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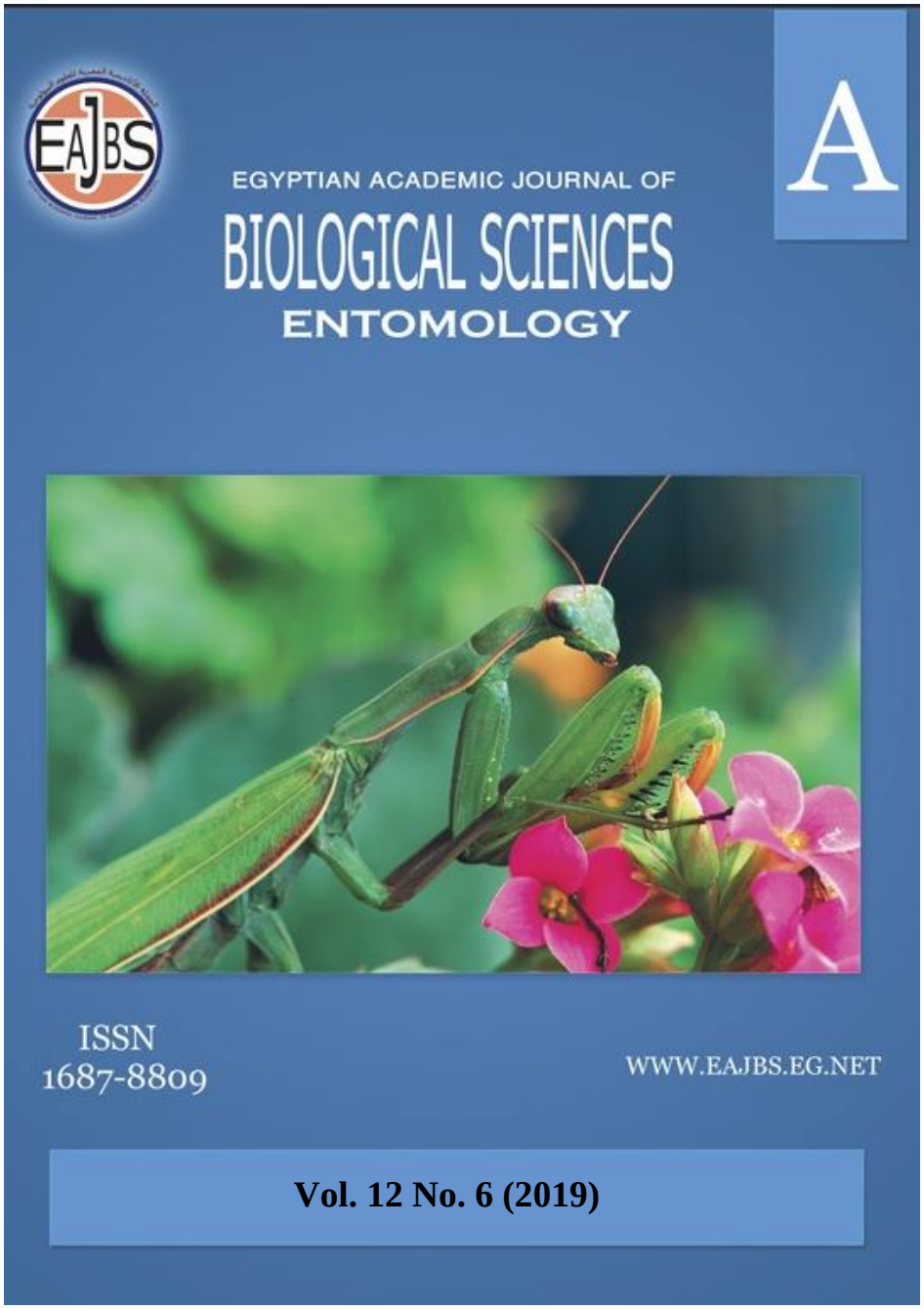

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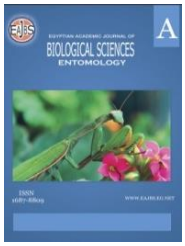

Influence of Different Mulberry Varieties on Food Consumption and Utilization of Silkworm, *Bombyx mori* L.

