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EVALUATION OF SOME DIETARY COMPONENTS ON CERTAIN BIOLOGICAL ASPECTS AND DIGESTIVE EFFICIENCY OF ERI SILKWORM
II. CONSUMPTION AND UTILIZATION OF FOOD

[67]

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ABSTRACT

Fourth and fifth larval instars of *Philosamia ricini* (Boisd.) were fed on different components of an artificial diet, which was recommended, by **Kaleemurrahman and Gouri (1982)** for this insect after replacing tapioca with castor leaf powder. Larva consumed 3.78 and 18.41 g of the control artificial diet during the fourth and fifth instars, respectively. The corresponding values for the fresh castor bean leaves where 3.16 and 18.08 g, with no significant difference between the values of both types of food. Replacement the soybean in the control diet with the same amount of bran caused an increase in the weight of ingested food by fifth instar larvae. The highest amount of consumed diet was recorded in the following cases: (control diet after replacing soybean with bran, control diet after adding sucrose and vitamin C, and control diet after adding sucrose, vitamin C, and casein, respectively). The same trend could be applied for approximate digestibility. The highest efficiency of converted food was recorded after feeding the larvae on fresh leaves [19.20 and 27.93 % were recorded for efficiency of conversion of ingested food to body matters (ECI) and efficiency of conversion of digested food to body matters (ECD) of the fifth instar larvae respectively]. Larvae fed on the control diet gave the lowest values of both ECI and ECD. Feeding the larvae on different types of tested artificial diet increased these values as compared with the control diet.

Key words: Eri silkworm, *Philosamia ricini*, Artificial diets, Consumption, Digestion, Food utilization, Food efficiency.

INTRODUCTION

The Eri silkworm, *Philosamia ricini* is one of the most important beneficial insects, which produces natural silk fibers. The main food for this insect in Egypt is the leaves of the castor bean plants, which are not available in all Egyptian locations at any time of the year. Therefore, it is necessary to suggest an artificial diet for rearing this insect allover the year. The composition of this diet must be simple and achieve the nutritional requirements of the experimental insect.

In the available literature, the amount of ingested and digested food, growth

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rate, efficiency of conversion of ingested and digested food to body matter varied according to different factors including type of food offered insects and their races (**Kuribayashi *et al* 1990; Tzenov, 1993 and Tzenov *et al* 1994**). The present work aimed at studying the effects of dietary components on the digestive efficiency of the Eri silk worm, *P. ricini* to select the most appropriate diet for rearing this beneficial insect and to ensure the results obtained in a previous paper (**Abdel-Khalek, 2002**).

MATERIAL AND METHODS

The artificial diet recommended by **Kaleemurrahman and Gouri (1982)** for rearing *P. ricini* larvae was used in the present work as control artificial diet after replacing tapioca leaf powder with castor leaf powder. Five types of artificial diets recorded in Table (1) were evaluated to study their effects on rates of consumption and utilization of food by the fourth and fifth instar larvae. Such late larval instars are considered a good indicator for the following stages (**Gomaa *et al* 1977**). The artificial diets were prepared as previously reported by the present author (**Abdel-Khalek, 2002**).

Larvae of *P. ricini* were reared on fresh castor bean leaves during the first three successive instars. At the beginning of the fourth instar, larvae were offered semi-synthetic diet till pupation and spinning the cocoons.

Larvae offered food daily under controlled conditions of 25 ± 2°C, 70 ± 3% R.H. and daily photoperiodic regime of 16: 8, L: D.

Larvae were reared in plastic dishes each measured 15 × 20 ×5 cm. (width, length and height, respectively) covered with muslin. The number of larvae per dish was 5and replicated 10 times for each instar and diet.

Table 1. Components of artificial diets for rearing *P. ricini* fourth and fifth instar larvae

Components of artificial diets	Weight of diet components (g)					
	D1	D2 * Control	D3	D4	D5	D6
Dry castor leaf powder	6.0	6.0	6.0	6.0	6.0	6.0
Soybean powder	-	1.0	1.0	1.0	1.0	1.0
Bran	1	-	-	-	-	-
Casein	-	-	-	-	-	1.0
Sucrose	-	-	-	1.0	1.0	1.0
Fructose	-	-	1.0	-	-	-
Ascorbic acid	-	-	-	-	0.090	0.090
Chloramphenicol	0.025	0.025	0.025	0.025	0.025	0.025
Agar-agar	1.0	1.0	1.0	1.0	1.0	1.0
Water	25	25	25	25	25	25

*According to **Kaleemurrahman and Gouri (1982)**

Cleaning nets having holes of 1 ×1 cm^2, were used on the dry leaves or diets. Faeces were weighed and removed at the end of each instar.

