J. Agric. Sci. Mansoura Univ., 32 (11): 9231 - 9242, 2007

EFFECT OF FEEDING WITH DIFFERENT VARIETIES OF MULBERRY LEAVES ON MORPHO-PHYSIOLOGICAL AND PRODUCTIVITY CHARACTERS OF SILKWORM (*Bombyx mori*, L.) BREEDS.

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ABSTRACT

Feeding silkworm breeds on four mulberry leaves varieties had a clear effect on:

1- Silkgland soluble protein and enzymes:

In general, silkworm breed EM_6 manifested the highest soluble protein and increased GPT activity in the silkgland, while, the lowest one was noticed in breed JH_3. In addition, feeding larvae on leaves of Moritiana and Kokuso-27 increased soluble protein and GPT activity; while, feeding Balady variety decreased soluble protein and hydrdyzing enzymes glutamic pyruvic transaminase (GPT) and glutamic ozaloacetic transaminase (GOT).

Breed JH_3 manifested the least levels of trehalase, amylase and invertase enzymes activities, while feeding larvae on other three breeds on leaves of Kokuso-27, Balady and Moritiana varieties increased (in descending order) the silkgland enzymes, while variety Kanva –2 recorded the minimum value.

2- Cocoon parameters:

Weight of fresh cocoon and cocoon shell weight were significantly affected by both of mulberry varieties and silkworm breeds, as feeding with Kanva-2 variety recorded the highest values. Also silk content ratio of fresh cocoon was increased in larvae fed on Kanva variety, while it was affected by silkworm breeds. Accordingly, leaves of Kanva-2 variety and breed JH_3 proved to be the most economic in this concern.

3- Silk filament characters:

Silkworm breed EM_6 and mulberry leaves Kanva-2 variety induced the longest of reeled filament and / or the heaviest weight of silk filament. However, size of silk filament was not affected either with silkworm breeds or mulberry varieties.

INTRODUCTION

The quality of mulberry leaves affects noticeably the growth and development of silkworm larvae, beside some morphomatrical and physiological parameters of silkgland, and directly related to the protein content in mulberry leaves. Meanwhile, the deficiencies in nitrogen, phosphorus and potassium as nutrients varied in varieties of mulberry leaves in turn affected the growth and economic characters of silkworm (Arseneve and Bromlei, 1957; Gabriel and Rapusas 1976 and Qader *et al*., 1992). As such, the nutritive values of mulberry leaves is correlated with the highest production efficiency of cocoon shell and higher cocoon weight, higher shell weight and a higher efficiency affecting of cocoon production directly affected by mulberry varieties (Coteanu and Rusu, 1989; Machii and Katagiri, 1991; Sarkar and Fujita, 1994; Qader, 1995 and Mahmoud, 2000).

The nutritive value of mulberry leaves seemed to affect the morphometry and the physiology of silkglands (Qader *et al*., 1995 and Mahmoud, 2000).

The present work was therefore, undertaken to investigate the effect of feeding four mulberry varieties on three bivoltine silkworm breeds concerning some morpho-physiological and productivity characters of silkworm such as silkgland soluble protein enzymes and cocoon silk filament characters.

MATERIALS AND METHODS

The present study was carried out during 1998 and 1999, seasons in the laboratories of Sericultural Agro-Mier Company Assiut Governorate, and plant protection Research Institute at Zagazig; meanwhile, technological studies were carried out in the Sericultural Department at Giza .

The mulberry varieties that used were: Moritiana, Kokuso-27 and Balady (*Morus alba*) as well as the variety Kanva-2 (*Morus indica*). In addition, three bivoltine silkworm breeds (Table, 1) were used. The effect of feeding with different mulberry varieties on some biological and productivity characters of the test breeds (CG_{16}, EM_6 and JH_3) were studied in three treatments (a, b and c). Each breed was fed on leaves of one mulberry variety separately using 300 silkworm larvae each 100 for one replicate (Table, 1). So, larvae of each replicate were kept on a plastic tray (100 x70 x15 cm) under a controlled rearing room at (27± 2 ^oC) and (95± 5 RH %) for the young instars (1-3) and at (24± 2 ^oC) and (75± 5 RH %) for the last two instars.

