SOME NOVEL ARTIFICIAL DIETS FOR REARING LARVAE AND ADULTS OF MEDITERRANEAN FRUIT FLY, *CERATITIS CAPITATA* (WIED.) (DIPTERA: TEPHRITIDAE) UNDER LABORATORY CONDITIONS IN EGYPT

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Abstract

The present work was conducted to evaluate some novel artificial diets for larvae and adults on some biological aspects of Med-fly, *Ceratitis capitata* (Wied.). Five different artificial diets for larvae consisted of wheat bran, grinded faba bean peel, wheat bran + grinded faba bean peel (1:1), wheat bran + grinded faba bean peel (1:2) and wheat bran + grinded faba bean peel (2:1) were used. Also, five different artificial diets for Med-fly adults consisted of sugar, sugar + protein hydrolyzate (3:1), sugar + alternative protein (1:1), alternative protein and protein hydrolyzate only were evaluated. The obtained results revealed that larval mortality (%) was high when larvae reared on grinded faba bean peel diet alone (29.4%). Pupal recovery (%) was lower when larvae reared on the grinded faba bean peel diet alone compared to the other diets. Rearing larvae of *C. capitata* on grinded faba bean peel diet alone produced smaller pupal weights, whereas diets contained mixture of wheat bran and grinded faba bean peel gave highest pupal weight compared to the standard diet. The oviposition period prolonged to 41.5 days when larvae reared on grinded faba bean peel diet alone but it, shorted to 16.5 days when larvae reared on diet contained wheat bran + grinded faba bean peel (1:1). Longevity of adult female and males prolonged to 48.3 and 48.8 days when larvae fed on grinded faba bean peel diet alone and shorted to 19.7 and 23.2 days when larvae fed on diet contained wheat bran + grinded faba bean peel (1:1). The highest adult emergence (%) occurred when larvae reared on wheat bran diet and slightly decreased when wheat bran mixed with grinded faba bean peel. Fecundity of *C. capitata* females whose larvae reared on the tested diets was relatively lower, the highest mean number of deposited eggs/female was found when larvae reared on wheat bran diet and mixture of wheat bran + grinded faba bean peel, while rearing larvae on grinded faba bean peel diet alone reduced deposited eggs/female. On the other hand, oviposition period of *C. capitata* females extended to 21.2 days when female adults fed on diet contained sugar + alternative protein (1:1) and reduced to 14.7 - 15.1 days when female fed on the standard diet and alternative protein diet, respectively. Feeding females on diet contained sugar only reduced the oviposition periods to 11.1 days whereas feeding females on protein hydrolyzate diet alone reduced the oviposition period to the minimum (1.53 days). Fecundity of *C. capitata* was higher (79.4

eggs/female) when females fed on standard diet (sugar + protein hydrolyzate at 3: 1) and reduced when females fed on sugar + alternative protein (1:1) diet and alternative protein diet. Feeding females on sugar only reduced the deposited eggs (10.7eggs/female) whereas feeding females on protein hydrolyzate only without sugar produced few numbers of eggs. Generally, the tested diets for rearing adults of *C. capitata* need additional studies on nutrient requirements to optimize the rearing process and improve the production of eggs at lower costs.

INTRODUCTION

Many researchers carried out several trials for rearing maggots and/or adults of Mediterranean fruit fly, *C. capitata* (Wied.) (Diptera: Tephritidae) on artificial diets such as Finney (1956) who reared *C. capitata* on fresh carrot medium. Christenson and Foot (1960) substituted dehydrated carrot for fresh carrot in larval medium. As the carrot medium was too expensive, wheat bran was used instead by Tanaka *et al.* (1969). Hasan (1974) found that 250 gm of yeast in media contained a mixture of dried carrot with wheat bran or rice bran gave high recovery percent and good quality of flies. Shehata (1985) reported low-cost diets for rearing the Med-fruit fly, *C. capitata*, low-cost ingredients to replace yeast hydrolyzate in the adult diets and the pure concentration of hydrochloric acid in the larval diets for the laboratory mass-rearing of *C. capitata*. He stated that there were no significant differences were observed in the biology of tephritid reared on these diets as compared with those reared on the standard diets.

