alba* Linn. Var. Kaeryang- Bpong (K_1), *Morus alba* Linn. Var. Kokuso-27 (K_2), *Morus alba* Linn. Var. Canava-2 (K_3), *Morus alba* Linn. Var. Suisfen (K_4) and *Morus alba* Linn. Var. Ardnyl (K_5).

The agronomical parameters recorded, were shoot length, number shoots/tree, number leaves/ shoot, leaf /shoot ratio, weight of 100 leaf, number leaves/100g, leaf yield/tree, leaf yield/fadden and leaf moisture percentage.

Young instars duration, fourth instar duration, fifth instar duration, total larval duration, pupation ratio, cocooning percentage, number of cocoons/liters, cocoon weight, cocoon shell weight, pupal weight and cocoon shell ratio, silk productivity, length and weight of silk filament, size of reeled thread (denier) and silk ratio (silk recovery) were registered.

Biochemical analysis was done to estimate the total chlorophyll, chlorophyll A and B & ratio of chlorophyll A/B and carotenoids.

INTRODUCTION

In addition to the nature of the silkworm, specific quality requirements of worms during different phases of growth and production of eggs reflect the importance of different mulberry varieties used in feeding the silkworm. It was also reported that the nutritive effects of leaf position play a major role in the quality of silkworm growth and silk production Adeduntan (2013).

The mulberry tree is an invaluable tree of immense economic importance in the silk industry for its foliage, which constitutes the chief food for the silkworm, *Bombyx mori* L. Further, the improvement of productivity traits in mulberry plays a vital role in the progress of the sericulture industry (Dandin *et al*. 2003 and Biasiolo *et al*. 2004).

Mulberry is considered a commercial crop because its stems, leaves, roots will be used for different purposes in agricultural, industrial, and pharmaceutical purposes. In addition to cultivated lands, it is also found along road shoulders and fences as well as intercropped with other crops (Metaferia, 2007).

The mulberry silkworm *Bombyx mori* L. belonging to the family Bombycidae are of common use in sericulture. They feed solely on leaves of mulberry (*Morus alba* L.). Therefore, the quality and quantity of mulberry leaf have an intimate relationship with the health of silkworm and quality silk production (Vidyasagar and Kotresha, 2003). Humans have immensely benefited from silk produced by silkworms and subsequent researchers have always been trying to unveil the factors that can be manipulated to the benefit of the silkworm rearers (Nair *et al*., 2004). The major factors which determine the productivity and profitability in sericulture are the yield and quality of mulberry leaves (Krishnaswami, 1978). The growth and development of silkworm and the economic characters of the cocoon are influenced to a great extent by the nutritional content of mulberry leaf and this in turn influences silk production. Several reports are available on the evaluation of mulberry varieties through silkworm rearing performances (Adolkar, 2007 and Seidavi, 2011).

The experiment aims to compare five mulberry varieties, in order to determine the best variety for economic characters of the mulberry silkworm. Also, comparisons between these verities were used for plant and biochemical parameters.

MATERIALS AND METHODS

Race of mulberry silkworm name D_{162} used for investigations. It was collected from the Sericulture Research Department breeding program (Ghazy, 2014). Three replicates were used for each treatment. The silkworm larvae were reared under normal conditions the average temperature was 21.54 ºC ± 1.606 and the relative humidity was 59.27% ± 7.35. Leaves were offered four times daily. Leaves were chopped during young instars. Polythene sheets used as a cover and bottom for young instars and wet foam surrounded the silkworm larvae (Ghazy, 2008). Whole leaves and shoots were offered for fourth and fifth instars respectively.

Five mulberry varieties were used for tests. These varieties were obtained from Sericulture Research Station in El-Qanater Alkhayria- Qalioubia governorate. These varieties were *Morus alba* Linn. Var. Kaeryang- Bpong (K_1), *Morus alba* Linn. Var. Kokuso-27 (K_2), *Morus alba* Linn. Var. Canava-2 (K_3), *Morus alba* Linn. Var. Suisfen (K_4) and *Morus alba* Linn. Var. Ardnyl (K_5).

Leaves of mulberry were harvested for feeding the 5^{th} larval instar. The agronomical parameters recorded were shoot length, number shoots/tree, number leaves/shoot, leaf/shoot ratio, the weight of 100 leaves, number leaves/100 g, leaf yield/tree, leaf yield/fadden and leaf moisture percentage. The mulberry field is planted with a measure of 0.3 X 2 m.