The cocoons were harvested seven days later. Cocoons of each replicate were dried in an oven (oven temperature was raised gradually up to 80 ^oC then kept under oven maximum temperature 80 ^oC) for six hours. Such cocoons were used to study the technology characters as follows:

1. Cocoon indices:

a. fresh cocoon weight (g.)
b. Cocoon shell weight(g.)
c. Silk content % = b/a x100 (Tanaka, 1964).

2- Reeled silk filament parameters:

The weight (mg) and length (m) of reeled silk filament were measured and recorded. The size of reeled filament (denier) was estimated according to (Tanaka, 1964) formula.

Size (dn.) = weight of silk filament /length of filament (m.) x 9000

Data obtained were statistically analyzed according to Snedecor and Cochran (1976) methods using software costat program.

Physiological measurements of the silkgland:

Preparation of samples for biochemical assay:

One gram in each of three replicates was taken from secretory silkglands and put in clean Jar. The gland samples were homogenized for 3 minutes in 10 ml. distilled water using a teflon homogenizer surrounded with a jacket of crushed ice. The homogenates were centrifuged at 3500 r.p.m. for 10 minutes at 5 ^oC . The supernatant was immediately assayed to

determine total soluble protein according to Gormall *et al.* (1949). The activities of both glutamic ozaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) were determined according to Reiteman and Frankel (1957). Trehalase, amylase and invertase enzymes were recorded and described by (Ishaaya and Swiriski, 1976) method.

Chemical analysis of mulberry leaves components:

Fresh mulberry leaves of varieties Kanva-2, Kokuso-27, Moritiana and Balady were subjected to a chemical analysis to determine the leaf content of crude protein, carbohydrates and leaf water content (Table, 2 & 6).

1- Estimation of total nitrogen was carried out according to Kcoh and Meekin (1924) method.
2- The total crude protein content of the leaves was determined using Kjeldhl method (A.O.A.C. 1965).
3- Determination of the total carbohydrates was achieved according to Bermfeld (1955) method.
4- Determination of leaf moisture content (%) was made by subtracting the difference between the completely dried (in an oven at 105 ^{o}C till the constant weight) and fresh leaves weight.

Table (1): The set of experiments of rearing the three silkworm breeds (CG_{16}, EM_6 and JH_3) on the leaves of mulberry varieties Kanva-2, Kokuso-27, Moritiana and Balady during autumn, 1998 at Agr-Mier lab, Assiut, Governorate.

Silkworm breeds / Mulberry varieties		CG_{16} (1)	EM_6 (2)	JH_3 (3)
Kanva -2	(A)	A1	A2	A3
Kokuso- 27	(B)	B1	B2	B3
Moritiana	(C)	C1	C2	C3
Balady	(D)	D1	D2	D3

Table (2): Biochemical analysis of various components presented in leaves of different mulberry varieties.

Component / Mulberry variety	N (%)	Total crude protein (%)	Total carbohydrate (%)	Moisture content (%)
Kanva -2	3.27	20.43	23.34	72.68
Kokuso -27	3.03	18.93	23.70	72.84
Moritiana	3.15	19.68	25.63	70.07
Balady	3.05	18.06	24.33	69.65

RESULTS AND DISCUSSION

1. Physiological measurements of the silkgland:

Biochemical analysis of total soluble protein and the activity of glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) enzymes in silkgland of CG_{16}, EM_6 and JH_3 breeds fed

on mulberry leaves of Kanva-2, Kokuso-27, Moritiana and Balady varieties are given in Table (3).

a. Total soluble protein in the silk gland:

The mean of total soluble protein in silk glands larvae fed with leaves of Moritiana variety induced the highest values (0.082 mg/g gland) regardless of silkworm breed. However, larvae of breed EM_6 possessed soluble protein more than other tested breeds (0.084 mg/g gland) regardless of mulberry variety. As such, the lowest values were recorded in mulberry leaves variety Kanva-2 and silkworm breed JH_3 (0.033 and 0.043 mg/g gland), respectively.

b. Activities of (GOT) and (GPT) in silkgland:

1. GPT activity:

The highest activity of GPT was noticed in the silkgland of larvae fed on Kokuso-27 mulberry variety (0.757 µm pyruvate separated/60 min/g. gland) and in silkgland of EM6 breed (0.781 µm pyruvate separated/60 min/g. gland). On the other hand, the least GPT activity (0.536 µm pyruvate separated/60 min/g. gland) was recorded in the silkgland of JH_3 larvae fed on the leaves of Balady mulberry variety.

