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Comparative impact among semi-artificial diets for *Pectinophora gossypiella* (Saund.) mass rearing technique

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Abstract
Five semi-artificial diets (A, B, C, D & E) were done for *Pectinophora gossypiella* (Saund.) rearing evaluation comparing with standard diet [1] in a laboratory conditions. Variability among diets components make opportunity for diets preparations with available locally ingredient. Semi-artificial diet (D) is the best diet evaluated for *P. gossypiella* rearing. Diet (D) based on kidney bean and soybean that was the best source for protein, carbohydrate, folic acid, iron & glycinin, followed by diet (A&B) that based on wheat grated, soybean & chick pea proteins. Meanwhile, diet (E) that based on wheat grated and chick pea proteins is the medium evaluation for *P. gossypiella* rearing quality. Diet (C) is the least quality for *P. gossypiella* rearing viability comparing with standard diet.

Keywords: semi-artificial, Laboratory, opportunity, Diet

Introduction
Cotton is attacked by many species of lepidopterous insects in different stages of crop growth and the pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechidae) is the most damaging pest and it is a widespread pest in almost all cotton growing countries of the world[2]. Moths of this pest are very active fliers, whereas larvae mostly remain inside the fruiting bodies (squares, flowers and bolls) and cause severe damage. They web the cotton flower petals, imparting a characteristic 'rosette' appearance. Feeding within the boll caused the malformation, rotting, premature or partial boll opening, reduction in fibre length and overall reduction in quality and quantity of the cotton. It is reared in Egypt on artificial diet to study its life history, behavior, susceptibility and resistance to chemical and biological pesticides. So, considerable effort has been invested in Egypt and the world in the development of low cost-effective artificial diets based on the use of cheaper ingredients [3-5].
This necessitated an artificial diet prepared from locally available ingredients with easily adoptable methodology by researches; with importation of expensive diet premixes can be avoided. So, the aim of the present work is to develop a mass rearing diet for pink bollworm, *Pectinophora gossypiella* (Saund.) using locally available ingredients as compared to the standard artificial diet [1].

Materials and Methods
The present work was done at Bollworms Research Department, Plant Protection Research Institute, Agriculture Research Center (ARC), Sabaheia branch, Egypt to evaluate five semi-artificial diets for mass rearing the pink bollworm, *P. gossypiella* as compared to semi-artificial diet [1]. The experiment was performed at 26±1ºC and 70-75% R.H. Composition of the five semi-artificial diets evaluated in this work in detailed as in Table (1).

Diet preparation
To prepare the tested diets A, B, C, D &E. The boiled water is added to kidney beans or wheat grated or soy bean or chick pea and put over heat for seventy minutes, lifted and left for twenty minutes to be cooled and clarifying water from them. They are blended with milk (Diet A) in an electric blender and put in the refrigerator for 24 hours. After that adding the other components to them and thoroughly blended and put in the refrigerator for 24 hours before being used.

Table 1: Semi-artificial diet ingredients

Ingredients	A	B	C	D	E	Standard
Kidney beans (g)	-	-	-	125	-	215
Wheat grated (g)	50	50	-	-	100	-
Soy bean (g)	225	120	-	25	-	-
Chick pea (g)	125	110	35	-	125	-
Cotton seed flour (g)	-	-	50	-	-	-
Ascorbic acid (g)	3	3	1.2	2	2.5	3
Sorbic acid (g)	2.4	3	0.5	1.5	2.1	1.25
Methyl paraben base Bp (g)	1.75	0.8	0.5	1.5	2.1	1.25
Yeast (g)	27	30	9	20	18	32
Agar-Agar (g)	-	32	19	20	25	11.25
Liquid milk (ml)	50	-	-	-	-	-
Multi- vitamins (ml)	8	5	1	5	5	-

Formaldhyde (ml)	2.5	3	1.5	2	2	3
Antibiotic (g)	0.2	0.2	0.2	0.2	0.2	-
Omega 3 (capsule)	-	1	-	-	1	-
Vitamin B_{12} (ml)		1	-	-	-	-

Standard diet [1] was modified from those developed [3, 4]. Diet (C) according [6].

Table 2: Multi vitamins composition Each 10 ml

Vitamine A	2400 I.U.
Vitamine D3	200 I.U.
Vitamine B1	2 mg
Vitamine B2	2 mg
Vitamine B6	1 mg
Vitamine C	100 mg
Vitamine E	2 mg
Nicotinamide	10 mg
Dexapanthenol	4 mg
Ferrous gluconate	86.356 mg

Omega 3: 500 mg/one capsule

Antibiotic used

Flumox® 500; Amoxycillin 250 mg and Flucloxacillin 250 mg, broad-spectrum antibiotic. A product of Egyptian International Pharmaceutical Industries Co., Egypt.