Awadallah and EL-Hakim (1987) They found that using cheaper ingredient as molasses and glucose in diet gave good yields of larvae. Recovery from egg to adult was 47%, 47% and 48.6% for sugar, molasses and glucose, respectively. The reduction of brewer`s yeast from 250 gm to 100 gm gave the same yield of pupae and good quality of adults. EL-Abbassi *et al*. (1991) evaluated certain local ingredients in artificial medium diet at different concentrations and ratios to obtain optimum medium for mass rearing of *C. capitata* that gives high yield of good quality insects at low price costs. Chang *et al.* (2001b) developed a chemically defined diet for rearing adult of *C. capitata.* The diet was prepared in two forms, agar and liquid and both showed comparable performance to the standard diet but the agar diet is considered to be the best diet tested.

Chang *et al.* (2007) developed a liquid diet for rearing *C. capitata*. They found that whole cell yeast to hydrolyzed yeast ratio of 3:1 was found to be the most suitable diet based on quality control parameters measured and cost-effectiveness. Pašková (2007) tested five larval diets for laboratory rearing of *C. capitata*. He found

that larvae reared on new agar-based diet reached better results than larvae reared on bran diet. Chang *et al.* (2011) tested four wheat germ oil alternatives (corn oil, vegetable oil, canola oil with 10% vitamin E, and canola oil with 20% vitamin E) to a fruit fly liquid larval diet as a replacement for wheat germ oil in the rearing of fruit fly larvae. They found that corn oil is a better alternative for *B. dorsalis*, and vegetable oil is best for *C. capitata*. Many researchers developed artificial diets for other species of fruit flies (Chang and Vargas (2007), Hernández *et al.* (2010) and Khan (2013)

The present work was conducted to study the effect of certain components of artificial diets on some biological aspects of both larvae and adults of Mediterranean fruit fly*, Ceratitis capitata* under laboratory conditions.

MATERIALS AND METHIODS

Med-fruit fly, *C. capitata* used for laboratory experiments was obtained from stock culture, continuously reared in Laboratory at Horticulture Insect Research Department, Plant Protection Research Institute (PPRI), Agriculture Research Center (ARC). Certain artificial diets for larvae and adults of Med-fly, *C. capitata* were evaluated under laboratory conditions (25±3ºC & 65±5%R.H.) to determine their effect on certain biological aspects of both larvae and adults.

1. **Larval Artificial Medium Diets:** Five artificial medium diets for rearing larvae of *C. capitata* were used. Each diet was replicated three times. About 3000 - 4000 one-day old eggs (nearly 0.3 ml) were put on each replicate weighed 1000 g (bulking diet). The tested larval artificial diets were:

- Wheat bran (330 g)
- Grinded faba bean peel (330 g)
- Wheat bran + grinded faba bean peel (1:1)
- Wheat bran + grinded faba bean peel (1:2)
- Wheat bran + grinded faba bean peel (2:1).

The other components of larval artificial diet (82 g molasses, 82 g brewer`s yeast, 3 g sodium benzoate, 3 g citric acid and 500 ml water) were added for each diet. The egg hatch (%), larval mortality (%) and larval duration (days) were determined. Also, the pupal recovery (%), pupal mortality (%), mean pupal weight (mg), pupal duration and % emergence flies were recorded. Twenty five pairs of newly emerged adults (25 males and 25 females) were selected from each treatment, replicated 3 times and put in small cages and fed on sugar solution and left for depositing eggs. The fecundity of adult females and longevity of both male & females were determined.

2. Adult Artificial Diets

Five artificial diets (three replicates for each) were tested for feeding Med-fly adults. Newly emerged adults of Med-fly were anesthetized in refrigerator for few seconds. Then, every Twenty five pairs (25 males and 25 females) were transferred in a small cage, replicated 3 times and put under laboratory conditions. Adults in small cages were fed on the following artificial diets:

- Sugar only
- Sugar + protein hydrolyzate (3:1) (Standard)
- Sugar + alternative protein (20 ml water + 2 ml Neodigstin +10 g molasses +10 g yeast) at ratio 1: 1.
- Alternative protein only.
- Protein hydrolyzate only.

All treatments were daily inspected. Some biological aspects of flies like fecundity of females and longevity of both males and females were estimated.