Ghada. M. Ahmed
Sericulture Research Department, Plant Protection Research Institute, Agric. Res. Center, Giza, Egypt.
Email: ghadahamadarc@gmail.com

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Mulberry, Varieties, Silkworm *Bombyx mori* L., *Morus alba*, food utilization.

ABSTRACT

Quality of mulberry varieties is affected the cocoon production. Selection of the best variety for rearing is primary key for successful rearing. Five mulberry varieties were investigated intend *Morus alba* Linn. Var. Kokuso-27 (M_1), *Morus alba* Linn. Var. Kaeryang- Bbong (M_2), *Morus alba* Linn. Var. Canava-2 (M_3), *Morus alba* Linn. Var. Ardnyl (M_4) and *Morus alba* Linn. Var. Suisfen (M_5). Characters of larval weight during third, fourth and fifth instars, growth rate, consumed food, approximate weight of food digested (AD), approximate digestibility (AD%), efficiency of conversion of ingested food to body substance (ECI), efficiency of conversion of food digested to body matter (ECD) of fourth and fifth instars, consumed food and fresh cocoon yield per 1000 larvae and leaf /cocoon ratio were investigated for all varieties under study. The results revealed that M_1 and M_5 have better mean values for larval weight during third, fourth and fifth instars, growth rate, consumed food, efficiency of conversion of ingested food to body substance (ECI) and efficiency of conversion of food digested to body matter (ECD) of fourth and fifth instars. As well as, varieties of M_1 and M_5 were best for approximate weight of food digested (AD), approximate digestibility (AD%) for fourth and fifth instars, leaf/cocoon ratio because of it earned the lowest average.

INTRODUCTION

Mulberry varieties are different in nutritional and water contents. Silkworm productivity is influenced by the nutritional value and water content of mulberry leaves. The mulberry silkworm, *Bombyx mori*, is a domesticated and monophagous insect, which feeds only on the leaves of mulberry for its nutrition. The mulberry leaves mainly constitute proteins, carbohydrates, vitamins, sterols, phagostimulants and minerals (Ramesha *et al*. 2010).

Optimize silk production in all seasons of the year. The raw materials required for silk synthesis, that is, amino acids and energy are derived from the leaf proteins consumed during 5^{th} instar. Hence, in the present investigation, a combined effect of leaf quality and rearing season on the rate of consumption and utilization of food by the selected silkworm races (Maribashetty *et al*. 1991). The enrichment of mulberry leaves with the aim of increasing the

production of the cocoon is a very important aspect (Islam *et al*. 2004). Generally, vitamins present in the mulberry leaves fulfill the minimum needs of silkworms but the amount of vitamins present in mulberry leaves diverges on the basis of environmental conditions, usage of fertilizers in the field, and mulberry varieties, and other field practices (Ito, 1978).

Studies aim to evaluate five mulberry verities and demined the best variety for silkworm rearing. Increase the profit of mulberry silkworm rearing activity.

MATERIALS AND METHODS

Five mulberry varieties were obtained from sericulture research department –plant protection research institute- Egypt. It were *Morus alba* Linn. Var. Kokuso-27 (M_1), *Morus alba* Linn. Var. Kaeryang- Bbong (M_2), *Morus alba* Linn. Var. Canava-2 (M_3), *Morus alba* Linn. Var. Ardnyl (M_4) and *Morus alba* Linn. Var. Suisfen (M_5).