1. GOT activity:

Obtained results clear that the activity of GOT enzymes in silkgland of larvae fed on leaves of variety Moritiana (0.068 µm pyruvate separated/60 min/g. gland) were the highest than other mulberry varieties and /or silkworm breeds.

In general, it could be concluded that silkworm breed EM6 manifested the highest soluble protein and GPT activity in its silkgland, whereas the least was detected in the gland of breed JH_3. In addition, feeding larvae on leaves of varieties Moritiana and Kokuso-27 induced higher silkgland content of soluble protein and GPT, respectively. However, feeding larvae on leaves of Balady variety caused the least content.

2. Determining the activities of carbohydrate hydrolyzing enzymes (Trehalase, amylase and Invertase) in silkgland:-

1.Trehalase enzyme:

As shown in Table (4) the mean content of trehalase enzyme in silkgland of silkworm larvae fed on mulberry varieties Kanva-2, Kokuso-27, Moritiana and Balady recorded: 63.97, 104.44, 84.86 and 65.28 µg glucose/ g gland/ min. for silkgland of breed CG_{16} ; 58.75, 77.03, 94.00 and 107.06 µg glucose/ g gland/ min. for silkgland of breed EM_6 and 63.97, 69.19, 54.83 and 57.44 µg glucose/g gland/ min. for silkgland of breed JH_3 respectively. The higher content of trehalase enzyme was recorded for silkworm larvae fed on variety Kokuso-27 (83.53 µg glucose/ g gland/ min.). and for breed EM_6 (84.21 µg glucose/ g gland/ min.).

2-Amylase enzyme:

Results in Table (4) clear that the mean content of amylase enzyme in silkgland of larvae fed on mulberry varieties of Kanva-2, Kokuso-27, Moritiana and Balady recorded 65.28, 69.20, 87.47 and 120.11 µg glucose/ g gland/ min. for silkgland of silkworm breed CG_{16}; 28.72, 77.02, 108.36 and 87.47 µg glucose/ g gland min.

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for silkgland breed EM_6 and 62.67, 58.75, 65.28 and 61.36 µg glucose/ g gland min. for silkgland of breed JH_3, respectively. It is obvious that the higher mean content of amylase enzyme was recorded with feeding on leaves of variety Balady (89.64 µg glucose/ g gland/min.), regardless of silkworm breed, and for breed CG_{16} (86.15 µg glucose/ g gland/ min.) regardless of mulberry variety.

3-Invertase enzyme:

As shown in Table (4) the mean content of invertase enzyme in silkgland of larvae of silkworm fed on varieties Kanva-2, Kokuso-27, Moritiana and Balady recorded 97.92, 104.44, 92.69 and 122.72 µg glucose/ g gland/ min. for silkgland of silkworm breed CG_{16}; 100.53, 118.53,133.16 and 139.69 µg glucose/ g gland/ min. for silkgland of silkworm breed EM_6 and 58.75, 63.97, 103.14 and 57.44 µg glucose/ g gland/ min. for silkgland of breed JH_3, respectively. It is clear that high mean of invertase enzyme was recorded for mulberry variety Moritiana (109.66 µg glucose/ g gland/ min.), and for silkworm breed EM_6 (122.98 µg glucose/ g gland/ min.). The available literature is very rare in this concern.

It could be concluded, in general, that silkworm breeds EM_6 and CG_{16} manifested the highest trehalase, invertase and amylase content in its silkgland respectively; whereas, the least was detected in the glands of breed JH_3. In addition, feeding larvae on leaves of varieties of Kokuso-27, Balady and Moritiana induced higher silk gland content of trehalase, amylase and invertase, respectively. However, feeding larvae on leaves of Kanva-2 variety caused the least silkgland content of carbohydrate hydrolyzing enzymes (trehalase, amylase and invertase).

3. Cocoon and reeled silk filament characters:

I-Cocoon indices:

Data regarding the effect of feeding larvae of silkworm breeds CG_{16}, EM_6 and JH_3 on mulberry leaves of varieties Kanva-2, Kokuso-27, Moritiana and Balady on cocoon indices are presented in Table (5).

a-Weight of fresh cocoon:

The mean weight of fresh cocoon resulted from larvae fed on mulberry leaves of varieties Kanva-2, Kokuso-27, Moritiana and Balady reached 1.775, 1.136, 1.140 and 1.048 g. for cocoon of silkworm breed CG_{16} ; 1.536, 1.349, 1.223 and 1.049 g. for cocoon of breed EM_6 and 1.678, 1.452, 1.260 and 1.392g. for cocoon of breed JH_3 , respectively.