RESULTS AND DISCUSSION

1. Larval Artificial Diets

Effect of larval artificial diets with different constituents on some biological aspects of Med-fly, *C. capitata* is illustrated in Table (1 & 2).

1.1. Larval stage

Results in Table (1) show the effect of the tested artificial diets on mortality and duration of *C. capitata* larvae under laboratory conditions.

1.1.1. Larval mortality (%)

Med-fly larvae reared on the tested diets showed insignificant difference in percentages of mortality (Table, 1). The highest percentage of mortality (29.4%) was found when larvae reared on grinded faba bean peel diet alone followed by wheat bran + grinded faba bean peel diet at 1:2 (25.4%) and wheat bran diet (20.4%) whereas mortality decreased to 18.4 and 16.4% for reared larvae on wheat bran + grinded faba bean peel diet at ratios of 1:1 and 2:1, respectively. Jang (1986) stated that deletion of niacin from an artificial diet developed for the Med-fruit fly, *C. capitata* resulted in high larval mortality. Pašková (2007) found that larvae reared on new agar-based diet reached better results than larvae reared on bran diet.

1.1.2. Larval duration

Duration of larvae reared on the tested artificial diets was nearly the same and ranged between 10.1 - 10.3 days. Awadallah and EL-Hakim (1987) found the larval stage of *C. capitata* reared on diet composed of glucose was less (6.9 days)

than those larvae reared on diets composed of sugar or molasses (8.3 days/each diet). Chang *et al.* (2001a) reported that, rearing larvae of *C. capitata* on a Meridic diet containing corncob as a bulking agent resulted 9.47 days for larval duration, Omission of all 10 essential amino acids from the Meridic diet mixture inhibited development of the 1st instar where deletion of eight non-essential amino acids, 10 vitamins, sugar, or ribonucleic acid delayed larval growth. Fay and Wornoayporn (2002) stated that, substitution of various inert substrates for wheat bran in the bulk larval diets of *C. capitata* extended the larval duration by more than 2 days compared with the standard Seibersdorf diet. Chang *et al.* (2007) found the larval duration lasted for 10.67days when larvae of *C. capitata* reared on a liquid diet with whole cell yeast to hydrolyzed yeast ratio of 3:1. Chang *et al.* (2011) showed that, larval duration lasted for 12.99 days when wheat germ oil substituted with vegetable oil in a liquid diet.

1.2. Pupal stage:

1.2.1. Pupal recovery (%)

The pupal recovery (%) of *C. capitata* reared on the tested diets insignificantly varied (Table 1). The highest percent of pupal recovery (81.5 - 83.9%) were found when larvae reared on wheat bran + grinded faba bean peel diet at ratios 1:1 and 2:1, respectively. The larvae reared on wheat bran and grinded faba bean peel (1:2) diets gave moderate pupal recovery (79.7 - 74.7%) while the larvae reared on grinded faba bean peel diet alone gave lower recovery percent (70.6%). Chang *et al.* (2001a) found that, rearing larvae of *C. capitata* on a Meridic diet containing corncob as a bulking agent resulted 93% for pupal recovery. Fay and Wornoayporn (2002) found that, substitution of various inert substrates for wheat bran in the bulk larval diets of *C. capitata* halved the pupal recovery levels.

1.2.2. Pupal weight

Data in Table (1) show that there were significant differences between means of pupal weight produced from the tested diets. Larvae reared on diet contained grinded faba bean peel alone produced very small pupae (5.9 mg) while those reared on the other tested diets gave higher pupal weight ranged between 10.4 -11.4 mm. Grinded faba bean has poor nutritive value compared with wheat bran. So, rearing larvae on grinded faba bean diet alone produced weaken pupae with smaller weights.

The obtained results are similar to that of Awadallah and EL-Hakim (1987) who found that rearing larvae of *C. capitata* on cane bagasse instead of wheat bran significantly increased the pupal production and decreases the average size and pupal weight. EL-Abbassi *et al*. (1991) reported that, sugarcane bagasse is not suitable for mass rearing of *C. capitata* because of its negative effect on main pupal weight and

size. Chang *et al.* (2001a) found that, rearing larvae of *C. capitata* on a Meridic diet containing corncob as a bulking agent resulted 9.52 mg for pupal weight, while larvae reared on diet without non-essential amino acids, vitamins, sugar or cholesterol resulted in pupal weight loss. Fay and Wornoayporn (2002) revealed that, substitution of various inert substrates for wheat bran in the bulk larval diets of Mediterranean fruit fly reduced the mean pupal size by ≥10%. Pašková (2007) showed that, rearing larvae of *C. capitata* on diets based on starch and microcellulose reduced the pupal efficacy to less than 5% and the pupal weight less than 7.5 mg.