Table 3: Antibiotic composition

Each dosage unit contains	Film coated tablets	capsules		5 ml suspension
		250 mg	500 mg	
Amoxycillin (as amoxicillin trihydrate)	500 mg 574 mg	125 mg	250 mg 286.9 mg	125 mg 143.47 mg
Flucloxacillin Sodium monohydrate)	500 mg 544 mg	125 mg	250 mg 272.5 mg	125 mg 136.32 mg

Insect colony

The newly hatched larvae of the pink bollworm, *P. gossypiella* used in this study was obtained from a culture maintained for many generations at Bollworms Research Department, Plant Protection Research Institute, Sabaheia branch, Agriculture Research Center (ARC) on semi-artificial diet described [1]. Five generations (20 observations) of insect were reared on each tested diets before beginning recording the experiment observations.

Diet evaluation

Newly hatched larvae of the pink bollworm, *P. gossypiella* were transferred individually to glass tubes (2×7.5 cm) containing about 4-5 g semi-artificial diet (Table 1), each tube were plugged tightly with absorbent cotton and placed in an incubator at the same previous conditions. Four replicates of 25 larvae were used for each tested diet. Pupae were removed from the diet and kept singly in glass tube (1.5 cm×12.5 cm length), closed with cotton plugs. For oviposition studies with emerging male and female moths were paired singly in glass containers (6.5 cm diameter× 6 cm height) provided with 10 % honey solution for feeding. The open ends of the containers were covered with pieces paper to facilitate egg lying. They were changed on alternate days and the egg were incubated and counted. When the moths were kept in groups for oviposition they were released into a large container (10 cm diameter×12 cm height) with other details remaining the same. Five successive generations of the insect were reared on five promising diets. Each generation was initiated by releasing 100 newly hatched larvae on the diet. The following parameters evaluated were investigated.

A. Larval Stage

1. Larval duration (days).
2. Larval weights (mg).
3. Larval mortality (%).
4. Larval growth index [7] = Pupation (%)/ Larval period (days).
5. Larval period index, LPI [8] = Larval period (days) on standard diet/ Larval period (days) on test diet.

B. Pupal Stage

1. Pupal duration (days).
2. Pupal weights (mg).
3. Pupation (%).
4. Pupal mortality (%).
5. Standarized growth index [7] = Pupal weight (gm)/ Larval period (days).
6. Pupal growth index [7] = Emergence (%)/ Pupal period (days).
7. Pupal period index (PPI) [8] = Pupal period (days) on standard diet/ Pupal period (days) on test diet.
8. Pupation index (PI) [8] = Pupation (%) on test diet/ pupation (%) on standard diet.
9. Fitness index [7] = Pupation (%) X Pupal weight (gm)/ Larval period + Pupal period.

C. Adult Stage

1. Adult emergence (%).
2. Growth index (GI) [9] = Adult emergence (%)/ Larval period (days) + Pupal period (days).
3. Survival index [8] = Adult emergence (%) on test diet/ Adult emergence (%) on standard diet.
4. Success index (Suc. I) [8] = Larval period index (LPI) + Pupal period index (PPI) + Pupation index (PI) + Survival index (Sur. I)/4
5. Adult male longevity (days).
6. Adult female longevity (days).
7. Pre-oviposition period (days).
8. Oviposition period (days).
9. Post-oviposition period (days).
10. No. of eggs/female

11. Ovipositional index (OI) [8] = Average no. of eggs per female on test diet/ Average no. of eggs per female on standard diet.
12. Egg hatchability (%).
13. Fecundity (%) [10] = No. of eggs per tested female/ No. of eggs per standard female.
14. Observed sterility (%) [11] = 100 – egg hatchability %.
15. Life cycle (days) extended from egg deposition to adult emergence.
16. Life span (days) extended from egg deposition to adult death.

Statistical Analysis

Biological parameters evaluation were statically analyzed with variance (ANOVA) [12] at least significant difference (L.S.D.) test and the probability level $p< 0.05$ was considered statistically significant [13].

Results and Discussion

Pink bollworm, *Pectinophora gossypiella* (Saund.) was reared on five tested semi-artificial diet (Table 1) and comparing with standard diet [1]. Five generations of *P. gossypiella* were rearing on tested diet, four replicates/ generation (20 observations) were done. The following biological parameters was observed and investigated.

A. Larval Stage.

1. Larval duration. Table (4) illustrated that larval duration of *P. gossypiella* was decreasing as affected by rearing on diet (D) (11.2 days) compared with standard diet (15.5 days).
2. Larval weights. All tested diet increased from larval weight of *P. gossypiella*, especially diet (B) (34.6 mg) compared with standard (21.4 mg) as in Table (4).
3. Larval mortality. Semi-artificial diet (D) had the least larval mortality (5.95%) of *P. gossypiella* compared with standard (13.7%). Also, all tested diets had larval mortality decreased than standard (Table 4).
4. Larval growth index. That parameter means increasing in survival rate and less growth period. Table (4) showed that semi-artificial diet (D) had the highest larval growth index of *P. gossypiella* and caused the highest survival rate and shortest growth period (8.39) compared with standard diet (5.59) and other diets.
5. Larval period index (LPI). Period index of larval as illustrated in Table (4) was the highest in *P. gossypiella* reared on semi-artificial diet (D) (1.38) compared with other diets and standard (1).

