Effect of Food Additives on the Productivity of Silk Worm *Bombyx mori* L.

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ABSTRACT

The aim of the present work is to study the effect of supplementing mulberry leaves with two types of honey and palm pollen either alone or mixed at a level of different concentrations on certain biological and reproductive parameters of the mulberry silkworm *Bombyx mori* L. particularly silk and egg production. The obtained results indicated that the treatment of mulberry leaves with mixture of citrus honey and palm pollen at a level of 5mg + 1gm / 100ml water significantly increased the biological parameters in comparison with that of the control. The treatments of both mixed types of honey bee with palm pollen increased moth's productivity and gave higher values in the egg production.

INTRODUCTION

The mulberry silkworm *Bombyx mori* L. is a beneficial insect producing the finest natural silk. Silk is called the Queen of textiles. The silkworm has long been considered as a monophagous insect with mulberry leaves as a known feed for a long time. The growth rate of *Bombyx mori* L. larvae and subsequent silk production depend mainly on the nutrient content of mulberry leaves. Fukuda (1960) reported that about 70% of silk protein produced by the *B. mori* is directly derived from the protein contents of mulberry leaves. Kumaraj *et al*., (1972) mentioned that the important factor influencing the growth and production of silkworm is the nutritional factor. The silkworms *Bombyx mori* L. require certain essential carbohydrates, proteins, amino acids, fatty acids, sterols and minerals for the growth of silk gland. and higher production of egg and silk (Ito, 1978). The nutritional elements of mulberry leaves determine the growth and development of the larvae and cocoon production (Seidavi *et al.*, 2005). Many attempts have been made to improve the quality and quantity of silk. Mulberry leaves have been supplemented with various nutrients for silkworm feeding to promote silk quality and quantity. The supplementation and fortification of mulberry leaves is a recent technique in sericulture research (Murugan *et al.*, 1998). Saikatsu *et al.*, (1989). studied the effect of admixing royal jelly in artificial diets on the growth, development, weight of cocoons and the number of eggs laid by the silkworm of *B. mori*. The importance of honey in the nutrition of silkworm was reported by several works (e.g El-Hattab (1985), El-Karaksy *et al.*, (1989)and Nagda El-Sayed (1999). Moreover, Al-Zannoon *et al.*, (2008) evaluated the efficiency of two varieties of mulberry leaves (*Morus alba* var Kokuso-27 and *Morus indica* var. Kanva-2) compared withthat of *Morus alba* var. Balady (native), for adopting the best feeding schedule for *Bombyx mori* L larvae. The present work aimed to evaluate the nutritional efficiency of Carob honey (*Ceratonia siliqua*), Citrus honey (*Citrus sp*.), and palm pollen (*Phoenix sp*.) and their mixtures for determining beneficial effect of each or these substances on the productivity of *Bombyx mori* L.

MATERIALS AND METHODS

The experiment was carried out on the Chinese F1 hybrid 9F7X of mulberry silkworm *Bombyx mori* L. the insect was reared at hygrothermic conditions of 25◦c ± 2◦c and 75 ± 5 % R.H.

The larvae were fed on fresh clean mulberry leaves until 4th instar. Only the raised 5th larval instar grouped in separate trays and used in the experiment.

Substances:

Two types of honey, palm pollen and their mixtures were tested as supplementary nutrients for the silkworm *B. mori*, these substances were as follows:

Honey:

1. **Carob honey (*Ceratonia siliqua*):**

Is somewhat rare, Carob honey is dark and crystallizes easily into a soft coarse texture. It has a medium aromatic intensity. Its tastes very similar to chocolate.

2. **Citrus honey (*Citrus* sp.):**

Light amber to white, the lighter color and milder flavor coming in years when there is a copious flowering large harvest and the honey is little contaminated by other nectars.

3. **Palm pollen (*Phoenix* spp.):**

Palm pollen is a fine powder containing the microgametophytes, which produce the male gametes (sperm cells). Pollen grains have a hard coat that protects the sperm cells during the process of their

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movement from the stamens to the pistil of flowering plants.