Analysis of data revealed highly significant differences in this parameter between the tested mulberry varieties and silkworm breeds. The highest significant record was detected for breed JH_3 and with variety Kanva-2. Obtained results are in parallel with those of Coteanu and Rusu (1989) who reported that the weight of fresh cocoon ranged between 1.833-2.297 g. according to the mulberry variety. Similar trends were also reported by Pillai and Jolly (1985), Nataraju *et al.* (1989), Giridhar and Reddy (1991a,b), Petkov (1995), Basavarajappa and Savanurmath (1996) and Mohmoud, Souad (2000). On the contrary, Karimullah *et al.* (1989) reported insignificant differences in this parameter between different mulberry varieties.

b- Cocoon shell weight:

Results in Table (5) clear that the mean weight of cocoon shell of cocoon resulted from larvae fed on mulberry leaves of varieties: Kanva-2, Kokuso-27, Moritiana and Balady recorded 0.329, 0.198, 0.205 and 0.184g for cocoons of silkworm breed CG_{16}; 0.310, 0.234, 0.207 and 0.178 g for cocoons of breed EM_6 and 0.337, 0.257, 0.209 and 0.258g for cocoons of breed JH_3, respectively. It is clear that the heaviest significant weight of cocoon shell was recorded for silkworm breed JH_3 and the mulberry variety-

Table (5): Cocoon indices of three silkworm breeds affected by feeding silkworm breeds on different mulberry varieties during autumn season of 1998.

Silkworm breeds / Mulberry variety	Fresh cocoon weight (g.)				Shell cocoon weight (g.)				Silk cocoon ratio (%)			
	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean
Kanva -2	1.775	1.536	1.678	1.662	0.329	0.310	0.337	0.325	18.55	20.36	20.17	19.69
Kokuso -27	1.136	1.349	1.452	1.312	0.198	0.234	0.257	0.230	17.36	17.48	17.82	17.55
Moritiana	1.140	1.223	1.260	1.208	0.205	0.207	0.209	0.204	17.97	17.01	16.63	17.21
Balady	1.048	1.049	1.392	1.163	0.184	0.178	0.258	0.206	17.48	16.63	17.82	17.51
Mean	1.275	1.289	1.445		0.229	0.232	0.263		17.84	17.96	18.16	
LSD var.	0.0494**				0.0142**				1.2075**			
LSD breed	0.0409**				0.0091**				N.S.			
LSD var. x breed	0.0817**				1.8225**				1.631*			

Table (6): Silk filament parameters of cocoon resulted from larval as affected by feeding silkworm breeds on different mulberry varieties during autumn season of 1998.

Silkworm breeds / Mulberry variety	Silk filament length (m)				Silk filament weight (g)				Silk filament size (dn.)			
	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean
Kanva -2	925.00	861.66	902.16	896.27	0.2210	0.1717	0.1805	0.1911	2.16	1.80	1.81	1.92
Kokuso -27	735.83	916.66	892.50	848.33	0.1448	0.1796	0.1874	0.1706	1.76	1.61	1.89	1.80
Moritiana	638.33	803.33	704.16	715.27	0.1248	0.1654	0.1559	0.1487	1.75	1.92	2.02	1.89
Balady	455.83	665.00	551.66	557.50	0.0987	0.1453	0.1174	0.1205	1.96	1.90	1.90	1.92
Mean	688.75	811.66	762.62		0.1473	0.1655	0.1603		1.91	1.84	1.90	
LSD var.	45.445**				0.0229**				N.S.			
LSD breed	34.505**				N.S.				N.S.			
LSD var. x breed	69.0141**				4.0510*				N.S.			