B. Pupal Stage

1. Pupal duration. As mentioned in Table (5), semi-artificial diet (D) had the least pupal duration of *P. gossypiella* (8.9 days) compared with standard (12.95 days).
2. Pupal weight. Table (5) showed that all tested semi-artificial diets caused pupal weights increasing, especially diet (D) (26.5 mg); while, standard diet had the least weight (19.2 mg) comparing with other tested diets.
3. Pupation. That parameter was the highly value (94.1%) when *P. gossypiella* reared on diet (D); while, standard pupation was 86.3% (Table 5).
4. Pupal mortality. During pupal duration, the mortality was the least (8.2%) as a result of rearing on diet (D) comparing with standard pupal mortality that was (14.6%).
5. Standardized growth index. Semi-artificial diet (D) was the best diet had the standardized growth index (2.36) compared with other tested diets and standard diet was 1.24 as described in Table (6).
6. Pupal growth index. Tested semi-artificial diets as in Table (6) had the highest pupal growth index, especially in *P. gossypiella* reared on diet (D) (10.3) compared with standard diet (6.59).
7. Pupal period index (PPI). Table (6) showed that *P. gossypiella* reared on diet (D) had the highest pupal period index (1.46) than other tested diets compared with standard diet (1).
8. Pupation index (PI). *P. gossypiella* pupation index was 1 for standard diet as in Table (6). On the other hand, *P. gossypiella* reared on diet (D) was 1.09 that was the highest value than other tested diets.
9. Fitness index. This parameter was belonging to pupal development viability was 58.7 in *P. gossypiella* reared on standard diet. Meanwhile, *P. gossypiella* reared on diet (D) had the highest fitness index (118.7) than other tested diets (Table 7).

Table 4: Larval stage as affected by rearing on different semi artificial diets

Diets	Larval Duration (days)					Means
	Generations					
	1st	2nd	3rd	4th	5th	
A	11.75 a	12.5 a	11.75 b	12.5 bc	11.5 b	12 a
B	12.25 a	13.25 a	13 ab	12.75 abc	12.75 ab	12.8 a
C	12.5 a	13.5 a	13.25 ab	13.75 abc	13.25 ab	13.3 a
D	11.5 a	11.75 a	11 b	11 c	10.75 b	11.2 a
E	14.5 a	15 a	14.75 a	15 ab	14.75 a	14.8 a
Standard	15 a	15.25 a	15.5 a	16.5 a	15 a	15.5 a
$L.S.D_{0.05}$	3.41	3.48	2.62	3.48	2.81	3.98
Diets	Larval weight (mg)					Means
	1st	2nd	3rd	4th	5th	
A	33.3 a	33.43 b	27.37 d	30.77 ab	30.82 ab	31.1 ab
B	31.23 a	38.41 a	34.53 a	34.43 a	34.37 a	34.6 a
C	21.78 c	31.93 b	31.15 bc	29.94 ab	28.35 bc	28.6 bc
D	26.77 b	26.23 c	31.72 ab	29.65 ab	27.83 bc	28.4 bc
E	22.67 c	21.75 d	28.74 cd	24.94 bc	25.47 cd	24.7 cd
Standard	21.16 c	21.53 d	20.77 e	21.78 c	21.57 d	21.4 a
$L.S.D_{0.05}$	2.72	3.02	2.81	5.86	4.93	4.54
Diets	Larval mortality (%)					Means

	1st	2nd	3rd	4th	5th	
A	8.5 c	8.75 cd	8.25 bc	8 c	9 cd	8.5 cd
B	9 c	9 c	9 b	8.75 c	10 bc	9.15 bcd
C	10.75 bc	11.5 b	10.75 ab	10 bc	11.5 bc	10.9 abc
D	5.5 d	7 d	6 c	5.25 d	6 d	5.95 d
E	12 ab	11.5 b	11 ab	11.75 ab	13 ab	11.85 ab
Standard	14 a	14 a	12.5 a	13 a	15 a	13.7 a
L.S.D$_{0.05}$	2.29	1.78	2.81	2.29	3.25	3.08
Diets	Larval growth index					Means
	1st	2nd	3rd	4th	5th	
A	7.79 ab	7.3 a	7.81 ab	7.36 ab	7.91 ab	7.63 ab
B	7.43 abc	6.87 a	7 abc	7.16 bc	7.06 abc	7.09 ab
C	7.14 abc	6.56 a	6.74 abc	6.55 bcd	6.68 bc	6.72 ab
D	8.22 a	7.91 a	8.55 a	8.61 a	8.74 a	8.39 a
E	6.07 bc	5.9 a	6.03 bc	5.88 cd	5.89 c	5.96 b
Standard	5.73 c	5.64 a	5.65 c	5.27 d	5.67 c	5.59 b
L.S.D$_{0.05}$	1.78	2.18	1.78	1.26	1.78	2.18
Diets	Larval Period Index					Means
	1st	2nd	3rd	4th	5th	
A	1.28 a	1.22 a	1.32 a	1.32 a	1.30 a	1.29 a
B	1.22 a	1.15 a	1.19 a	1.29 a	1.18 a	1.21 a
C	1.2 a	1.13 a	1.17 a	1.2 a	1.13 a	1.17 a
D	1.30 a	1.29 a	1.41 a	1.5 a	1.39 a	1.38 a
E	1.03 a	1.02 a	1.05 a	1.1 a	1.02 a	1.04 a
Standard	1 a	1 a	1 a	1 a	1 a	1 a
L.S.D$_{0.05}$	0.73	0.73	0.73	0.73	0.73	0.73