Experimental design:

The experiments included nine of tested substance alone treatments and eighteen treatments of admixed ones in addition to control (Table 1). Every treatment was replicated three times. Each replicate contained 15 fifth instar larvae. The mulberry leaves were dipped in the prepared dilutions of abovementioned substances and demonstrated in table 1.

After the leaves being dried, they were introduced to the larvae. For control, larvae were supplied with untreated leaves.

Estimation of studied parameters:

Fresh weights of mature 5^{th} instar larvae, pupae, fresh cocoons and cocoon shells were weighted. Prior to spinning cocoons, a sample of three mature experimented larvae was dissected and the silk glands were drawn and weighted.

Randomly selected three emerged female moths of the performed treatments were allowed to mate with three male moths, each couple was kept in its numerical paper bag. After oviposition, the number of deposited eggs per female moth was counted and recorded.

Also, the effective rate of rearing (E.R.R) as calculated and recorded according to this following equation

E.R.R=No. of cocoon harvested χ 100/ total No.of larvae reared.

Data were subjected to the analysis of variance ANOVA Test and the least significant differences (LSD) at the 5% level were determined according to computer program (COSTAT) and Duncan's Multiple Range Testes modified by Steel and Torrie (1981) to compare the estimated means of the inspected paramaters at different intervals.

RESULTS AND DISCUSSION

Effect of added food additives alone and /or mixed to mulberry leaves on some biological parameters of silkworm *Bombyx mori* L.

- Effect of food additives alone:-

The results in Table, 2 illustrate the mean weights of full grown larvae and it was found to be significantly different. It is shown that the use of tested pollen rates of Po_2, Po_4 and Po_1 gave the heaviest weights of larvae (4.005, 3.75 and 3.67 g., respectively), while the mean weight of control larvae amounted to (3.56 g). The least mean weight of larvae has been achieved by using Co_1 (2.97 g).

Significant differences were noted between the measured mean weights of silk gland in the control and made treatments. A similar trend of results was determined for the estimated weight of silk gland; the heaviest weight of silk gland was achieved by Po_2 (0.51g).

Also the results showed revealed that a similar trend was attained for pupal weight, so the heaviest weight of pupa was obtained in treatment Po_2 and comprised 1.609 g. with 0.382% increase over control. The lightest weight (0.965 g.) was indicated for the treatment of Co_1 (0.965g) with a decrease -0.262 than the control.

The results in Table, 3 indicate that Po_2 and Po_4 gave the heaviest weights of cocoon and cocoon shell with an average of 1.962g, 0.61g and 1.827g, 0.515., respectively. The heaviest obtained weight of cocoon in the Po_2 treatment gave a rate of 0.312% increase over control.

Moreover, the included results in Table, 3 proved that both treatment of $Po_2$and Po_4 gave the highest number of laid eggs with an average of 509.33 and 482.33 eggs/female with 92% and 65% increase over control followed by the treatment of Po_1 and C_5 450.33 and 429.67 eggs in respect. The lowest calculated average (122.66 eggs/ female) was recorded from the Co_1 which gave minor results in most tests. Also, the greatest E.R.R. was achieved by PO1(100%)followed by C1(96.296%) and C3(96.296%).

Effect of food additives mixtures:-

Results in Table, 4 summarized the effect of the tested materials on the mean weight of larva, mean weight of silk gland and mean weight of pupa. The C_5Po_1 gave the heaviest mean of larva, silk gland and pupa weight of 4.168 g,0.538g and 1.828g., respectively with an increase 0.603%, 0.186% and 0.645% over control., respectively. The lowest weight of larva 2.833 g. was recorded for the mixture Co_3po_1 with an increase -0.732% over control.