Eggs of silkworm, *Bombyx mori* L. hybrid of Giza C (K_{232} X R_{153}) was obtained from sericulture research department Giza – Egypt. Three replicates were adopted for each mulberry variety. Each replicate was containing three hundred larvae. Plastic sheets, foam, and chopped mulberry leaves were used for young silkworms (Ghazy, 2008). Whole leaves offered during fourth and fifth instars. Mulberry variety used for fed the young and grown silkworm larvae. Average room temperature was 21.54 ±1.60 ºC and humidity percentage was 59.27 ± 7.35%.

Growth rate measured as the gain in weight over the initial weight at the 4^{th} and 5^{th} instars was calculated according to the following equation of (Waldbauer, 1968) as follows.

$$\textbf{Growth rate} = \frac{\text{Weight gained during the period}}{\text{Duration of the period (days) X Mean of insect weight}}$$

Larvae were weighed at the end of third and fourth instars. As well as the matured larvae were weighed.

Food consumed, ingested, digested, and converted in to dry matter and indices were determined using the standard gravimetric methods of Waldbaur (1964).

Estimation of the mean weight of fresh food consumed by 4^{th} and 5^{th} larval instar of the different mulberry leave varieties were determined as follow:

1. **Approximate weight of food digested (AD)**

   (AD) = Weight of consumed food - Weight of fresh remnant

2. **Approximate digestibility (AD%)**

$$\textbf{(AD\%)} = \frac{\text{Approximate weight of food digested}}{\text{Weight of consumed food}} \times 100$$

3. **Efficiency of conversion of ingested food to body substances (ECI)**

$$\textbf{(ECI)} = \frac{\text{Increase in weight of larvae}}{\text{Weight of consumed food}} \times 100$$

4. **Efficiency of conversion of food digested to body matter (ECD)**

$$\textbf{(ECD)} = \frac{\text{Increase in weight of larvae}}{\text{Approximate weight of food digested}} \times 100$$

Weight of fresh remnant = Weight of dry remnant X Blank

$$\textbf{Blank} = \frac{\text{Total weight of fresh leaves fed to the larvae during an instar}}{\text{Weight of dry leaves in the control tray at the end of the same instar.}}$$

Leaf /Cocoon ratio was calculated according (Sannappa *et al*. 2000). Registered data were analyzed using SAS program (1998).

RESULTS AND DISCUSSION

Data in Table 1. showed the effect of some mulberry varieties on larval weight of silkworm. Highly significant differences were obtained between treatments, instars, and interactions between treatment and instars. Best results were recorded for M_1 and M_5. Average of M_1 and M_5 were better than other varieties for weights of third, fourth, and fifth instar larvae traits.

Varieties of M_1 and M_5 were superior for larval weight during third, fourth, and fifth instars.

The previous results are in agreement with the findings of (Sajgotra *et al*. 2018) who investigate nine mulberry varieties. They stated that, a maximum larval weight was recorded in mulberry variety S-146 fed worms followed by Tr-8 fed worms.

Table (1). Effect of some mulberry varieties on larval weight of silkworm.

Treatment	Third larvae weigh (g)	Fourth larvae weigh (g)	Fifth larvae weigh (g)	Average	F Treatment	LSD 0.05	F I×T	LSD 0.05
M_1	0.133	0.587	3.514	1.411	99.710**	0.048	78.000**	0.083
M_2	0.117	0.511	2.586	1.072				
M_3	0.113	0.520	2.456	1.030				
M_4	0.120	0.503	2.722	1.115				
M_5	0.124	0.561	3.349	1.345				
Mean	0.121	0.537	2. 926					
F Instar	12899.600**							
LSD 0.05	0.083							

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

The Effect of some mulberry varieties on growth rate of silkworm was found in Table 2. Differences between treatments, instars, and interactions between treatments and instars were highly significant.

M_1 and M_5 were the best growth rate than others. Growth rate during fourth instar was faster than growth rate during fifth instar. M_1 and M_5 have a faster growth rate during fifth instars.

The growth rate of fourth and fifth instars were faster for larvae fed on M_1 and M_5 varieties.