Twenty plants were selected randomly from each mulberry variety (Hosny and Mahmoud, 2002). Leaf yield was converted to ton per feddan and crop was calculated according to the formula of (Zhen *et al*., 1988).

Leaf yield per feddan (ton)

$$= \frac{\text{Average leaf yield per plant (kg) X Actual number of plants per feddan}}{1000}$$

Young instars duration, fourth instar duration, fifth instar duration and total larval duration were recorded. Pupation ration and numbers of cocoons/liter were registered.

Cocooning percentage was calculated according to the formula of Goudar and Kaliwal (2000).

$$\text{Cocooning percentage (\%)} = \frac{\text{No. of cocoons formed}}{\text{Total number of larvae kept}} \text{X100}$$

Cocoon weight, cocoon shell weight, pupal weight and cocoon shell ratio were observed for females and males.

Silk productivity was adopted by using the following equation of Chattopadhyay *et al*. (1995).

$$\text{Silk productivity (cg)} = \frac{\text{Cocoon shell weight (cg)}}{\text{Fifth instar duration (day)}}$$

Where cg: Centigram

The length and weight of silk filament were investigated. The size of the reeled thread (denier) and silk ratio (silk recovery) were calculated as follows (Tanaka, 1964).

$$Silk\ \ filament\ \ (denier) = \frac{\text{Wt. of silk filament (g)}}{\text{Length of filament (m)}} X 9000$$

Where: Denier = Weight of reeled thread with length 9000 meters by gram. Also, silk ratio was estimated as follows:

$$Silk\ ratio = \frac{\text{Wt. of silk filament}}{\text{Wt. of dried cocoon}} X 100$$

Biochemical analysis was done to estimate the total chlorophyll, chlorophyll A and B & ratio of chlorophyll A/B and carotenoids (Holden, 1965).

Statistical analysis was applied to the collected data using SAS program (1998).

RESULTS AND DISCUSSION

Data in Table.1. showed the difference between five mulberry varieties for seven biological characters. Significant differences were detected for young instars duration, fourth duration, fifth duration, total larval duration, pupation ratio, cocooning percentage and number of cocoons/liter parameters. A variety of K_2 was the best for all the previous parameters, followed by K_4 and K_5 varieties. The performance of mulberry silkworm larvae varies according to the variety of mulberry plants used.

Table. 1. Different between five mulberry varieties for seven biological characters.

Parameters / Varieties	Young instars duration (days)	Fourth duration (days)	Fifth duration (days)	Total larval duration (days)	Pupation ratio (%)	Cocooning percentage (%)	Number of cocoons/liters
K_1	18.080	5.151	9.052	36.282	96.767	98.400	151.000
K_2	16.166	4.833	8.115	33.166	99.900	99.600	115.000
K_3	18.119	5.179	9.093	36.391	95.333	98.200	161.000
K_4	17.083	5.083	8.167	34.363	98.467	99.533	128.000
K_5	18.068	5.145	8.137	35.349	97.533	99.200	133.000
F between treatments	2418.940**	70.160**	992.090**	825.530**	34.980**	4.010*	107.810**
LSD 5%	0.055	0.053	0.051	0.149	0.918	1.021	5.578

Where: k_1, k_2, k_3, k_4, k_5, (code of mulberry varieties) & (*) significant at 0.05, (**) highly significant at 0.01.

These results are in agreement with the findings of Shifa *et al*. (2018) studied the influence of different mulberry (*Morus* spp.) varieties on the rearing performance of mulberry silkworms, *Bombyx mori* L. They reported that significantly longer larval duration was recorded in the worms fed on the local check followed by Nekemete and Jimma. However, the lowest duration was recorded when worms fed on S-13 and K-2.

Also, Pakhale *et al*. (2014) evaluated some mulberry varieties on the performance and economic traits of the mulberry silkworm. They registered that; variety BER-1 was significantly lowest larval duration over the rest of the treatments followed by variety Kanva- 2. The highest larval duration was recorded in larvae fed on leaves of S-30 variety.

Differences between five mulberry varieties for five economic characters were described in Table .2. Highly significant differences were obtained between varieties. A variety of K_2 was best for cocoon wt., cocoon shell wt., pupal wt., cocoon shell ratio and silk productivity parameters**.** It was followed by K_4, K_5 and K_1 varieties.