Table 5: Pupal stage as affected by rearing on different semi artificial diets

Diets	**Pupal Duration (days)**					**Means**
	Generations					
	1st	2nd	3rd	4th	5th	
A	8.25 ab	9.75 b	9.75 c	10.25 cd	9.25 a	9.45 bc
B	8.75 ab	10.75 ab	10 c	11 bcd	9.75 a	10.1 bc
C	9.25 ab	11.5 ab	11 bc	12.5 bc	10 a	10.9 abc
D	7.5 b	9.25 b	9 c	9.75 d	9 a	8.9 c
E	10.25 a	12 ab	12.75 ab	13.75 ab	10.75 a	11.9 ab
Standard	10.75 a	13.25 a	14.5 a	15.25 a	11 a	12.95 a
L.S.D$_{0.05}$	2.29	2.81	1.92	2.52	2.29	2.29
Diets	Pupal weights (mg)					Means
	1st	2nd	3rd	4th	5th	
A	21.93 abc	25.92 a	28.52 a	25.39 a	27.2 a	25.8 a
B	21.46 abc	23.66 ab	23.57 b	22.87 ab	21.97 d	22.7 b
C	19.97 bc	17.13 c	22.78 b	19.1 cd	20.95 e	19.98 bc
D	23.34 a	25.95 a	30.71 a	25.59 a	26.77 b	26.5 a
E	22.6 ab	23.38 ab	21.09 bc	21.1 bc	22.72 c	22.2 bc
Standard	19.13 c	20.64 bc	18.05 c	18.01 d	19.97 f	19.2 c
L.S.D$_{0.05}$	3.08	4.82	4.04	2.62	3.41	3.08
Diets	Pupation (%)					Means
	1st	2nd	3rd	4th	5th	
A	91.5 b	91.25 ab	91.75 ab	92 ab	91 ab	91.5 ab
B	91 b	91 ab	91 ab	91.25 bc	90 ab	90.9 ab
C	89.25 bc	88.5 bc	89.25 bc	90 bcd	88.5 bc	89.1 bc
D	94.5 a	93 a	94 a	94.75 a	94 a	94.1 a
E	88 cd	88.5 bc	89 bc	88.25 cd	87 bc	88.2 bc
Standard	86 d	86 c	87.5 c	87 d	85 c	86.3 c
L.S.D$_{0.05}$	2.18	3.17	3.08	3.08	4.17	3.98
Diets	Pupal mortality (%)					Means
	1st	2nd	3rd	4th	5th	
A	10.75 b	11.25 a	11 b	10.5 bc	12 ab	11.1 b
B	10.5 b	11.75 a	11.75 ab	12 abc	12.5 ab	11.7 ab
C	11.25 ab	12.5 a	13 ab	12.75 ab	13.75 a	12.7 ab
D	7.5 c	8.25 b	7.75 c	8.5 c	9 b	8.2 c
E	12 ab	13 a	13.75 ab	14 ab	14.5 a	13.4 ab
Standard	13.25 a	14 a	14.75 a	15 a	16 a	14.6 a
L.S.D$_{0.05}$	2.18	2.72	3.17	3.56	3.91	2.72

Table 6: Different indexes as affected by rearing on different semi artificial diets

Diets	Standardized growth index					Means
	Generations					
	1st	2nd	3rd	4th	5th	
A	1.87 ab	2.07 a	2.43 ab	2.03 ab	2.37 a	2.15 a
B	1.75 bc	1.79 b	1.81 bc	1.79 abc	1.72 b	1.77 b
C	1.59 c	1.27 d	1.72 bc	1.39 bc	1.58 b	1.51 c
D	2.03 a	2.21 a	2.79 a	2.33 a	2.49 a	2.36 a
E	1.56 c	1.56 c	1.43 c	1.41 bc	1.54 bc	1.49 cd
Standard	1.28 d	1.35 cd	1.16 c	1.09 c	1.33 c	1.24 d
L.S.D0.05	0.22	0.22	0.73	0.77	0.24	0.25
Diets	Pupal growth index					Means
	1st	2nd	3rd	4th	5th	
A	10.8 ab	9.10 ab	9.13 ab	8.73 ab	9.51 ab	9.41 ab
B	10.2 bc	8.21 abc	8.83 ab	8 abc	8.97 ab	8.78 abc
C	9.59 bcd	7.61 abc	7.91 bc	6.98 abc	8.63 ab	8.05 abc
D	12.3 a	9.92 a	10.3 a	9.38 a	10.1 a	10.3 a
E	8.59 cd	7.25 bc	6.76 cd	6.25 bc	7.95 ab	7.27 bc
Standard	8.07 d	6.49 c	5.88 d	5.57 c	7.64 b	6.59 c
L.S.D0.05	1.78	2.18	1.78	2.72	2.18	2.41
Diets	Pupal Period index					Means
	1st	2nd	3rd	4th	5th	
A	1.30 ab	1.36 a	1.49 ab	1.49 ab	1.19 ab	1.37 ab
B	1.23 ab	1.23 ab	1.45 ab	1.39 abc	1.13 ab	1.29 ab
C	1.16 ab	1.15 ab	1.32 bc	1.22 bcd	1.1 ab	1.19 bc
D	1.43 a	1.43 a	1.61 a	1.56 a	1.22 a	1.46 a
E	1.05 b	1.10 ab	1.14 cd	1.11 cd	1.02 b	1.09 cd
Standard	1 b	1 b	1 d	1 d	1 b	1 d
L.S.D0.05	0.33	0.31	0.24	0.27	0.18	0.18
Diets	Pupation index					Means
	1st	2nd	3rd	4th	5th	
A	1.06 a	1.06 ab	1.05 a	1.06 b	1.07 b	1.06 a
B	1.06 a	1.06 ab	1.04 a	1.05 b	1.06 bc	1.05 a
C	1.04 a	1.03 bc	1.02 a	1.03 c	1.04 cd	1.03 a
D	1.09 a	1.08 a	1.07 a	1.09 a	1.11 a	1.09 a
E	1.02 a	1.03 bc	1.02 a	1.01 d	1.02 de	1.02 a
Standard	1 a	1 c	1 a	1 d	1 e	1 a
L.S.D0.05	0.73	0.03	0.73	0.02	0.03	0.73