At the same time, the weight of cocoon in experimental sets showed an increase in the weight of cocoon over the control. Whereas the highest and lowest mean weight of cocoon were observed by C_5Po_1 (2.127g) and Co_3 $PO_1$1.24 (1.24 g), respectively (Table 5).The results obtained in table (5) show that the treatment of mulberry leaves with food additives reflected on the weight of cocoon, cocoon shell and number of total eggs. The heaviest weight of cocoon shell was obtained from C5Po1 that comprised 0.413 g. with 0.156% increase over control.

The present results in Table,5 indicate that $C_5Po_1$and Co_1Po_1 gave the greatest results with an average of 735.66 and 643.66 eggs/female followed by the Co_5Po1 and c5$po_4$with 267.33% and 175.33% increase over control. The lowest calculated average (150.66 eggs/

female) was recorded from the Co_3Po_1which gave minor results in most tests. Also, the greatest E.R.R. were achieved by C_1Po_1, C_3 Po_2, C_3Po_4, C_5Po_2 and C_5Po_4 (100%) followed by Co_1Po_1, Co_3Po_4, C_1Po_2, C_1Po_4, C_5Po_1 and control (96.296%).

However, these results are in accordance with Hashida (1961) who stated that honey is a valuable agent that can be added to mulberry leaves and those reported by Nagda El-Sayed (1989 and 1994),

Table 1. The tested concentrations of adopted treatments (individuals and mixtures) of different types of tested substances

Substance	Carob honey(CO) (ml)			Citrus honey(C) (ml)		
Palm pollen (PO) (gm)	1	3	5	1	3	5
1	1g+1ml	1g+3ml	1g+5ml	1g+1ml	1g+3ml	1g+5ml
2	2g+1ml	2g+3ml	2g+5ml	2g+1ml	2g+3ml	2g+5ml
4	4g+1ml	4g+3ml	4g+5ml	4g+1ml	4g+3ml	4g+5ml

Table 2. Effect of certain food additives to mulberry leaves on some biological parameters of silkworm *Bombyx mori* L.

Treatment	Weight of larva (g)		Weight of silk gland (g)		Weight of pupa (g)		% increase over control		
							Weight of larva	Weight of silk gland	Weight of pupa
Co1	2.97	f	0.322	e	0.965	g	-0.595	-0.026	-0.262
Co3	3.037	ef	0.435	bc	1.122	f	-0.528	0.087	-0.105
Co5	3.233	e	0.427	bc	1.135	f	-0.332	0.079	-0.092
C1	3.457	d	0.455	b	1.15	f	-0.108	0.107	-0.077
C3	3.487	cd	0.375	d	1.193	e	-0.078	0.027	-0.034
C5	3.598	bcd	0.337	e	1.257	d	0.033	-0.011	0.03
Po1	3.677	bc	0.412	c	1.348	c	0.112	0.064	0.121
Po2	4.005	a	0.51	a	1.609	a	0.44	0.162	0.382
Po4	3.757	b	0.455	b	1.48	b	0.192	0.107	0.253
Cont	3.565	bcd	0.348	de	1.227	de	0	0	0
LSD .05	0.197		0.029		0.036				

Co = Carob honey, Po = Palm pollen, C = Citrus honey and Cont = Control

* Means followed with the same letter (s) are not significantly different.

Table 3. Effect of certain food additives to mulberry leaves on silk and egg production of silkworm *Bombyx mori* L.

Treatment	Weight of cocoon (g)		Weight of cocoon shell (g)		No. of total egg		% increase over control			E.R.R.
							Weight of cocoon	Weight of cocoon shell	No. of total egg	
Co1	1.24	f	0.275	c	122.67	e	-0.41	-0.072	-294.666	92.593
Co3	1.556	d	0.3	c	178.33	de	-0.094	-0.047	-239.003	96.296
Co5	1.47	e	0.303	c	263	cde	-0.18	-0.044	-154.333	88.889
C1	1.803	b	0.313	c	286	bcde	0.153	-0.034	-131.333	96.296
C3	1.703	c	0.32	c	365	abcd	0.053	-0.027	-52.333	96.296
C5	1.435	e	0.353	c	429.67	abc	-0.215	0.006	12.334	96.296
Po1	1.652	c	0.477	b	450.33	abc	0.002	0.13	33	100
Po2	1.962	a	0.61	a	509.33	a	0.312	0.263	92	96.296
Po4	1.827	b	0.515	b	482.33	ab	0.177	0.168	65	96.296
Cont	1.65	c	0.347	c	417.33	abc	0	0	0	96.296
LSD .05	0.068		0.077		181.533					