1.2.3. Pupal duration

Data in Table (1) show that the tested diets had insignificant effect on the pupal duration. The duration ranged between 9.2 and 9.5 days

1.3. Adult emergence (%)

All pupae resulted from the tested larval artificial diets were incubated under laboratory conditions. After emergence, adults were paired in three replicates to determine the biological aspects of adults.

Mean percentage emergence of adult flies varied (Table, 1). The emergence of *C. capitata* flies decreased to 58.3% when larvae reared on grinded faba bean peel diet alone. Highest adult emergence of Med-flies was obtained when larvae reared on wheat bran diet alone (90.9%). Mixture of wheat bran with grinded faba bean peel at ratios of 1:1, 1:2 and 2:1 recorded emergence percentages of 90.2, 90.5 and 90.3%, respectively. Awadallah and EL-Hakim (1987) found that, the adult emergence (%) of *C. capitata* reached to 92.6, 82.2 and 82% when larvae reared of on diets composed of sugar, molasses and glucose, respectively. Chang *et al.* (2001a) reported that, rearing larvae of *C. capitata* on a Meridic diet containing corncob as a bulking agent resulting 92.95% adult emergence. Fay and Wornoayporn (2002) revealed that, the mean percentage of adult flies of *C. capitata* produced from the different inert substrates ranged 50.4 to 76.1% compared with 71.7% for the standard wheat bran (Seibersdorf) diet.

1.3.1. % emergence of male and females

The percentages of emerged male and females were similar (Table, 1) with the tested diets without significant different means. The sex ratio of male: female for larvae reared on the tested diets was almost close to 50:50.

1.3.2. Pre-oviposition period

Statistical analyses of data in Table (2) showed that pre-oviposition periods of Med-fly, *C. capitata* female adults emerged from larvae reared on the tested diets were significantly affected (F values = 17.7 & LSD = 0.644). The longest mean period reached 5 days when larvae fed on grinded faba bean peel diet, but reduced to 3.7

days when larvae fed on wheat bran diet. The pre-oviposition period was insignificantly reduced to 3 days when larvae reared on wheat bran + grinded faba bean peel diet at ratios of 1:1 and 1:2.

1.3.3. Oviposition period

Data in Table (2) show that, the differences between oviposition period of females resulted from the tested larval diets were highly significant (F value = 66.4 & LSD = 4.24). Oviposition period extended to 41.5 days when larvae fed on grinded faba bean peel diet alone and reduced to 38.4 days when larvae fed on wheat bran + grinded faba bean peel diet (1:2). Lower oviposition periods (23.6 - 24.5 days) were noticed for larvae reared on wheat bran alone and wheat bran + grinded faba bean peel diet (2:1).The lowest oviposition period (16.5 days) occurred when larvae reared on wheat bran + grinded faba bean peel diet (1:1). Awadallah and EL-Hakim (1987) found the oviposition periods of *C. capitata* females extended to 50.5, 44 and 50 days when whose larvae reared on diets composed of sugar, molasses and glucose, respectively

1.3.4. Post-oviposition period

Data in Table (2) show that, post-oviposition periods of Med-fly females were insignificantly affected when larvae reared on the tested diets.

1.3.5. Male longevity

Longevity of males significantly varied (F value = 25.8 & LSD = 7.15) (Table, 2). The longest period occurred when larvae fed on grinded faba bean peel diet alone and wheat bran + grinded faba bean peel diet (1:2), the longevity extended to 48.8 and 42.6 days, respectively. The shortest longevity were found when larvae fed on wheat bran diet and wheat bran + grinded faba bean peel diet at ratios of 1:1 and 2: 1, the male longevity reduced to 26.3, 23.2 and 29 days, respectively.