C. Adult stage

1. Adult emergence. Table (7) described that *P. gossypiella* adult emergence reared on diet (D) was 91.8% that was the highest adult emergence than other tested diets. While, standard diet was 85.4% for *P. gossypiella* adult emergence reared on it.
2. Growth index (GI). Table (7) showed the same trend of other parameters that *P. gossypiella* reared on diet (D) had growth index of 4.43 that considered the highest growth index than other tested diets and comparing with standard diet (3.02).
3. Survival index. Table (7) showed that survival index was 1.07 for *P. gossypiella* reared on diet (D) compared with *P. gossypiella* reared on standard diet (1).
4. Success index. Diet (D) had the highest value (1.25) of *P. gossypiella* success index than other tested diets; while standard diet was 1 as mentioned in Table (7).
5. Adult male longevity. *P. gossypiella* adult male longevity was 14.1 days that reared on diet (D) compared with adult male longevity reared on standard diet (9.65 days) as in Table (8).
6. Adult female longevity. The same trend was found in adult female longevity (Table 8). Adult female longevity of *P. gossypiella* reared on diet (D) was 17 days that was the highest value than other tested diets compared with *P. gossypiella* reared on standard diet had adult female longevity of 12.9 days.
7. Pre-oviposition period. *P. gossypiella* reared on five semi-artificial diets and standard had the same pre-oviposition period that was two days (Table 8).
8. Oviposition period. Oviposition period of *P. gossypiella* reared on diet (D) was 12.6 days (Table 8) as comparing with *P. gossypiella* reared on standard diet that had oviposition period (8 days).
9. Post-oviposition period. That period of *P. gossypiella* had the nearly value in the most diets results except for diet (E) that was 3.15 days; while, standard diet had 2.85 days (Table 8).
10. No. of eggs/female. Highest no. of eggs/female was 226.4 eggs deposited by *P. gossypiella* adult females rearing on diet (D) compared with other tested diets and standard diet that was 125.6 egg/ female as described in Table (9).
11. Ovipositional index (OI). Semi-artificial diet (D) had the highest ovipositional index (1.80) for *P. gossypiella*. Whereas, the standard diet was the least ovipositional index (1) as tabulated in Table (9).
12. Egg hatchability. As the same trend of previous parameters; the egg hatchability reached to 93.1% when *P. gossypiella* reared on diet (D) as in Table (9); while, *P. gossypiella* reared on standard diet had egg hatchability of 88.2%.
13. Fecundity. *P. gossypiella* reared on diet (D) had fecundity of 180.2% that was the highest fecundity

percent than other tested diets or standard diet (100%) as mentioned in Table (9).

14. Observed sterility. Standard diet had 11.8% observed sterility for *P. gossypiella* reared on it. Meanwhile, *P. gossypiella* when reared on diet (D) had 6.9% observed sterility that considered the least observed sterility percent as in Table (9).
15. Life cycle. Shortest life cycle for *P. gossypiella* reared on diet (D) was 24.9 days; this value gradually increased among five tested diet until reached to 32.4 days for *P. gossypiella* reared on standard diet (Table 10).
16. Life span. *P. gossypiella* life span was as well as the same trend that was found in life cycle parameters in the same Table (10).

In the present study, throughout the rearing methodology, fungal contamination of the diet, pupal and the adult malformations were not observed.