Known weights of each semi-artificial diets were offered larvae as stripes. The weights of remaining diet as well as the weight of faeces were weighed on the next day just before offering the new fresh diet.

To study the effect of different types of diets on the food consumption of *P. ricini* 4th and 5th instar larvae, following formulae suggested by **Waldbauer (1968)** and modified by **El-Shaarawy and Gomaa (1972)** were used:

$$I = O - R$$

Where:

I = Weight of fresh ingested food (g)
O = Weight of fresh food offered (g)
R = Weight of fresh remnants [a] (g)

[a] = Weight of fresh remnants = weight of dry remnants (g) × Blank [b]

$$[b] = Blank = \frac{F}{W}$$

Where:

F = Weight of fresh food offered larvae till the end of the instar (g).

W= Weight of dry food in the control without larvae for the same period (g).

$$D = I - C$$

Where:

D = Approximate weight of digested food (g)
C = weight of faeces (g).

$$AD\ (\%) = \frac{D}{I} X\ 100$$

Where:

AD= Approximate digestibility (%)

$$E.C.I\ (\%) = \frac{L}{I} X\ 100$$

Where:

E.C.I. = Efficiency of conversion of ingested food to body matter
L = Increase in weight of larvae (g)

$$E.C.D\ (\%) = \frac{L}{D} X\ 100$$

Where: E.C.D = Efficiency of conversion of digested food to body matter

RESULTS AND DISCUSSION

1. Weights of ingested and digested food

Data in Table (2), show that late instars of *P. ricini* larvae consumed an average of 3.78 and 18.41 g of the artificial control diet (D2) suggested by **Kaleemurrahman and Gouri (1982)** during the fourth and fifth instars, respectively. These averages were slightly lower than those of larvae fed on fresh castor oil bean leaves, where 3.16 and 18.08 g of food were consumed by the fourth and fifth instar larvae, respectively, with no significant difference between the values of both types of food. **Joshi (1991)** reared *P. ricini* in the laboratory on different artificial diets. He found that the fifth

Table 2. Mean weight of food ingested and digested by fourth and fifth instar larvae of *P. ricini* Boisd. reared on different diets.

Type of diets	Mean weight of food (g) ± S.E.					
	Ingested food			Digested food		
	4th instar	5th instar	Mean	4th instar	5th instar	Mean
Fresh leaves	3.16 ± 0.44	18.08± 1.65	10.62±1.60	1.82 ±0.38	15.47± 0.51	8.65 ± 0.45
D1	4.87 ± 0.36	22.96 ± 5.42	13.92 ± 2.89	3.39 ± 0.32	13.71± 0.70	8.55 ± 0.51
D2 (Control)	3.78 ± 0.19	18.41 ± 3.00	11.10 ± 1.60	2.58 ± 0.15	9.97 ± 0.45	6.28 ± 0.30
D3	1.91 ± 0.25	17.36 ± 1.32	9.64 ± 0.79	1.05 ± 0.14	5.72 ± 0.67	3.39 ± 0.41
D4	1.80 ± 0.28	21.63 ± 1.67	11.72 ± 0.98	0.92 ± 0.15	8.87 ± 0.89	4.90 ± 0.52
D5	5.85 ± 0.64	20.48 ± 1.30	13.17± 0.97	3.36 ± 1.02	14.12 ± 0.58	8.74 ± 0.80
D6	2.72 ± 0.24	20.48 ± 1.30	11.60 ± 0.77	2.09 ± 0.39	14.62 ±1.08	8.36 ± 0.74
Mean of artificial diet	3.49 ± 0.33	20.22 ± 2.34	11.68 ± 1.33	2.17 ± 0.36	11.78 ± 0.73	6.98 ± 0.55
L.S.D 0.05	2.09	3.11	-	1.33	1.01	-

instar larvae consumed food ranging between 80.82 and 84.06 % of the total amount of food ingested during the whole instar.

Replacement the soybean in the control diet with the same amount of bran (D1) caused an insignificant increase in the weight of ingested food for the fourth instar larvae (4.87 g/ larva). However this increase was significant for the fifth instar larvae (22.96 g/ larva). This may be due to the stimulatory effect of bran to larval feeding mechanism. Such mechanism may be stimulated by vitamin B, which is considered as a principal dietary component in the bran.

