SOME BIOLOGICAL ASPECTS OF THE PEACH AND MEDITERRANEAN FRUIT FLIES REARING ON ARTIFICIAL DIETS

Ismail Y. A. Sharara [1] and Ali, A. Amin [2]

1-Faculty of Agriculture – Fayoum University

2-Plant Protection Research Institute – Agriculture Research Center.

ABSTRACT

The present work was designed to investigate some biological aspects of the peach fruit fly, *Bactrocera zonata* (Saunders) and the medfly, *Ceratitits capitata* (Wiedmann) on two artificial diets. Two larval diets of **Awadallah, (1978) and Qureshi *et. al.*, (1974)** were experimented for rearing both flies. **Awadallah, (1978)** diet was the most preferable for rearing larvae of both fruit flies indicating by the lowest period of immature stage durations and the highest percentages of survival, additionally this diet is economic and practicable for laboratory manipulation. The gradual decrease of sugar and yeast quantities by modifying the standard diet that based on wheat bran affected significantly the total duration period of immature stages and total recovery percentages of *B. zonata* and C. *capitata*. Regardless the minimum percentages of recovery that resulting from absence of sugar, *C. capitata* seems to be more tolerant for such absence. Effect of food attractant feeding on fecundity and longevity of *B. zonata* adults was studied. The pre-oviposition period was insignificantly varied (15.80 and 14.80 days, for flies that fed on food attractant and protein hydrolysate, respectively). The ovipositioin period of females that fed on food attractant lasted for 24.80 days, while those fed on protein hydrolystae lasted in average of 32.60 days. Significant difference was observed between the two types of feeding. The post-oviposition periods were significantly varied which averaged 16.40 and 17.20 days for females fed on the food attractant and protein hydrolysate, respectively. The longevity of males and females feeding on the food attractant averaged 59.48 and 63.85 days for male and female, respectively, and averaged 62.35 and 67.60 days for those flies feeding on protein hydrolysate. Females that fed on food attractant deposited 127.65 eggs/ female with a daily mean of 6.38 egg/ female/ day, while those fed on protein hydrolysate deposited 517.35 egg/ female with a daily mean of 32.33 egg/ female/ day.

Key words : Tephritidae - fruit fly – *Bactrocera zonata* – *Ceratitits capitata* – - artificial diet -biology.

INTRODUCTION

The family Tephritidae, the true fruit flies, includes about 4000 species arranged in 500 genera **(White & Elson- Harris 1994).** The Mediterranean fruit fly, *Ceratitits capitata* (Wiedemann) and the peach fruit fly, *Bactrocera zonata* (Saunders) are the most tephritids that inflicts significantly economic losses to peach, apricot, guava, mango, fig and citrus allover the governorates of Egypt. Many larval diets were used for rearing tepherids, in Egypt, **Awadalla, (1978)** reported a larval diet based on wheat bran for rearing *C. capitata*, the diet ingredients were locally available**.** Also, **Quershi *et. al.*, (1974)** reported a larval diet based on wheat shorts for rearing *B. zonata* .

Carbohydrates are one of the most nutrient for insect life, such requirement is ensured by body needed for growth, survival and metamorphosis energy. **Tsitsipis, (1992**) mentioned that most of tephritids larval diets contain carbohydrate, sucrose as an energy source, additionally, a change of an ingredient or the concentration thereof, upsets a multidimensional and delicate equilibrium. The ratios, solids to liquids, carbon to nitrogen and relationships between similar classes of nutrients change, affecting the nutritional and physical characteristics of the diet. Contrary to that**, Manoukas, (1977)** concluded that all ingredient of *B. oleae* diet are essential for normal growth and development except sugar**.** While, **Fernandes and Zucoloto (1997)** demonstrated the superior performance *C. capitata* larvae when feeding on the apical portion of papaya compared to larvae that feed on the basal portion, to the higher levels of sugars in the apical portion.

In Egypt, the investigations that concerning relationship of competition between the two fruit flies are still in lack, thus, requiring much effort to understand this relationship. Interpretation such relationship through the biological studies could be support the specialists in order to save more information as a base of fruit flies management programme. Therefore, the mentioned two diets were experimented for selecting one of them to save cultures of the two flies in the laboratory during execution of biological studies depending upon the better biological parameters that can be obtained. Also, the study was conducted to compare the ability of both fruit flies to complete their larval growth under different levels of carbohydrates and yeast by modification the added quantities of sugar and yeast separately.

MATERIALS AND METHODS

The biological experimental studies of the peach fruit fly, *B. zonata* and *C. capitata* were carried out at the laboratory of the Plant Protection Department, Faculty of Agriculture, Fayoum University.