These results are agreed with those found by (Sabhat *et al*. 2019) they evaluate three silkworm breeds and three mulberry varieties. They revealed that, a relatively higher increase in growth rate was observed in all the races on Goshoerami and Ichinose than Kokuso-20.

Table 3. represented the effect of some mulberry varieties on consumed food of silkworm. Data revealed highly significant differences between treatments, instars, and interactions between treatments and instars. Highly consumed was registered for M_1 and M_5 varieties. Also, M_1 and M_5 highly consumed by larvae during fourth and fifth instars comparing with the other varieties. Larvae of silkworm were highly consumed food of M_1 and M_5 varieties.

These results are in accordance with those found by (Koul *et al*. 1994) who examined leaf consumption of 7 varieties of mulberry of NS_2, Sujanpur, Chak majra, BC $_{259}$, TR $_{10}$, Kanva-2 and Ichinose. The maximum leaf consumption/4th instar larvae of *Bombyx mori* in

BC 259, whereas the minimum leaf consumption was on Chak majra. The same results were obtained in 5th instar larvae.

Table (2). Effect of some mulberry varieties on growth rate of silkworm.

Treatment	Fourth growth rate	Fifth growth rate	Average	F Treatment	LSD 0.05	F I×T	LSD 0.05
M_1	0.110	0.104	0.107	45.25**	0.002	55.53**	0.002
M_2	0.110	0.089	0.099				
M_3	0.111	0.88	0.0995				
M_4	0.108	0.102	0.105				
M_5	0.110	0.104	0.108				
Means	0.110	0.097					
F Instar	599.060**						
LSD 0.05	0.001						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

Table (3): Effect of some mulberry varieties on consumed food of silkworm**.**

Treatment	Fourth consumed food (g)	Fifth consumed food (g)	Average	F Treatment	LSD 0.05	F I×T	LSD 0.05
M_1	3.786	13.600	8.691	124.660**	0.324	49.020**	0.458
M_2	2.830	10.079	6.455				
M_3	2.713	9.173	5.943				
M_4	2.850	12.151	7.500				
M_5	3.713	13.374	8544				
Means	3.178	11.675					
F Instar	7501.97**						
LSD 0.05	0.205						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

Effect of some mulberry varieties on approximate weight of food digested (AD) of silkworm were observed inTable 4.

Lowest average of approximate weight of food digested (AD) obtained for M_1 and M_5. Also, AD for fifth instar was higher than fourth instar. In addition, M_1 and M_5 were lower AD during fourth and fifth instars.

Approximate weight of food digested (AD) registered low average for M_1 and M_5 varieties for both fourth and fifth instars.

These results are supported by (Sabhat *et al*. 2019) they reared three silkworm breeds namely, SK_1, SH_6, and NB_4D_2 on three different mulberry varieties such as Ichinose, Kokuso -20 and Goshoerami under temperate climates of Kashmir. They found that the leaf digestion of all the races was relatively higher on Goshoerami followed by Ichinose and Kokuso-20.

Data calculated in Table 5. appeared the effect of some mulberry varieties on approximate digestibility (AD%) of silkworm. Minimum approximate digestibility (AD %) was found for M_1 and M_5 varieties. Fourth AD% was higher than fifth AD%.

Regardless the insignificant for interactions between treatment and instars, the M_1 and M_5 were lowest AD% for fourth and fifth instars.

The approximate digestibility (AD %) was lowest for M_1 and M_5 varieties for fourth and fifth instars.

The previous results proved by the findings of Kumar and Kumar, 2011 observed eleven mulberry varieties. They concluded that the digestibility ranged from 30.49 to 41.82% with highest of 41.82% recorded for V-1 and the lowest of 30.49% recorded for V-2.

Table 4: Effect of some mulberry varieties on approximate weight of food digested (AD) of silkworm.