Kanva-2, while the least was recorded for breed CG_{16} and varieties Balady and Moritiana. Data of the present work are in partial accordance with those of Machii and Katagiri (1991 and Sarkar and Fujita (1994). However, the present results are comparably lower than those of Coteanu and Rusu (1989) who stated that this parameter ranged between 374-450 mg for the tested varieties and this variation may be due to the varied varieties of

mulberry and races of silkworm. Rearing conditions may also contribute, in this respect.

c-Silk content % :

As shown in Table (6), the mean silk content % of fresh cocoon resulted from larvae reared on mulberry varieties Kanva-2, Kokuso-27, Moritiana and Balady recorded 18.55, 17.36, 17.97 and 17.48 % for cocoon of silkworm breed CG_{16}; 20.36, 17.48, 17.01 and 16.63 % for cocoon of silkworm breed EM_6 and 20.17, 17.82, 16.63 and 17.82 % for cocoon of silkworm breed JH_3, respectively. It is obvious that the feeding silkworm larvae on mulberry leaves of variety Kanva-2 induced the highest significant silk content in the resulting cocoons. However, no significant was detected between the tested silkworm breeds.

In this connection, many authors such as Pillai and Jolly (1985), Takahashi *et al.* (1987), Giridhar and Reddy (1991 a, b) and Machii and Katagiri (1991) recorded similar variations between mulberry variety in increasing or decreasing silk content %.

Generally, it could be concluded that mulberry variety Kanva-2 is the best food for mulberry silkworm larvae for obtaining the highest cocoon indices (cocoon weight, cocoon shell weight and percent the silk content), whereas variety Balady proved to be the least in this respect. In addition, rearing silkworm breed JH_3 proved to be the most economic, as it produced the highest significant cocoon indices. The superiority of the mulberry variety Kanva-2 could be attributed to its higher content of protein (20.43 %) and moisture content (72.68 %) compared to the respective figures (18.06 and 69.65 %) found in Balady variety.

This conclusion is in agreement with those of Li and Sang (1984) who stated that the highest cocoon indices are related to the higher protein and water of the mulberry leaves fed to the larvae. Also, Arseneve and Bromlei (1957), Sarkar and Fujita (1994) and Qader (1995) stated that the nutritional value of mulberry leaves affect greatly and positively cocoon parameters. Moreover, the variation recorded between the tested mulberry varieties in this respect was also reported by Das and Vijayaraghavan (1990) and Giridhar and Reddy (1991 a, b).

2-Reeled silk filament parameters:

The reeled silk filament characters of silkworm breeds (CG_{16}, EM_6 and JH_3) fed on the leaves of mulberry varieties (Kanva-2, Kokuso-27, Moritiana and Balady) are presented in Table (6).

a-Length of reeled silk filament (m):

The mean length of reeled silk filament of cocoon spinned by full grown larvae fed on the leaves of mulberry varieties: Kanva-2, Kokuso-27, Moritiana and Balady recorded: 925, 735.83, 638.33 and 455.83 m. for cocoons of silkworm breed CG_{16} ; 861.66, 916.66, 803.33 and 665 m. for cocoons of breed EM_6 and 902.16, 892.5,704.16 and 551.66 m. for cocoons of breed JH_3, respectively. It is obvious that the differences between the three silkworm breeds and between mulberry varieties tested were significant. Generally, breed EM_6 among the three breeds tested, and variety Kanva-2

among the four varieties tested showed the highest significant length, while breed CG_{16} and variety Balady showed the least significant length of reeled silk filament.

b-Weight of silk filament (g):

The mean weight of silk filament of cocoons spun by larvae fed on mulberry leaves of varieties Kanva-2, Kokuso-27, Moritiana and Balady attained 0.2210, 0.1448, 0.1248 and 0.0987g. for cocoons of breed CG_{16}; 0.1717, 0.1796, 0.1654 and 0.1453 g. for cocoons of breed EM_6 and 0.1805, 0.1874, 0.1559 and 0.1174 g. for cocoons of breed JH_3, respectively. Significant differences were noticed between mulberry varieties, being the highest for Kanva-2 and the least for Balady variety. On the contrary, the differences between the three silkworm breeds tested were insignificant.

c-Size of silk filament (dn.):

Data presented in Table (6) revealed that the mean size of reeled silk filament spun by larvae fed on leaves of mulberry varieties: Kanva-2, Kokuso-27, Moritiana and Balady recorded: 2.16, 1.76, 1.75 and 1.96 dn. for cocoons of breed CG_{16}; 1.80, 1.61,1.92 and 1.90 dn. for cocoons of breed EM_6 and 1.81, 1.89, 2.02 and 1.90 dn. for cocoons of breed JH_3, respectively. It is clear that the differences between mulberry varieties and between silkworm breeds tested were insignificant.