Table 7: Adult stage as affected by rearing on different semi artificial diets

Diets	Fitness Index					Means
	Generations					
	1st	2nd	3rd	4th	5th	
A	100.3 b	106.1 b	121.7 b	102.5 a	119 b	109.9 b
B	92.9 c	89.7 c	93.3 c	87.7 c	88.3 c	90.4 c
C	81.8 d	60.6 e	83.7 d	65.4 d	79.6 d	74.2 d
D	116.1 a	114.9 a	137.5 a	97.8 b	127.1 a	118.7 a
E	80.2 d	76.6 c	68.3 e	64.7 d	77.5 d	73.5 d
Standard	63.8 e	62.3 e	52.6 f	49.3 e	65.3 e	58.7 e
L.S.D$_{0.05}$	3.98	4.48	3.41	4.17	4.36	4.65
Diets	Adult emergence (%)					Means
	1st	2nd	3rd	4th	5th	
A	89.25 b	88.75 ab	89 b	89.5 b	88 b	88.9 b
B	89 bc	88.25 b	88.25 bc	88 bc	87.5 b	88.2 bc
C	88.75 bc	87.5 b	87 cd	87.25 cd	86.25 bc	87.4 bc
D	92.5 a	91.75 a	92.25 a	91.5 a	91 a	91.8 a
E	88 bc	87 b	86.25 d	86 de	85.5 cd	86.6 cd
Standard	86.75 c	86 b	85.25 d	85 e	84 d	85.4 d
L.S.D$_{0.05}$	2.18	3.08	1.78	1.78	1.78	1.78
Diets	Growth index (GI)					Means
	1st	2nd	3rd	4th	5th	
A	4.46 a	3.98 a	4.14 ab	3.93 a	4.23 a	4.15 ab
B	4.24 a	3.68 a	3.84 ab	3.69 a	3.91 a	3.87 ab
C	4.07 a	3.5 a	3.58 ab	3.32 a	3.70 a	3.63 ab
D	4.87 a	4.37 a	4.61 a	3.69 a	4.59 a	4.43 a
E	3.55 a	3.22 a	3.14 b	2.99 a	3.35 a	3.25 ab
Standard	3.36 a	3.02 a	2.84 b	2.67 a	3.23 a	3.02 b
L.S.D$_{0.05}$	1.78	1.26	1.26	1.26	1.26	1.26
Diets	Survival index					Means
	1st	2nd	3rd	4th	5th	
A	1.03 b	1.03 b	1.04 b	1.05 b	1.05 b	1.04 b
B	1.03 b	1.03 b	1.04 b	1.04 bc	1.04 bc	1.03 bc
C	1.02 bc	1.02 bc	1.02 bc	1.03 c	1.03 cd	1.02 cd
D	1.07 a	1.07 a	1.08 a	1.08 a	1.08 a	1.07 a
E	1.01 cd	1.01 cd	1.01 c	1.01 d	1.02 d	1.01 de
Standard	1 d	1 d	1 c	1 d	1 e	1 e
L.S.D$_{0.05}$	0.02	0.02	0.02	0.02	0.02	0.02
Diets	Success index (Suc. I)					Means
	1st	2nd	3rd	4th	5th	
A	1.17 a	1.17 ab	1.23 ab	1.23 ab	1.15 a	1.19 ab
B	1.14 a	1.12 bc	1.18 ab	1.19 b	1.10 a	1.15 abc
C	1.11 ab	1.08 cd	1.13 bc	1.12 bc	1.08 a	1.104 bcd
D	1.22 a	1.22 a	1.29 a	1.31 a	1.2 a	1.25 a
E	1.03 bc	1.04 de	1.06 cd	1.06 cd	1.02 a	1.042 cd
Standard	1 c	1 e	1 d	1 d	1 a	1 d
L.S.D$_{0.05}$	0.103	0.08	0.105	0.105	0.73	0.104

Table 8: Longevity and oviposition periods as affected by rearing on different semi artificial diets

Diets	Adult Male Longevity (days)					Means
	Generations					
	1st	2nd	3rd	4th	5th	
A	12.25 ab	11.25 ab	11.25 ab	12.75 ab	13.5 a	12.2 ab
B	11.5 ab	10.75 b	13 ab	11.75 ab	12.25 a	11.9 ab
C	11.25 ab	9.25 b	12.5 ab	10.5 ab	11.75 a	11.1 ab