Treatment	Fourth AD (g)	Fifth AD (g)	Average	F Treatment	LSD 0.05	F I× T	LSD 0.05
M_1	1.063	3.056	2.060	14.680**	0.876	5.260**	1.238
M_2	2.033	7.108	4.571				
M_3	2.359	7.270	4.828				
M_4	1.837	5.877	3.857				
M_5	1.686	4.400	3.043				
Mean	1.795	5.542					
F Instar	199.750**						
LSD 0.05	0.554						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01

Table 5: Effect of some mulberry varieties on approximate digestibility (AD %) of silkworm.

Treatment	Fourth AD (%)	Fifth AD (%)	Average	F Treatment	LSD 0.05	F I× T	LSD 0.05
M_1	28.186	22.412	25.299	118.310**	6.347	1.180	-
M_2	71.844	70.526	71.185				
M_3	86.952	79.543	83.248				
M_4	64.462	56.648	60.555				
M_5	47.192	32.903	40.048				
Means	59.727	52.406					
F Instar	14.470**						
LSD 0.05	4.014						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

Efficiency of conversion of ingested food to body substance (ECI) of silkworm for some mulberry varieties was listed in Table 6. No significant differences were detected. M_1 and M_5 have best average. Same results obtained for the interaction. The M_1 and M_5 have best ECI for fourth instar and fifth instar.

Efficiency of conversion of ingested food to body substance (ECI) revealed highest mean for M_1 and M_5 varieties for fourth and fifth instars.

These results are proved by Ahmed (1999) and Prabhakara *et al.* (2000) confirmed the differences the rate of ECI when larvae were fed on different mulberry varieties.

Table 7. showed the effect of some mulberry varieties on efficiency of conversion of food digested to body matter (ECD) of silkworm. M_1 and M_5 earned highest average. They have the highest mean for fourth and fifth instars.

Efficiency of conversion of food digested to body matter (ECD) of silkworm showed the highest values for M_1 and M_5 varieties.

These results are coincidence with the results of (Ruth *et al*. 2019) who stated that, significant variations were observed in the ECI and ECD parameters between the silkworm strains and mulberry varieties. High ECI and ECD were recorded in the SK_6 x SK_7 strain reared on Hmute mulberry varieties.

Table 6: Effect of some mulberry varieties on efficiency of conversion of ingested food to body substance (ECI) of silkworm.

Treatment	Fourth ECI (%)	Fifth ECI (%)	Average	F Treatment	LSD 0.05	F I× T	LSD 0.05
M_1	14.671	12.687	13.679	2.650	-	0.100	-
M_2	11.305	10.397	10.851				
M_3	10.672	9.635	10.153				
M_4	12.230	10.515	11.373				
M_5	13.002	12.280	12.641				
Means	12.376	11.102					
F Instar	2.68						
LSD 0.05	-						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

Table 7: Effect of some mulberry varieties on efficiency of conversion of digested to body matter (ECD) of silkworm.

Treatment	Fourth ECD (%)	Fifth ECD (%)	Average	F Treatment	LSD 0.05	F I×T	LSD 0.05
M_1	56.869	58.281	57.575	44.640**	8.234	0.66	-
M_2	15.701	14.743	15.222				
M_3	12.235	12.117	12.176				
M_4	18.967	18.503	18.735				
M_5	27.514	37.389	32.452				
Means	26.257	28.206					
F Instar	0.610						
LSD 0.05	-						

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & T × I (Treatment X Instar) (*) significant at 0.05, (**) highly significant at 0.01.

Effect of some mulberry varieties on leaf /cocoon ratio of silkworm was checked Table 8. M_1 and M_5 obtained highest of consumed food and fresh cocoon yield per 1000 larvae. The same varieties have the lowest leaf /cocoon ratio.

Varieties of M_1 and M_5 represented best means of leaf /cocoon ratio. These results are in agreement with those found by Rathod *et al*. (2015) there was significantly highest cocoon yield of treatment T_2 that is the sole feeding the leaves of mulberry variety V_1. The significantly lowest cocoon yield was obtained in treatment T_1 that the larvae fed on the leaves of M_5.