Data concerning reeled filament characters in the present work varied according to the mulberry variety fed to the larvae. This statement is in accordance with that of Bheemanna *et al.*(1989 c) and Qader (1995). In conclusion, mulberry variety Kanva-2 proved to be the most suitable variety for feeding silkworm larvae to gain the highest reelable silk filament technological parameters. On the other hand, variety Balady is not recommended for economic rearing of mulberry silkworm due the reduced silk filament characters obtained and this conclusion could be attributed to the highest protein and moisture content of Kanva-2, and the inverse is true for Balady variety (Tables: 2&6).This atement is spun by that of Li and Sang (1984), Sarkar and Fujita (1994) and Qader (1995).

Discussing the data obtained concerning the cocoon and reelable silk filament characters revealed the following remarks:

Although the cocoon shell weight is higher in cocoons of breed JH_3 (0.263 g.) than those of breed EM_6 (0.232 g.), yet the silk filament length (811.66 m.) and weight (0.1655 g.) in the later are greater than that of the former which recorded (762.62 m and 0.1603 g.), respectively. The sole interpretation of this phenomenon in silk filament is that the thickness of the sericine layer surrounding the fibroin are greater, so most of these layers are molten in the boiling water during cocoon cooking in preparation for reeling process.

Feeding silkworm larvae on the mulberry leaves of variety Kanva-2 induced the highest fresh cocoon weight, shell weight, silk filament length, silk weight and silkgland weight, however it showed the least soluble protein and the carbohydrate hydrolyzing enzymes; i.e. of trehalase. amylase and invertase of the silkgland and this may be due to its least content of carbohydrate among the tested mulberry varieties (Tables: 2 & 6).

The highest length and the heaviest weight of reeled silk filament of cocoons obtained from silkworm breed EM_6 were in parallel with the highest silkgland contents of soluble protein. GPT, trehalase and invertase enzymes needed to meet with the higher demand of energy for protein synthesis process taken place in the silkgland of this breed. On the contrary, breed JH_3, although it possessed the highest cocoon shell weight and silkgland weight, yet it contained the least amount of soluble protein as well as carbohydrate and protein hydrolyzing enzymes (GPT,GOT, trehalase, amylase, invertase). Therefore, it manifested relatively lower length and weight of reeled silk filament.

Feeding silkworm on the mulberry leaves of Balady variety caused the least cocoon weight, silkgland length, silk weight and protein hydrolyzing enzymes (GPT, GOT). On the other hand, it contained the highest amylase enzyme to meet with its higher carbohydrate content. Generally, the higher the crude protein and water contents in the silkgland, thoroughly the lower the carbohydrate content

In such connection, Mahmoud, (2000) found that in autumn season: rearing of silkworm larvae fed on the leaves of varieties: Kokuso-20, -27, Kanva-2 and Moritiana, that Kokuso-27 leaves contain the highest soluble sugar, starch, moisture fat and crude protein contents, while Moritiana variety possessed the least contents of all determined components.

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تأثير التغذية بأوراق أصناف مختلفة من التوت على بعض الصفات المورفومترية والفسيولوجية وإنتاجية سلالات الحرير

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أجرى هذا البحث لدراسة تأثير التغذية بأوراق أربعة أصناف من التوت على بعض الصفات المورفومترية والفسيولوجية والإنتاجية لثلاث سلالات من ديدان الحرير (CG_{16}, JH_3, EM_6) ثنائية الجيل ويمكن تلخيص النتائج المتحصل عليها كمايلى:-