D	13.5 a	14.75 a	15 a	14 a	13.25 a	14.1 a
E	10.5 ab	11.75 ab	12.25 ab	11.5 ab	13.5 a	11.9 ab
Standard	10 b	9 b	9.25 b	10.25 b	9.75 a	9.65 b
L.S.D$_{0.05}$	2.81	3.41	4.71	3.41	3.48	3.17
Diets	Adult female longevity (days)					Means
	1st	2nd	3rd	4th	5th	
A	17.25 ab	16 a	15.75 a	16.25 a	12.25 b	15.5 ab
B	17 ab	15.25 a	15 a	15.25 a	12 b	14.9 ab
C	16.5 ab	14 a	14.24 ab	15 ab	10.75 b	14.1 ab
D	18.5 a	17.25 a	17 a	17 a	15.25 a	17 a
E	17 ab	15.75 a	13.5 ab	13.75 ab	11.5 b	14.3 ab
Standard	15.25 b	15 a	11 b	12 b	11 b	12.9 b
L.S.D$_{0.05}$	2.52	2.99	3.41	2.99	2.18	3.56
Diets	Pre-oviposition period (days)					Means
	1st	2nd	3rd	4th	5th	
A	2	2	2	2	2	2
B	2	2	2	2	2	2
C	2	2	2	2	2	2
D	2	2	2	2	2	2
E	2	2	2	2	2	2
Standard	2	2	2	2	2	2
Diets	Oviposition period (days)					Means
	1st	2nd	3rd	4th	5th	
A	12.25 ab	11.25 ab	10.5 ab	11.75 ab	9 b	10.95 ab
B	12 ab	10 bc	10 ab	10.25 abc	8.25 b	10.1 bc
C	11.5 ab	9.25 c	9.25 b	10 abc	7.75 b	9.55 bc
D	13.5 a	12.5 a	12.75 a	12.25 a	11.75 a	12.6 a
E	12 ab	9 cd	8.25 b	9.25 bc	7.25 b	9.15 bc
Standard	10 b	7.25 d	7.75 b	8 c	7 b	8 c
L.S.D$_{0.05}$	2.18	1.78	2.72	2.52	2.52	2.18
Diets	Post-Oviposition Period (days)					Means
	1st	2nd	3rd	4th	5th	
A	3 a	2.75 c	3.25 a	2.5 ab	1.25 bc	2.55 a
B	3 a	3.25 bc	3 a	1.5 b	1.75 abc	2.5 a
C	3 a	2.75 c	2.99 a	3 a	1 c	2.55 a
D	3 a	2.75 c	2.25 ab	2.75 a	1.5 abc	2.45 a
E	3 a	4.75 ab	3.25 a	2.5 ab	2.25 a	3.15 a
Standard	3.25 a	5.75 a	1.25 b	2 ab	2 ab	2.85 a
L.S.D$_{0.05}$	1.26	1.78	1.26	1.03	0.73	1.26

Table 9: Egg viability as affected by rearing on different semi artificial diets.

Diets	**No. of eggs / Female**					Means
	Generations					
	1st	2nd	3rd	4th	5th	
A	164.3 cd	163.6 cd	159.7 c	156.6 c	156.9 c	160.2 c
B	189.1 b	185.5 b	185.6 b	185.5 d	187.3 b	186.6 b
C	179.9 bc	178.6 bc	174.3 b	177.7 b	177.2 b	177.6 b
D	229.5 a	223.5 a	220 a	230.6 a	228.3 a	226.4 a
E	149.7 d	148.5 de	146.2 d	144.03 c	147.8 c	147.2 d
Standard	128.9 e	131.8 e	119.9 e	121.2 d	126.5 d	125.6 e
L.S.D$_{0.05}$	17.8	18.3	12.6	12.6	17.8	
Diets	Ovipositional index					Means
	1st	2nd	3rd	4th	5th	
A	1.28 cd	1.24 bcd	1.33 bc	1.29 bcd	1.24 cd	1.28 c
B	1.47 b	1.41 b	1.55 ab	1.53 b	1.48 b	1.49 bc
C	1.39 bc	1.36 bc	1.45 b	1.47 bc	1.40 bc	1.41 c
D	1.78 a	1.69 a	1.84 a	1.90 a	1.80 a	1.80 a
E	1.16 de	1.13 cd	1.22 bc	1.19 cd	1.17 de	1.65 ab
Standard	1 e	1 d	1 c	1 d	1 e	1 d
L.S.D$_{0.05}$	0.18	0.24	0.33	0.31	0.18	0.22
Diets	Egg hatchability (%)					Means
	1st	2nd	3rd	4th	5th	
A	90.25 a	91 a	92 a	92 a	91.25 a	91.3 a
B	89.25 a	90.25 a	90.75 a	90.75 a	90.25 a	90.3 a
C	89.25 a	90 a	89.5 a	89 a	90 a	89.6 a
D	92 a	92.75 a	93.5 a	93.25 a	94 a	93.1 a
E	88.75 a	89.5 a	89 a	88.5 a	89 a	88.95 a

Standard	88.5 a	89 a	88.25 a	87 a	88.25 a	88.2 a
L.S.D0.05	10.4	10.9	10.3 a	8.25 a	16.3 a	10.9 a
Diets	Fecundity (%)					Means
	1st	2nd	3rd	4th	5th	
A	127.5 cd	124.1 c	133.2 d	129.2 c	124.03 c	127.5 d
B	146.8 b	140.7 b	154.9 b	153.03 b	148.02 b	148.5 c
C	139.7 bc	135.5 b	145.5 c	146.6 b	140.06 b	141.3 c
D	178.1 a	169.6 a	183.6 a	190.3 a	180.5 a	180.2 a
E	116.2 d	112.7 d	121.9 e	118.8 c	116.8 c	164.7 b
Standard	100 e	100 e	100 f	100 d	100 d	100 e
L.S.D0.05	12.6	10.4	8.15	10.5	10.9	7.86
Diets	Observed sterility (%)					Means
	1st	2nd	3rd	4th	5th	
A	9.75 ab	9 ab	8 cd	8 c	8.75 c	8.7 bc
B	10.75 ab	9.75 a	9.25 bc	9.25 bc	9.75 bc	9.75 abc
C	10.75 ab	10 a	10.5 ab	11 ab	10 abc	10.5 ab
D	8 b	7.25 b	6.5 d	6.75 c	6 d	6.9 c
E	11.25 a	10.5 a	11 ab	11.5 ab	11 ab	11.1 ab
Standard	11.5 a	11 a	11.75 a	13 a	11.75 a	11.8 a
L.S.D0.05	2.81	2.29	2.18	2.41	1.78	2.81