And, Jayaramaiah and Sannappa (2005) reported that leaf/cocoon ratio was higher in Karnataka India (30-35: 1) comparing to the same in Japan (15-18: 1).

Table 8: Effect of some mulberry varieties on leaf /cocoon ratio of silkworm

Treatment	Consumed food / 1000 larvae (Kg)	Fresh cocoon yield / 1000 larvae (Kg)	Leaf /cocoon ratio
M_1	17.491	1.397	12.518
M_2	13.097	0.899	15.053
M_3	12.027	0.763	15.821
M_4	15.304	1.050	14.740
M_5	17.214	1.254	13.785
F Treatment	129.380**	14.640**	1.180
LSD 0.05	0.674	0.212	-

Where: M_1, M_2, M_3, M_4, M_5, (code of mulberry varieties) & (*) significant at 0.05, (**) highly significant at 0.01.

CONCLUSION

Five varieties of *Morus alba* were evaluated. Varieties of *Morus alba* Linn. Var. Kokuso-27 (M_1) and *Morus alba* Linn. Var. Suisfen (M_5) acquired best results for larval weight during third, fourth and fifth instars, growth rate, consumed food, approximate weight of food digested (AD), approximate digestibility (AD%), efficiency of conversion of ingested food to body substance (ECI), efficiency of conversion of food digested to body matter (ECD) of fourth and fifth instars, fresh cocoon yield per 1000 larvae and leaf /cocoon ratio. So, the M_1 and M_5 recommend cultivating instead of the local variety. As well as, recommended planting these varieties in new fields.

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ARABIC SUMMARY

تأثير أصناف مختلفه من التوت على كفاءة التغذية والإستفادة لديدان الحرير التوتيه ***Bombyx mori* L**

غادة محمود احمد

قسم بحوث الحرير - معهد بحوث وقاية النباتات - مركز البحوث الزراعية

تؤثر جودة أصناف التوت على إنتاج الشرانق. فالإختيار الأفضل لأصناف التوت يعتبر المفتاح الأساسي لنجاح التربية . فقد تم فحص خمسة أصناف من نبات التوت وهم

Morus alba Linn. Var. Kokuso-27 (M_1), *Morus alba* Linn. Var. Kaeryang- Bbong (M_2), *Morus alba* Linn. Var. Canava-2 (M_3), *Morus alba* Linn. Var. Ardnyl (M_4)and *Morus alba* Linn. Var. Suisfen (M_5).

تم فحص صفات وزن اليرقات خلال العمر الثالث، الرابع، الخامس، معدل النمو، الغذاء المستهلك، الوزن التقريبي للغذاء المهضوم (AD)، قابليه الهضم التقريبيه (% AD)، كفاءه تحويل الغذاء المبتلع لكتله الجسم (ECI)، كفاءة تحويل الغذاء المهضوم لكتله الجسم (ECD) وذلك للعمرين الرابع والخامس، الغذاء المستهلك لكل ١٠٠٠ يرقه، محصول الشرانق الناتج من ١٠٠٠ يرقه وكذلك نسبه الأوراق / الشرانق لجميع الأصناف قيد الدراسة.

أوضحت النتائج أن الصنفين (M_1) و (M_5) لديهما أفضل قيم بالنسبه لمتوسط وزن اليرقات خلال العمر الثالث، الرابع، الخامس، معدل النمو، الغذاء المستهلك، كفاءه تحويل الغذاء المبتلع لكتله الجسم (ECI)، كفاءة تحويل الغذاء المهضوم لكتله الجسم (ECD) للأعمار الرابع والخامس. بالإضافة إلي ذلك، الصنفين ((M_1 و (M_5) هم أفضل الأصناف في الوزن التقريبي للغذاء المهضوم (AD)، قابليه الهضم التقريبيه ((% AD للأعمار الرابع و الخامس و كذلك نسبه الأوراق / الشرانق لأنها سجلت أقل متوسط.