1.3.6. Female longevity

The differences between female longevity of Med-fly, *C. capitata* reared as maggots on different diets were statistically significant (F value = 50 & LSD = 13.2) showing the same trend as male longevity (Table, 2). The longest period occurred when larvae reared on grinded faba bean peel diet alone and wheat bran + grinded faba bean peel diet (1:2), the longevity reached to 48.3 and 41.7 days, respectively. On the other hand, female longevity decreased to 28.3, 19.7 and 28.3 days when whose larvae fed on wheat bran diet alone and wheat bran + grinded faba bean peel diet at ratios of 1:1 and 2:1, respectively. Awadallah and EL-Hakim (1987) found that longevity of adult male of *C. capitata* was lower than female when whose larvae reared on diet composed of sugar, molasses and glucose.

1.3.7. Fecundity

The highest mean number of deposited eggs/female was recorded 53.6, 52.0, 42.3 and 41.6 eggs/female for larvae fed on wheat bran diet and wheat bran + grinded faba bean peel at ratios of 1:2, 1:1 and 2:1, respectively. The lowest mean number of deposited eggs was 32.7eggs/female for larvae fed on grinded faba bean peel diet alone. The present results disagreement with results of Awadallah and EL-Hakim (1987) found that rearing larvae of *C. capitata* on diets composed of sugar, molasses and glucose produced higher mean numbers of eggs per female. Foda *et al.* (1989) revealed that, *C. capitata* reared on wheat bran diet increased the mean number of eggs per female.

1.3.8. Hatchability

Percentages of hatchability for deposited eggs from females fed on larval stage on different medium diets were determined and illustrated also in Table (2). Percentages of hatchability varied insignificantly and ranged between 89.7 - 90.7%.

2. Adult Artificial Diets

Effect of adult artificial diets on certain biological aspects of *C. capitata* was determined and represented in Table (3).

2.1. Pre-oviposition period

The tested diets had insignificant effect on pre-oviposition period of newly emerged flies where this period was nearly the same for females fed on the tested diets.

2.2. Oviposition period

Results in Table (3) show that, oviposition period of Mid-fly females significantly affected by feeding on the tested diets (F value = 44.2). Oviposition period extended to 21.2 days when females fed on diet contains sugar + alternative protein (1:1) and reduced to 14.7 - 15.1 days when female fed on the standard diet (sugar + protein hydrolyzate 3:1) and alternative protein diet. Feeding adult females on diet contains sugar only reduced the oviposition period to 11.1 days whereas feeding females on protein hydrolyzate diet alone reduced the oviposition period to the minimum (1.53 days).

2.3. Post-oviposition period

Post-oviposition periods of adult females were insignificantly affected (Table, 3).

2.4. Male longevity

Male longevity was significantly affected (F value = 14.9 & LSD = 4.0) by feeding on the tested diets (Table, 3). Longevity of males insignificantly prolonged to 16.4, 15.7, 15.0 and 14.2 days when males fed on diets of sugar + alternative protein, alternative protein only, sugar only and sugar + protein hydrolyzate (3:1),

respectively. The shortest longevity was 4.9 days when males fed on protein hydrolyzate only.

2.5. Female longevity

As show in Table (3), female longevity was significantly affected (F value = 48.8 & LSD value = 3.6) by feeding on the different tested diets. The longest period was occurred when females fed on diet of sugar + alternative protein (24.3 days) and reduced to 17.9 and 18.3 days when females fed on sugar + protein hydrolyzate (3:1) and alternative protein only, respectively. Longevity of *C. capitata* females recoded intermediate period (14.3 days) when adults fed on sugar only. The shortest longevity was 3.7 days for females fed on protein hydrolyzate only.

2.6. Fecundity of females

Data presented in Table (3) show fecundity of Med-fly, *C. capitata* females fed on the tested diets. The mean number of eggs deposited by females fed on different diets significantly varied according to the used diet. The highest mean number of deposited eggs (79.4 eggs) was obtained with females fed on sugar + protein hydrolyzate (3:1), whereas the lowest ones (0.017 eggs) was shown with females fed on protein hydrolyzate only. The other tested diets showed insignificantly differences in mean numbers of deposited eggs/female.