An addition of one-gram fructose to the control diet (D3) insignificantly decreased the amounts of food ingested by the fourth and fifth instars larvae (1.91 and 17.36 g / larvae, respectively) as compared with the amounts of consumed control diet and the consumed fresh leaves by both larval instars.

However, an addition of one gram sucrose to the control diet (D4) gave the relative equal amount of consumed food by the fourth instar larvae (1.80 g / larva), but increased the food ingested by the fifth instar (21.63 g / larva). The opposite was, however, true after addition of one-gram sucrose and 90 mg vitamin C (D5). In this case, the highest amount of food was consumed by the fourth instar larvae (5.85 g/ larva) and an insignificant increase of ingested food by the fifth instar (20.48 g/ larva).

Finally, addition of sucrose, vitamin C and casein to the control diet decreased the amount of the food consumed by the fourth instar larvae as compared with that composed of sucrose and vitamin C only (D5) eaten by the fourth instar ones (2.79 g/ larva). However, no apparent difference was noticed for the fifth instar larvae (20.48 g/ larva).

The data given in Table (2), clearly show that the same trend could be applied for the weights of food digested by the fourth and fifth instar larvae of *P. ricini* as being affected by the structure of the artificial diet offered old larvae. The highest amount of food consumed by the larvae was recorded when they offered (D1), (D5) and (D6) (control diet after replacing soybean with bran, after adding sucrose and ascorbic acid, and after adding sucrose, ascorbic acid and casein, respectively).

The differences between the mean weights of these three types of diets consumed by either the fourth or the fifth instar larvae, proved to be statistically insignificant.

2. Approximate digestibility (AD)

The data given Table (3) show that feeding the old larvae of *P. ricini* on the fresh leaves of caster bean leaves resulted in an approximate digestibility (AD) of 57.59 and 85.56 % for the fourth and fifth instar larvae, respectively. It is well known that the last instar larvae of any lepidopterous insect species are voracious feeders and the high rate of food utilization during this instar is considered as a good indicator for the following stages. Therefore, AD of the fifth instar larvae of *P. ricini* will be betaken into consideration.

Table 3. Approximate digestibility (AD) for fourth and fifth larval instars of *P. ricini* fed on different types of artificial diet

Type of diets	Approximate digestibility (AD) (%) for		
	4^{th} instar	5^{th} instar	Mean
Fresh castor leaves	57.59	85.56	71.58
D1	69.61	67.82	68.72
D2 (Control)	68.25	35.09	51.67
D3	54.97	32.95	43.96
D4	51.11	41.01	46.06
D5	57.44	48.34	52.89
D6	76.84	46.45	61.65
Mean of artificial diet	63.04	45.28	54.16

As shown in Table (3), the highest AD (85.56 %) was obtained when larvae were fed on natural food (castor bean leaves), while feeding them on the control artificial diet resulted in 35.09 % AD only, with a rate of decrement of 58.99 % as compared with natural food. However, replacement the soybean with bran increased the AD (67.82 %) to be near that of larvae fed on caster bean leaves, with a rate of decrement of 20.73 % only. Feeding the 5th instar larvae on the other tested diets gave an apparent decrease in the rate of digestibility. The lowest (43.96%) was obtained in case of D3 followed by D4, D5 and D6.

3. Efficiency of conversion of ingested and digested food to body matters

The data given in Table (4) show the efficiency of conversion of ingested (ECI) and digested food (ECD) to body matters.

Generally ECI value was always lower than the corresponding ECD for any tested larval instar. Means of 16.22 and 14.70 % was recorded for ECI of the fourth and fifth larval instars. The corresponding values for ECD were 32.21 and 38.56 %.

As reported in AD, the fifth instar larvae will be taken into consideration for both ECI and ECD. As shown in Table (4), the highest efficiency of convert food was recorded after feeding the larvae on fresh leaves. Means of 19.20 and 27.93 % were recorded for ECI and ECD of the fifth instar respectively.

Feeding the larvae on the control artificial diet resulted in the lowest values of both ECI and ECD. However, feeding them on different types of tested diet increased these values as compared with the control diet.

Table 4. Efficiency of conversion of ingested (ECI) and digested (ECD) food to body matter after feeding *P. ricini* fourth and fifth instars larvae on different types of diets.