Co = Carob honey , Po = Palm pollen , C = Citrus honey and Cont = Control

E.R.R.=Effective rate of rearing %

* Means followed with the same letter (s) are not significantly different.

Table 4. Effect of certain food additives to mulberry leaves on some biological parameters of silkworm *Bombyx mori* L.

Treatment	Weight of larva (g)		Weight of silk gland (g)		Weight of pupa (g)		% increase over control		
							Weight of larva	Weight of silk gland	Weight of pupa
Co1Po1	4.063	ab	0.465	b	1.772	b	0.498	0.113	0.589
Co1Po2	3.673	fgh	0.383	ef	1.21	hi	0.108	0.031	0.027
Co1Po4	3.544	i	0.35	ghi	1.147	j	-0.021	-0.002	-0.036
Co3Po1	2.833	l	0.322	i	0.965	l	-0.732	-0.03	-0.218
Co3Po2	3.27	j	0.327	hi	1.06	k	-0.295	-0.025	-0.123
Co3Po4	3.843	cde	0.43	cd	1.335	f	0.278	0.078	0.152
Co5Po1	4.025	b	0.453	bc	1.722	c	0.46	0.101	0.539
Co5Po2	3.528	i	0.335	hi	1.115	j	-0.037	-0.017	-0.068
Co5Po4	3.54	i	0.338	hi	1.118	j	-0.025	-0.014	-0.065
C1Po1	3.898	cd	0.435	c	1.358	f	0.333	0.083	0.175
C1Po2	3.15	k	0.322	i	0.975	l	-0.415	-0.03	-0.208
C1Po4	3.762	ef	0.403	de	1.24	gh	0.197	0.051	0.057
C3Po1	3.575	ghi	0.37	fg	1.193	i	0.01	0.018	0.01
C3Po2	3.687	fg	0.397	ef	1.213	hi	0.122	0.045	0.03
C3Po4	3.955	bc	0.443	bc	1.43	e	0.39	0.091	0.247
C5Po1	4.168	a	0.538	a	1.828	a	0.603	0.186	0.645
C5Po2	3.782	def	0.407	de	1.272	g	0.217	0.055	0.089
C5Po4	4.023	b	0.447	bc	1.657	d	0.458	0.095	0.474
Cont	3.565	hi	0.352	gh	1.183	i	0	0	0
LSD .05	0.112		0.026		0.035				

Co = Carob honey, Po = Palm pollen, C = Citrus honey and Cont = Control

* Means followed with the same letter (s) are not significantly different.

Table 5. Effect of certain food additives to mulberry leaves on silk and egg production of silkworm *Bombyx mori* L.