El-Hakim and Basilly (1986) revealed that, females of *C. capitata* fed on enzymatic yeast hydrolyzate and brewer`s yeast (1:1) produced 846.0 eggs/female while those fed on enzymatic yeast hydrolyzate alone produced 656.3 eggs. Chang *et al.* (2001b) found that adults of *C. capitata* reared on agar diet produced more eggs than those reared on a protein hydrolysate + sugar (1:3) diet.

2.7. Hatchability

Results obtained (Table, 3) showed that, hatchability percentages for eggs deposited by females fed on the tested diets insignificantly affected except with the diet of protein hydrolyzate only where females laid very low amounts of eggs. Generally, the tested diets for rearing adults of *C. capitata* need additional studies on nutrient requirements to optimize the rearing process to improve the production of eggs at lower cost. So, mass-rearing of fruit flies requires the development of an artificial diet that is effective, easy to prepare, manage and inexpensive.

Table 1. Effect of larval diets on certain biological aspects of Med-fruit fly, *C. capitata* reared under Laboratory conditions.

Parameters \ Diets	Wheat bran	Grinded faba bean peel	Wheat bran + grinded faba bean peel (1:1)	Wheat bran + grinded faba bean peel (1:2)	Wheat bran + grinded faba bean peel (2:1)	F values	LSD $_{at\ 0.5}$ values
Mean % hatched eggs	90 ± 2.9 BC	85 ± 2.9 C	100 ± 0.0 A	98.3 ±1.7 AB	81.7 ± 4.4 C	7.6**	9.50
Larval mortality (%)	20.4± 5.9	29.4 ± 3.1	18.4± 1.7	25.4 ± 0.4	16.4 ± 1.6	2.4	-
Mean larval duration (days)	10.3 ± 0.07	10.3 ± 0.0	10.1 ± 0.06	10.1 ± 0.09	10.1 ± 0.06	2.3	-
Pupal recovery (%)	79.7 ± 6.0	70.6 ± 3.1	81.5 ± 1.7	74.7 ± 0.44	83.9 ± 1.7	2.4	-
Pupal mortality (%)	9.3 ± 2.1 B	41.7 ± 4.2 A	10.2 ± 1.9 B	9.1 ± 2.1 B	9.7 ± 1.9 B	50.8**	6.6
Mean weight of pupa (mg)	10.4 ± 0.46 A	5.9 ± 3.9 B	11.4 ± 0.44 A	11.4 ± 0.39 A	11.2 ± 0.49 A	10.1**	2.7
Pupal duration (days)	9.2 ± 0.3	9.5 ± 0.28	9.3 ± 0.23	9.2 ± 0.12	9.3 ± 0.21	0.16	-
% emerged flies	90.9 ± 2.1 A	58.3 ± 7.2 B	90.2 ± 1.9 A	90.5 ± 2.2 A	90.3 ± 1.9 A	51.2**	6.6
% of male emergence	51.3 ± 1.3	52.4 ± 2.4	50.0 ±1.9	50.0 ± 2.2	48.7 ± 1.3	0.45	-
% of female emergence	48.7 ± 1.3	47.6 ± 2.4	50.0 ±1.9	50.0 ± 2.2	51.3 ± 1.3	0.45	-

Means in the same row followed by the same letter are insignificantly differed (P > 0.05).

Table 2. Effect of larval artificial diets on oviposition period, longevity of males and females and fecundity of Med-fly, *C. capitata* reared under Laboratory conditions.