1. **محتوى غدة الحرير من البروتين والأنزيمات المحللة GOT and GPT :-** سلالة ديدان الحرير EM_6 ذات غدة حرير محتواها عالى من البروتين الذائب ونشاط عالى لإنزيم GPT ، وعلى العكس وجد أن المستوى المنخفض من البروتين الذائب وانخفاض في نشاط انزيم GPT فى غدة سلالة ديدان الحرير JH_3 . وبالإضافة إلى ذلك فان تغذية اليرقات على أوراق التوت صنف Moritiana ، Kokuso-27 تؤدى إلى زيادة البروتين الذائب ونشاط عالى لإنزيم GPT ، وعلى العكس فان تغذية اليرقات على أوراق التوت البلدى تؤدى إلي انخفاض البروتين الذائب ونشاط إنزيمات GPT ، GOT. كما أوضحت النتائج المتحصل عليها أن سلالات EM_6 ، CG_{16} تمتاز غددها باحتوائها على مستويات عالية من إنزيمات الريهاليز والأميليز والانفرتيز عند مقارنتها بالسلالة JH_3 . وبالإضافة إلي ذلك فان تغذية اليرقات على أصناف Kokuso-27 ، Balady ، Moritiana تؤدى إلي زيادة محتوى غدد اليرقات من الأنزيمات فى ترتيب تنازلى فى هذه الأصناف على التوالى ، بينما تؤدى تغذية اليرقات على الصنف Kanva-2 إلى انخفاض محتوى الغدد من هذه الإنزيمات إلي أدنى حد.
2. **قياسات الشرانق** :- الوزن الطازج للشرنقة ووزن غطاء الشرنقة تتأثر تأثير معنوياً بصنف التوت وسلالة دودة الحرير وأن يرقات السلالة JH_3 ، والصنف Kanva-2 سجلت أعلى القيم فى هذا الصدد عند مقارنتها بالسلالة CG_{16} والصنف البلدى أو Moritiana، وكذلك أتضح أن النسبة المئوية لحرير الشرانق الطازجة تزداد فى اليرقات التى تغذت على صنف التوت Kanva-2 ولم تتأثر هذه الصفة بسلالة ديدان الحرير، وقد ترتبط هذه الصفة بمحتوى أوراق التوت من البروتين ونسبة الرطوبة مثل الصنف Kanva-2 تحتوى على 20.42 % بروتين ، 72.68 % ماء بالمقارنة 18.88 % بروتين ، 69.68 % ماء فى الصنف البلدى.

   وبناء على ذلك فان أوراق صنف التوت Kanva-2 وسلالة ديدان الحريرJH_3 تعتبر ذات أهمية اقتصادية فى هذا الصدد بالمقارنة بالأصناف والسلالات الأخرى.
3. **قياسات خيط الحرير**: لوحظ نفس الاتجاه أيضا فى الصفات الإنتاجية حيث وجد أن أطول وأثقل خيط حرير سجل لنفس الصنف والسلالة ، هذا ولوحظ أن سمك خيط الحرير لايتاثر باختلاف سلالة ديدان الحرير أو صنف التوت.

Table (3): Biochemical analysis of total soluble protein and protein enzymes (GPT, GOT) presented in silkgland of full grown larvae (a sample of one gram) in three mulberry silkworm breeds fed on different mulberry varieties.

Silkworm breeds / Mulberry variety	Silkgland content and enzymes activity											
	Soluble protein (mg./g.)				GPT				GOT			
	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean
Kanva -2	0.042	0.038	0.020	0.033	0.916	0.648	0.365	0.643	0.068	0.075	0.056	0.066
Kokuso -27	0.069	0.086	0.047	0.067	0.736	0.839	0.696	0.757	0.074	0.044	0.047	0.064
Moritiana	0.082	0.074	0.090	0.082	0.713	0.812	0.729	0.751	0.070	0.069	0.066	0.068
Balady	0.049	0.138	0.043	0.076	0.406	0.827	0.357	0.530	0.071	0.049	0.049	0.056
Mean	0.061	0.084	0.050		0.694	0.781	0.536		0.070	0.059	0.054	

Table (4): Biochemical analysis of three enzymes (trehalase, amylase and invertase) presented in silkgland of full grown larvae (a sample of one gram) in three mulberry silkworm breeds fed on different mulberry varieties.

Silkworm breeds / Mulberry variety	Silkgland enzymes											
	Trehalase				Amylase				Invertase			
	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean	CG_{16}	EM_6	JH_3	Mean
Kanva -2	63.97	85.75	63.97	62.23	65.28	28.72	62.67	52.22	97.92	100.53	58.75	85.73
Kokuso -27	104.44	77.03	69.19	83.55	69.20	77.02	58.75	68.32	104.44	118.53	63.97	95.64
Moritiana	84.86	94.00	54.83	77.89	87.47	108.36	65.28	27.03	92.69	133.16	103.14	109.66
Balady	65.28	107.06	57.44	76.59	120.11	87.47	61.36	89.64	122.72	139.69	57.44	106.61
Mean	79.64	84.21	61.36		86.15	75.39	62.15		104.44	122.98	70.82	