Table 10: Life cycle & span as affected by rearing on different semi artificial diets

Diets	**Life Cycle**					**Means**
	Generations					
	1st	2nd	3rd	4th	5th	
A	24 b	26.3 cd	25.5 e	26.8 d	24.8 bc	25.5 c
B	25 b	28 bc	27 d	27.8 cd	26.4 bc	26.8 c
C	25.8 b	29 b	28.3 c	30.3 bc	27.3 ab	28.1 bc
D	23 b	25 d	24 f	28.8 cd	23.8 c	24.9 c
E	28.8 a	31 a	31.5 b	32.8 b	29.5 a	30.7 ab
Standard	29.8 a	32.5 a	34 a	35.8 a	30 a	32.4 a
L.S.D0.05	2.99	1.78	1.26	2.52	2.72	3.41
Diets	Life Span					Means
	1st	2nd	3rd	4th	5th	
A	41.3 a	37.6 c	41.3 a	43.1 a	37.1 a	40.1 b
B	42 a	38.8 bc	42 a	43.1 a	38.4 a	40.9 ab
C	42.3 a	43 ab	42.5 a	45.3 a	38.1 a	42.3 ab
D	41.5 a	42.3 b	41 a	45.8 a	39.1 a	41.9 ab
E	45.8 a	46.8 a	45 a	46.6 a	39 a	44.6 a
Standard	45.1 a	41.5 bc	45 a	47.8 a	39 a	43.7 ab
L.S.D0.05	4.17	3.91	4.17	5.14	2.71	3.56

It can be concluded that the tested five semi-artificial diets can be classified according to quality for *P. gossypiella* rearing:

1. First category was the most best diet (D) for *P. gossypiella* rearing that based on kidney beans and soybean proteins that contained protein, carbohydrate, folic acid, iron (kidney bean); in addition to glycinin and coglycinin (soybean) for growth supporting that leads to decrease the growth periods of immature stages and the pest fecundity. Also, ascorbic acid, yeast and multivitamins increase from insect viability. Meanwhile, uses of sorbic acid, methyl paraben base, formaldehyde and antibiotic based on bacteria and fungi killer or growth limited for shelf life increasing. In general semi- artificial diet (D) was recorded as the shortest larval, pupal duration (11.2 & 8.9 days) compared with standard diet (15.5 & 12.95 days); also, it was the least larval and pupal mortality (5.95 % & 8.2%) compared with standard diet (13.7% & 14.6%). Egg hatchability and adult emergence were recorded as 93.1% and 91.8 % as a result of rearing on diet (D) compared with standard diet. Moreover the highest growth index of larval and pupal was 8.39 & 10.3 that reared on diet (D). The growth index emphasizes the importance of both survival rate and developmental time in measuring of diet quality [14] that showed the higher survival rates and shorter development time's lead to yield higher values of growth index.
2. Second category containing diets (A&B); although, the two artificial diets based on wheat grated, soybean and chickpea proteins, they defect from methionine in chick pea protein that effect on growth viability of different stages of *P. gossypiella* compared with diet (D) in the first category.
3. Third category that was diets (C&G). Diet (C) based on the least quantity of chick pea and considered the only diet based on cotton seed flour. On the other hand, diet (G) based on wheat grated and chick pea proteins.

Authors reared the pink bollworm, *Pectinophora gossypiella* (Saunders) on different diets compositions [15] that reared *P. gossypiella* larvae on a diet of cotton seed and chickpea flours for the first 10 days and subsequently on pieces of okra attained rapid growth and development. This two-phase diet has been used for successful laboratory rearing of 51 generations of the pink bollworm. Meanwhile, [16] adequate media used for *Helicoverpa armigera* (Hubner), *Earias vitelli* (Fabricius), *Spodoptera litura* (Fabricius),

Spodoptera exigua (Hubner) (all Lepidoptera: Noctuidae), *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechidae) to rear colonies for multiple generations under laboratory conditions. Diet differed from the published diets in eliminating the use of ingredients such as wheat germ and plant derived powders such as sorghum leaf and cotton seed and substituting them with chickpea flour. It had been reported to show a positive effect on development and to be effective for continuous rearing of insect species mentioned. Recentrly, [17] found a simple and inexpensive method that uses freshly excised green bolls (~10 day old) of cotton (*Gossypium hirsutum* L.) is developed for laboratory rearing of pink bollworm, *Pectinophora gossypiella* (Saund.). The method was highly useful in understanding the pink bollworm phenology mediated through alterations and or aberrations in nutritional status of its host crop i.e. cotton.

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