Parameters / Diets	Wheat bran	Grinded faba bean peel	Wheat bran + grinded faba bean peel (1:1)	Wheat bran + grinded faba bean peel (1:2)	Wheat bran + grinded faba bean peel (2:1)	F values	LSD $_{at\ 0.5}$ values
Mean pre-oviposition period (days)	3.7 ± 0.3 B	5.0 ± 0.0 A	3.0 ± 0.0 C	3.0 ± 0.0 C	3.3 ± 0.3 BC	17.7**	0.644
Mean oviposition period (days)	23.6 ± 0.3 B	41.5 ± 0.8 A	16.5 ± 2.6 C	38.4 ± 0.9 A	24.5 ± 0.1 B	66.4**	4.24
Mean Post-oviposition period (days)	1.07 ± 0.4	1.9 ± 1.1	0.20 ± 0.01	0.27 ± 2.5	0.47 ± 0.2	1.96	-
Male longevity (days)	26.3 ± 1.8 B	48.8 ± 2.7 A	23.2 ± 2.8 B	42.6 ± 0.6 A	29.0 ± 0.7 B	25.8**	7.15
Female longevity (days)	28.3±0.3 B	48.3 ± 1.8 A	19.7 ± 2.6 B	41.7 ± 0.9 A	28.3 ± 0.7 B	50.0**	13.2
Mean No. of deposited eggs	1339.2±142.1 A	818.3±75.7 B	1057.8±53.9 AB	1299.5±35.3 A	1039.5±94.9 AB	4.9*	313.1
Mean No. of deposited eggs/female	53.6 ± 5.7 A	32.7 ± 3.0 B	42.3 ± 2.2 AB	52.0 ± 1.4 A	41.6 ± 3.8 AB	4.9*	12.5
Mean No. of deposited eggs/female/day	2.3 ± 0.22 AB	0.79 ± 0.09 D	2.6 ± 0.43 A	1.36 ± 0.04 CD	1.7 ± 0.16 BC	12.8**	0.68
% Hatchability	90.3 ± 1.5	90.0 ± 0.6	90.0 ± 1.2	90.7 ± 1.2	89.7 ± 0.9	0.10	-

Means in the same row followed by the same letter are insignificantly differed (P > 0.05).

Table 3. Effect of artificial diets on certain biological aspects of Med-fly, *C. capitata* adults under laboratory conditions.

Parameters \ Diets	Sugar only	Sugar + protein hydrolyzate (3:1)	Sugar + alternative protein (1:1)	Alternative protein	Protein hydrolyzate	F values	LSD $_{at\ 0.5}$ values
Mean pre-oviposition period (days)	3.0 ± 0.0	3.0 ± 0.0	3.0 ± 0.0	3.0 ± 0.0	2.0 ± 0.99	1.0	-
Mean oviposition period (days)	11.13 ± 1.23 C	14.7 ± 2.12 B	21.17 ± 0.7 A	15.1 ± 2.36 B	1.53 ± 0.77 D	44.2**	3.5
Mean Post-oviposition period (days)	0.20 ± 0.06	0.20 ± 0.004	0.17 ± 0.003	0.23 ± 0.033	0.13 ± 0.067	0.81	-
Male longevity (days)	15.0 ± 1.33 A	14.2 ± 1.64 A	16.4 ± 1.93 A	15.7 ± 0.62 A	4.9 ± 0.24 B	14.9**	4.0
Female longevity (days)	14.3 ±1.27 C	17.9 ± 2.12 B	24.3 ± 7.31 A	18.3 ± 2.40 B	3.7±1.83 D	48.8**	3.6
Mean No. of deposited eggs	266.8 ± 14.9 B	1984.8 ± 59.1 A	882.0 ± 14.6 B	819.8 ± 17.6 B	0.42 ± 0.22 B	7.6**	904.0
Mean No. of deposited eggs/female	10.7 ± 0.38 B	79.4 ± 15.0 A	35.3 ± 0.37 B	32.8 ± 4.5 B	0.017 ± 0.01 B	7.6**	36.2
Mean No. of deposited eggs/female/day	0.96 ± 0.06 B	5.4 ± 1.1 A	1.7 ± 0.03 B	2.2 ± 0.25 B	0.01 ± 0.001 B	4.2*	3.0
% Hatchability	90 ±1.5	90 ±0.6	90 ±1.2	91 ±1.8	-	-	-

Means in the same row followed by the same letter are insignificantly differed (P > 0.05).

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بعض البيئات الغذائية الصناعية الجديدة فى تربية اليرقات والحشرات الكاملة لذبابة فاكهة البحر المتوسط تحت الظروف المعملية بمصر