Table. 2. Different between five mulberry varieties for five economic characters.

Parameters / Varieties	Cocoon weight (g)	Cocoon shell weight (g)	Pupal weight (g)	Cocoon shell ratio (%)	Silk Productivity (cg)
K_1	1.035	0.203	0.831	19.731	2.243
K_2	1.376	0.302	1.080	22.119	3.717
K_3	0.967	0.185	0.787	19.288	2.033
K_4	1.295	0.268	1.033	20.872	3.278
K_5	1.211	0.242	0.966	20.167	2.968
F between varieties	168.200**	164.160**	130.160**	21.210**	252.240**
LSD 5%	0.037	0.010	0.031	0.670	0.124

Where: k_1, k_2, k_3, k_4, k_5, (code of mulberry varieties) & (*) significant at 0.05, (**) highly significant at 0.01.

The previous results agree with the results of Bahar *et al*. (2011) observed the performance of polyvoltine silkworm, *Bombyx mori* L. on different mulberry plant varieties. They stated that, statistically significant differences among different varieties on cocoon characteristics. The highest performance was observed by feeding the variety BSRM-34 in respect of the single cocoon weight, shell weight and pupal weight, followed by the average performance of varieties BSRM-57 and BSRM-59. The poorest performance was showed by feeding the variety BSRM-58.

Differences between sex and interactions between varieties & sex of five mulberry varieties for five economic characters were founded in Table.3. Significant differences appeared between sexes for cocoon wt., pupal wt., cocoon shell ratio and silk productivity. Also, there were significant differences in the interaction of cocoon wt., cocoon shell wt., pupal wt., and silk productivity parameters. Variety K_2 was the best for cocoon wt., cocoon shell wt., pupal wt., cocoon shell ratio and silk productivity parameters for females and males. There was followed by K_4, K_5, and K_1 varieties.

These results are in accordance with those founded by Koul *et al*. (1979); Tayade & Jawale (1984); Thangamani & Vivekanandan (1984); Bari *et al*. (1985) and Lalfelpuii *et al*. (2014). They stated that, mulberry variety plays a great role in the cocoon characters.

Data presented in Table. 4. represented the difference between five mulberry varieties for four technological parameters. Highly significant differences were noticed. Varieties of K_2, K_4, K_5 and K_1 were the best for the length of silk filament, the weight of silk filament, size of reeled thread and silk ratio parameters.

These results are confirmed by the results of Kasiviswanathan *et al*. (1970); Krishnaswami *et al*. (1973); Ullal & Narasimhanna (1981); Ashfaq *et al*. (2001); Machii & Katagiri (1991) and Kerenhap *et al*. (2008) they proved that, silkworm, *Bombyx mori*

L. mostly depend on the mulberry variety. The growth and development of silkworm larvae vary with mulberry variety and the variation is more in later stages than the initial stages. The variation may due to the quality or moisture content of mulberry leaves used at different stages or the nutritional composition of different varieties.

Table.3. Different between sex and interactions between varieties & sex of five mulberry varieties for five economiccharacters.

Parameters / Varieties	Cocoon wt. (g)		Cocoon shell wt. (g)		Pupal wt. (g)		Cocoon shell ratio (%)		Silk Productivity(cg)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
K_1	1.112	0.958	0.204	0.203	0.908	0.754	18.346	21.115	2.250	2.235
K_2	1.506	1.245	0.301	0.303	1.210	0.949	19.975	24.263	3.705	3.730
K_3	1.038	0.895	0.182	0.188	0.861	0.713	17.583	20.993	2.002	2.064
K_4	1.423	1.167	0.275	0.260	1.163	0.904	19.402	22.343	3.371	3.184
K_5	1.363	1.059	0.253	0.230	1.105	0.826	18.591	21.744	3.105	2.831
Mean	1.288	1.065	0.243	0.237	1.049	0.829	18.779	22.092	2.887	2.809
F Between Sex	353.080**		3.520		491.940**		236.980**		3.870*	
LSD 5%	0.023		-		0.020		0.424		0.078	
F Interaction Variety X Sex	7.150**		2.650*		8.220**		1.530		2.690*	
LSD 5%	0.056		0.011		0.051		-		0.126	

Where: k_1, k_2, k_3, k_4, k_5, (code of mulberry varieties) &v ×sex (varieties X sex) (*) significant at 0.05, (**) highly significant at 0.01

Table.4. Different between five mulberry varieties for four technologicalparameters.