Treatment	Weight of cocoon (g)		Weight of cocoon shell (g)		No. of total egg		% increase over control			E.R.R.
							Weight ofcocoon	Weight of cocoon shell	No. of total egg	
Co1Po1	2.127	a	0.405	a	643.67	ab	0.677	0.148	175.334	96.296
Co1Po2	1.475	g	0.278	fg	536.33	bc	0.025	0.021	68	88.889
Co1Po4	1.447	hi	0.238	gh	372.33	de	-0.003	-0.019	-96	85.185
Co3Po1	1.24	k	0.068	j	150.67	f	-0.21	-0.189	-317.666	92.593
Co3Po2	1.25	k	0.128	i	256	ef	-0.2	-0.129	-212.333	85.185
Co3Po4	1.608	de	0.307	cdef	558.33	bc	0.158	0.05	90	96.296
Co5Po1	2.01	b	0.395	ab	618.33	abc	0.56	0.138	150	85.185
Co5Po2	1.34	j	0.14	i	263	ef	-0.11	-0.117	-205.333	81.481
Co5Po4	1.44	i	0.203	h	356	de	-0.01	-0.054	-112.333	88.889
C1Po1	1.633	cd	0.332	cde	578.67	abc	0.183	0.075	110.334	100
C1Po2	1.247	k	0.078	j	227.67	ef	-0.203	-0.179	-240.666	96.296
C1Po4	1.537	f	0.293	ef	544.33	bc	0.087	0.036	76	96.296
C3Po1	1.473	gh	0.275	fg	497	bcd	0.023	0.018	28.667	92.593
C3Po2	1.517	f	0.287	efg	539	bc	0.067	0.03	70.667	100
C3Po4	1.635	cd	0.343	cd	590	abc	0.185	0.086	121.667	100
C5Po1	2.127	a	0.413	a	735.67	a	0.677	0.156	267.334	96.296
C5Po2	1.583	e	0.298	def	553	bc	0.133	0.041	84.667	100
C5Po4	1.645	c	0.353	bc	607.67	abc	0.195	0.096	139.334	100
Cont	1.45	ghi	0.257	fg	468.33	cd	0	0	0	96.296
LSD .05	0.026		0.044		141.993					

Co = Carob honey, Po = Palm pollen, C = Citrus honey and Cont = Control. E.R.R.=Effective rate of rearing %

* Means followed with the same letter (s) are not significantly different.

Govindan *et al.,* (1988), El-Karaksy and Idriss (1990), Muniandy *et al.,* (1995), Sarker *et al* (1995) and Manoharan (1997) who found that the detected parameters of fitness component of *Philosamia ricini* Boisd or *Bombyx mori* L. larvae were significantly affected by the evaluated food additives. Nagda El-Sayed *et al* (1996) found that the black cumin at 10 and 20% (w/v) gave the heaviest weights of larvae, silk gland and male and female pupae of the mulberry silkworm *B. mori* L.. Also, Nagda El-Sayed (1999) reported that the mixture of honey and black cumin seeds gave the heaviest weights of larvae, pupae and dry silk gland. Also Magda Abd El- Aziz,. (2002) found that larvae treated with some vegetable oils gave high efficiency on the mean weight of cocoon shell and number of deposited eggs/female at low concentration of 0.05%.

Ngukue *et al.,* (2007) found that the treatment of late age silkworm larvae with royal jelly elicits favourable response in improving the commercial qualities of silk fibre and can be used in sericulture for yield enhancement. Zah *et al.,* (2011) used different sources of fat on four different silkworm hybrid strands, they observed an increase in the individual mass and silk quantity compared to the control.

In conclusion the results of the present study proved the significant efficiency of the use of honey, oils and mixtures of them in improving the biometrics of *Bombyx mori* L. leading to increase of silk and egg production.

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الملخص العربي

تأثيرإضافة بعض المواد الغذائية على إنتاجية ديدان الحرير التوتية

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يهدف هذا البحث دراسة تأثير بعض أنواع نحل العسل، حبوب لقاح النخيل وخليط منهما بأضافتهما إلى أوراق التوت بتركيزات مختلفة وذلك على بعض القياسات البيولوجية والأنتاجية وتم ذلك بتغذية يرقات العمرالخامس على اوراق توت معاملة وذلك لزيادة الأنتاجية من الحرير والبيض.

وقد أدت أضافة ومعاملة أوراق التوت بالتركيزات المختلفة من حبوب لقاح النخيل إلى زيادة معنوية القياسات البيولوجية والإنتاجية مقارنة بالكنترول. أما الخليط من عسل الموالح وحبوب لقاح النخيل وكذلك بعض تركيزات من عسل الخروب وحبوب لقاح النخيل أدى إلى زيادة معنوية فى القياسات البيولوجية والإنتاجية بالمقارنة بالكنترول.