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تم تقييم بعض البيئات الغذائية الجديدة فى تربية اليرقات والحشرات الكاملة لذبابة فاكهة البحر المتوسط حيث استخدمت خمس بيئات غذائية فى تربية يرقات ذبابة الفاكهة هى بيئة مكونة من نخالة القمح (الردة) ، مطحون قشر الفول ، نخالة القمح + مطحون قشر الفول (1:1) ، نخالة القمح + مطحون قشر الفول (1 : 2) ونخالة القمح + مطحون قشرالفول (2 : 1). كما تم تقييم خمس بيئات غذائية اخرى فى تغذية الحشرات الكاملة هى: سكر ، سكر+ بروتين هيدروليزات (3 :1) (البيئـــــة القياسية) ، سكر + بديل البروتين ، بديل البروتين وبروتين هيدروليزات منفردا. واتضح من نتائج الدراسة ان نسب موت اليرقات كانت عالية عند تربيتها على بيئة مطحون قشرالفول (29.4%) فقط وكانت نسب تعذير اليرقات منخفضة عند تغذيتها على بيئة مطحون قشرالفول ايضا ، كما وجد من الدراسة ان تغذية اليرقات على بيئة مطحون قشرالفول أعطت عذارى صغيرة الحجم خفيفة الوزن مقارنة بالعذارى التى تغذت يرقاتها على بيئة مكونة من نخالة القمح + مطحون قشرالفول والتى أعطت عذارى كبيرة الحجم ثقيلة الوزن.

ومن ناحية أخرى، طالت فترة وضع البيض الى 41.5 يوما عند تربية اليرقات على بيئة مطحون قشرالفول منفردا وانخفضت فترة وضع البيض الى 16.5يوما عند تربية اليرقات على بيئة مكونة من نخالة القمح + مطحون قشرالفول (1 : 1). كما امتدت فنرة حياة الاناث والذكور الى 48.4 و48.8 يوما عند تغذية يرقاتها على بيئة مطحون قشرالفول فقط وانخفضت الى 19.7و23.2 يوما عند تغذية اليرقات على بيئة مكونة من نخالة القمح + مطحون قشرالفول (1 : 1). كانت اعلى نسب خروج للحشرات الكاملة عند تربية يرقاتها على بيئة مكونة من نخالة القمح وانخفضت نسب خروج الحشرات الكاملة قليلا عند تربية يرقاتها على نخالة قمح مخلوطة مع قشرالفول. كما وجد من الدراسة انخفاض متوسط عدد البيض/انثى عند تربية يرقات ذبابة الفاكهة على البيئات المختبرة ، وكان أعلى متوسط لعدد البيض/انثى عند تغذية اليرقات على بيئة نخالة القمح وعلى نخالة قمح مخلوطة مع قشرالفول ، كما انخفض متوسط عدد البيض/انثى بدرجة كبيرة عند تربية اليرقات على بيئة مطحون قشرالفول فقط .

واتضح من نتائج الدراسة ايضا ، ان فترة وضع البيض تأثرت كثيرا بتغذية الحشرات الكاملة على البيئات الغذائية المختبرة حيث امتدت فترة وضع البيض الى 21.2 يوما عند تغذية الاناث على بيئة غذائية مكونة من السكر + بديل البروتين (1 :1) وانخفضت فترة وضع البيض الى 14.7 و 15.1 يوما عند تغذية الاناث على البيئة القياسية (سكر + بروتين هيدروليزات (3 :1) وبيئة بديل البروتين ، وعند تغذية الاناث على سكر فقط انخفضت فترة وضع البيض الى 11.1 يوما كما انخفضت فترة وضع البيض بدرجة كبيرة (1.53 يوما) عند تغذية الاناث على بروتين هيدروليزات فقط بدون اضافة سكر. كان اعلى متوسط لعدد البيض79.4 بيضة/انثى عند تغذية الاناث على البيئة القياسية (سكر + بروتين هيدروليزات (3 :1) وانخفض متوسط عدد البيض/انثى عند تغذية الاناث على بيئة مكونة من سكر + بديل البروتين (1 : 1) وبيئة بديل البروتين فقط ، وعندما تغذت الاناث على بيئة مكونة من سكر فقط انخفض متوسط عدد البيض الى 10.7 بيضة/انثى ، كما وضعت الاناث اعداد ضئيلة جدا من البيض عند تغذيتها على بيئة مكونة من بروتين هيدروليزات فقط بدون اضافة السكر . وعموما فان البيئات المختبرة تحتاج مزيدا من الدراسة لتحديد الاحتياجات الغذائية المثلى لتربية اطوار الحشرة المختلفة وتحسين انتاجية وضع البيض بأقل التكاليف.