Parameters / Varieties	Length of silk filament (m)	Weight of silk filament (g)	Size of reeled thread (denier)	Silk ratio (%)
K_1	774.750	0.145	1.727	35.159
K_2	927.750	0.250	2.439	43.147
K_3	748.750	0.139	1.701	33.307
K_4	914.750	0.215	2.126	41.537
K_5	909.000	0.204	2.053	38.840
F between varieties	10.160**	48.260**	13.090**	9.580**
LSD 5%	75.650	0.019	0.238	3.767

Where: k_1, k_2, k_3, k_4, k_5, (code of mulberry varieties) & (*) significant at 0.05, (**) highly significant at 0.01.

Differences between five mulberry varieties for eight plant parameters were illustrated in Table.5. Significant differences were discovered for all plant parameters under study except leaf/shoot ratio. Variety of K_2 was superior for shoot length, No. shoots/tree, No. leaves/shoot, leaf /shoot ratio, No. leaves/100 g, leaf yield/tree, and leaf yield/fadden, followed by K_4, K_5 and K_1 variety.

These results are in accordance with those founded by Yogananda Murthy *et al*. (2012) for their screening of selected mulberry (*Morus*) germplasm varieties. They declared that, mulberry varieties were evaluated for the propagation parameters, mulberry variety S_{1708} recorded the highest shoot length and shorter shoot length was recorded in C_6.

Also, Gandhi Doss *et al*. (2012) studied the development of mulberry varieties for sustainable growth and leaf yield in temperate and subtropical regions of India. They recorded that, the average annual leaf yield of these hybrids varied, the heaviest recorded

for CT-210 and the lowest showed for CT-19. The average plant height was maximum in CT-77 and minimum in CT-159. The hybrids showed significant variability in all the characters such as total shoot length, number of leaves per plant, the weight of 100 leaves and leaf yield.

Table.5. Different between five mulberry varieties for eight plant parameters.

Parameters / Varieties	Shoot length (cm)	No. shoots/ tree	No. leaves/ shoot	Leaf /Shoot Ratio	Wt. leaves /shoot (g)	No. leaves/ 100 g	Leaf yield/ tree (kg)	Leaf yield/ fadden (ton)
K_1	116.670	27.667	22.600	0.818	301.560	38.000	1.013	7.093
K_2	132.750	34.000	30.666	0.902	431.700	27.000	1.550	10.850
K_3	54.890	25.667	21.000	0.852	255.000	57.333	0.893	6.253
K_4	127.040	32.000	27.315	0.858	467.030	28.667	1.525	10.677
K_5	123.130	30.000	25.740	0.859	384.700	36.667	1.301	9.109
F between varieties	18.870**	3.400*	21.990**	0.200	22.330**	34.140**	8.670**	8.670*
LSD 5%	23.100	5.676	2.574	-	59.000	6.509	0.317	2.220

Where: k_1, k_2, k_3, k_4, k_5, (code of mulberry varieties) & No. number, Wt. weight (*) significant at 0.05, (**) highly significant at 0.01.

Different between five mulberry varieties for six biochemical parameters (Table, 6). Significant differences were recorded for leaf moisture, chlorophyll A, total chlorophyll and carotenoids. And non-significant differences registered for chlorophyll B and chl. A/B ratio parameters. Regardless of the insignificant differences, the best variety were K_2, K_4, K_5 and K_1 varieties, respectively.

Table.6. Different between five mulberry varieties for six biochemical parameters.

Parameters / Varieties	Leaf moisture %	Chlorophyll A (mg/g)	Chlorophyll B (mg/g)	Total chlorophyll (mg/g)	Chlorophyll A/B ratio	Carotenoids
K_1	64.651	1.823	0.627	2.450	2.940	0.129
K_2	70.797	3.080	1.470	4.550	3.356	1.278
K_3	63.533	1.617	0.590	2.207	2.775	0.111
K_4	68.551	2.876	1.057	3.933	2.797	0.278
K_5	66.550	1.876	0.666	2.542	2.845	0.229
F Between varieties	3.770*	6.500**	2.070	9.310**	0.080	3.500*
LSD 5%	4.760	0.830	-	1.073	-	0.830

Where: k1, k2, k3, k4, k5, (code of mulberry varieties) & (*) significant at 0.05, (**) highly significant at 0.01.