Type of diets	Mean weight of food (g) ± S.E.					
	Ingested food			Digested food		
	4th instar	5th instar	Mean	4th instar	5th instar	Mean
Fresh leaves	32.80 ± 0.15	19.20 ± 0.43	26.00 ± 0.29	61.49±0.18	27.93±0.54	44.71±0.36
D1	16.02 ± 0.19	17.73 ± 0.09	16.88 ± 0.21	37.44 ± 0.22	42.17 ± 0.03	39.81± 0.13
D2 (Control)	21.03 ± 0.36	9.07 ± 0.05	15.05 ± 0.14	30.81 ± 0.46	25.85 ± 0.13	28.33 ± 0.30
D3	10.87 ± 0.27	13.92 ± 0.21	12.40 ± 0.24	24.38 ± 0.48	42.26 ± 0.42	33.32 ± 0.45
D4	12.49 ± 0.24	14.06 ± 0.17	13.28 ± 0.21	24.56 ± 0.12	34.26 ± 0.31	29.41 ± 0.22
D5	16.48 ± 0.04	16.41 ± 0.20	16.45 ± 0.12	38.71 ± 0.06	43.94 ± 0.48	41.33 ± 0.27
D6	20.43 ± 0.28	17.03 ± 0.21	18.73 ± 0.25	37.38 ± 0.17	42.86 ± 0.14	40.12 ± 0.16
Mean of artificial diet	16.22 ± 0.23	14.70 ± 0.16	15.46 ± 0.19	32.21± 0.25	38.56 ± 0.25	35.39 ± 0.25
L.S.D 0.05	2.14	1.96	-	1.51	1.92	-

In case of ECI, the highest values (16.41, 17.03 and 17.73 %) were recorded after feeding the larvae of the fifth instar on D5, D6 and D1, respectively, with no significant deference between these means. The same trend could be applied for ECD. The highest values (42.17, 42.26, 42.86 and 43.94 %) were obtained after rearing the fifth instar larvae on D1, D2 (Control), D3, D6 and D5, respectively, with no significant difference between theses means. L.S.D values emphasize the obtained results. It is important to notice that all ECD of the tested artificial diets offered the fifth larval instar were always higher than that given for the same larvae fed on fresh leaves.

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تقييم بعض المكونات الغذائية على بعض النواحى البيولوجية و كفاءة الهضم فى دودة حرير الخروع

٢- استهلاك الغذاء و الاستفادة منه

[٦٧]

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أظهرت نتائج هذه الدراسة وجود ارتباط موجب بين وزن الغذاء المستهلك ووزن الغذاء المستفاد منه عند تغذية اليرقات خلال العمرين الأخيرين (الرابع و الخامس) لدودة حرير الخروع على البيئة المصنعة التى اقترحها **كاليم الرحمن وجورى (١٩٨٢)** والتى استخدمت كمقارنة.

و قد وجد أن اليرقة استهلكت فى المتوسط ٣,٧٨ ، ١٨,٤١ جم أثناء تغذيتها على البيئة المصنعة (الكنترول) خلال العمرين الرابع و الخامس على التوالى ، بينما تغذت على ٣,١٦ ، ١٨,٠٨ جم من أوراق الخروع الطازجة خلال هذين العمرين بدون وجود اختلافات جوهرية بين الحالتين.

عند استبدال فول الصويا فى البيئة المصنعة المقارنة بنفس الكمية من الردة لوحظ ان ذلك يسبب فى زيادة فى وزن الغذاء المتناول بواسطة العمر اليرقى الخامس. وكانت أعلى كمية مستهلكة من البيئة الغذائية قد سجلت فى الحالات التالية: البيئة التى استبدلت فول الصويا بالردة ، والبيئة التى أضيفت لها السكروز وفيتامين ج ، والبيئة بعد إضافة السكروز و فيتامين ج والكازين على التوالى. و يمكن تطبيق نفس الاتجاه مع معامل الهضم التقريبى.

هذا وقد سجلت أعلى كفاءة تحويل كل من الغذاء المستهلك و المستفاد الى مكونات جسمية عند تغذية يرقات العمر الخامس على أوراق الخروع الطازجة (١٩,٢٠%، ٢٧,٩٣ % على التوالى)، بينما اليرقات التى تغذت على البيئة المصنعة المقارنة قد أعطت أقل قيم فى كفاءة تحويل كل من الغذاء المستهلك والغذاء المهضوم الى مكونات جسمية.

لوحظ عند تغذية اليرقات على البيئات الصناعية المختبرة انه قد تم التحصل على أعلى قيم عن مثيلتها من البيئة المصنعة المقارنة.

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