Similar results are obtained by Kumar *et al*. (2018) who evaluated the leaf quality of 10 selected mulberry clones viz., BC-259, K-2, RFS-175, S-1, S-146, S-776, S-1635, S-1531, Tr8 and UP-1 through phytochemical analysis. It was apparent from the results of analysis that, moisture content and moisture retention capacity were significantly high in S-1635and lowest in CM leaves. Also, Kalaivani *et al*. (2013) evaluated that, the number of primary metabolites of mulberry leaf. Considering the chlorophyll content, MR_2 has the maximum chlorophyll content and Kanva-2 has the minimum chlorophyll-A content. Chlorophyll B is maximum MR_2 and minimum in Kanva-2. The total chlorophyll content is more in MR_2 and less in Kanva-2. The ratio between chlorophyll A and chlorophyll B is maximum in Mysore local and minimum in Kanva-2.

CONCLUSION

Results of five mulberry varieties showed significant differences for young instars duration, fourth duration, fifth duration, total larval duration, pupation ratio, cocooning percentage, number of cocoons/liters, cocoon weight, cocoon shell weight, pupal weight, cocoon shell ratio, silk productivity parameters. A variety of K_2 was the best for all the previous parameters, followed by K_4 and K_5 varieties.

It is clear that, silkworm characters vary due to the varied plant variety which differed in nutrient, quality and total biochemical composition of the leaf.

Plant parameters represented significant differences for plant parameters under study except for the leaf /shoot ratio. Variety of K_2 was superior for shoot length, No. shoots/tree, No. leaves/ shoot, leaf /shoot ratio, No. leaves/100 g, leaf yield/tree, and leaf yield/fadden, followed by K_4, K_5 and K_1 variety.

Leaf moisture, chlorophyll A, total chlorophyll and carotenoids parameters obvious that, significant differences. While non-significant differences were detected for chlorophyll B and chlorophyll A/B ratio parameters. Generally, the best varieties were K_2, K_4, K_5 and K_1 varieties, respectively. From the previous results, varieties of *Morus alba* Linn. Var. Kokuso-27 (K_2), *Morus alba* Linn. Var. Suisfen (K_4) and *Morus alba* Linn. Var. Ardnyl (K_5) were recommended for silkworm rearing to raise silk production.

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ARABIC SUMMARY

مقارنة بين بعض أصناف التوت على الصفات الإقتصادية لديدان الحرير *Bombyx mori L*

غادةمحموداحمد

قسم بحوث الحرير- معهد بحوث وقاية النباتات - مركز البحوث الزراعية- الجيزة - مصر.

تم إختبار خمسه أصناف من التوت و هم (*Morus alba* Linn. Var Kaeryang -Bpong (K_1), *Morus alba* Linn. Var. Kokuso-27 (K_2), *Morus alba* Linn. Var. Canava-2 (K_3), *Morus alba* Linn. Var. Suisfen (K_4) and *Morus alba* Linn. Var. Ardnyl (K_5). و ذلكبتسجيل بعض القياسات النباتيه لهم و هي طول الأفرع ، عدد الأفرع لكل شجرة ، عدد الأوراق لكل فرع ، نسبه الأوراق الي الفروع ، وزن 100 ورقه ، عدد الأوراق في 100 جرام ، محصول الأوراق لكل شجرة ، محصول الأوراق لكل فدان و حساب نسبه الرطوبه في الأوراق.

كما تم تسجيل كلا من طول العمر اليرقي للاعمار الصغيرة ، طول العمر اليرقي للعمرالرابع ،طول العمر اليرقي للعمر الخامس ، طول الطور اليرقي ، نسبه التعذير، نسبه التشرنق ،عدد الشرانق في اللتر، وزن الشرنقة، وزن غلاف الشرنقة، وزن العذاري ، نسبه المحتوي الحريري و إنتاجيه الحرير، طول و وزن خيط الحرير، قياس حجم الخيط المحلول بالدنيير و نسبه الحرير. بالإضافة الي بعض القياسات البيوكميائيه و تتمثل في قياس كلا من الكلوروفيل الكلي، الكلوروفيل A، الكلوروفيلB ،النسبه بين الكلوروفيل A إلي الكلوروفيل B و الكاروتينات.