1. The stock culture

The laboratory stock culture of both two fruit flies were started as pupae supplying by Department of Horticultural Research Insect, Plant Protection Research Institute, ARC.The adult of the two mentioned flies were reared under laboratory conditions inside wooden cages (25 x 25 x 25 cm.). Adult flies were fed sugar, and protein hydrolysate (3:1). Water was provided by a plastic container having a cotton wick to be impregnated with water. Day light was available to the adults through a glass window. The oviposited eggs of *B. zonata* were received through receptacle (cylindrical tubes with fine holes), while the oviposited eggs of *C. capitata* were received in the a water pan placed under the cage. Eggs were daily collected and transferred to plastic trays containing larvae diet. The biological parameters were included survival and durations of immature stages under a temperature of 25±1.0°C.

2. Biological aspects studied:

2.a. Egg incubation period and hatchability:

One hundred eggs of each fruit fly species was collected during one hour of oviposition. The collected eggs were placed over a moistened black cloth (10 x 2cm) which divided into equal 10 squares (10 eggs for each square in appropriate arrangement). The moistened toilet paper was placed on larval diet on paper cup measuring 12.5 x 12.5 cm. Eggs hatching was examined twice a day by using sterio-microscope.

2.b. Larval duration and pupation percentage :

The newly hatched larvae were transferred to paper cups containing diet. Such paper cups were placed on larger plastic container in which its bottom a layer of clean sand to receive the fully mature larvae for pupation. Larval period duration was estimated by counting days from placing the newly hatched larvae until larvae pupation, also, pupal recovery percentage was estimated by counting pupated larvae and non- pupated.

2.c. Pupal duration and emergence percentage:

The newly formed pupae for each fruit fly were collected at the same time of pupation. Ten pupae (2 days old) were randomly selected and weighted. The collected pupae were placed on plastic Petri-dishes (12 cm diameter) in rate of 20 pupae per dish in order to study pupal stage duration and emergence percentage.

3. Effect of modifications of the standard diet on durations and survival percentages of immature stage of *B. zonata* and *C. capitata* :

In order to compare the ability of each fruit flies to complete their growth in different levels of feeding and according to the result that indicated the diet based on wheat bran was the better for larval growth, this diet was modified by changing the added quantities of sugar and yeast separately. The modification relies on gradual decrease of sugar and yeast in 4 different levels, 75% (62.25 gm), 50% (41.50 gm), 25% (20.75 gm) and 0% (0 gm) of the standard diet level of sugar and yeast (83 gm). The biological parameters were included duration periods and survival percentages of immature stages under a constant temperature of 25±1.0°C. The parameters were calculated by the same technique mentioned above.

4. Adult stage:

4.a. Effect of food attractant feeding on fecundity and longevity of *B. zonata* adults:

Two sources of protein hydrolysated were selected to estimate their efficiency as a source of protein for adult flies feeding of *B. zonata* adults. The 1st source was in solid state, while the other was in liquid state (Cable Star) supplied by the Central Laboratory of Pesticides, Formulations Department. For each treatment, ten pairs of newly emerged flies of *B. zonata* were randomly selected and reared inside a small cage (15 x 15 x 15 cm) providing with granules of sugar, and protein hydrolyzate and water. The liquid source of protein was presented to the flies by saturated sponge, while sugar and water were presented as mentioned above. Such cages were kept inside an incubator adjusted to 25°C± 1.0 and a photo period of L : D, 14: 10. The experimental cages were replicated 5 times.

For estimating fertility, eggs were daily received on yellow receptacle and placed as mentioned above to estimate fertility and the number of eggs per each cage was counted by using a black cloth divided into squares to facilitate counting.

The statistical analysis:

The statistical analysis was done as one way ANOVA and means separated was conducted by using L.S.D. at the probability of 5% (**Costat. 1990).**

RESULTS & DISCUSSION

1. Larval diet selecting :

Table (1) shows the effect of the two diets that based on wheat bran and wheat shorts on the duration periods and survival of immature stages of the two flies (*B. zonata* and *C. capitata*).

B.1.a. Egg stage :

B.1.a.1. Egg incubation period :

The tabulated data indicated that the lowest required time for completion embryogenesis of *B. zonata* averaged 2.62 days on wheat bran diet than that on wheat shorts diet (2.72 days). Statistically, insignificant variation is observed between the two averages. On the other side, the averages of *C. capitata* eggs were significantly varied (2.36 and 2.92 days on wheat bran and wheat shorts diets, respectively).

For *B. zonata*, these results are in similar to those obtained by the following authors rearing on artificial diets at an average temperature of 25°C; **Rana *et. al.*, 1992** (2.6 days), **Ducky *et. al.*, 2004** (49 hours), and **Afia, 2007** (2.32 days). While these results varied somewhat with that reported by **El-Minshawy *et. al.*, 1999** (3.5 days), Some results are fluctuated up and down above the obtained results according to the used diet or rearing conditions. For *C. capitata*, the obtained result is similar to those previously obtained by **Vargas *et. al.*, 2000,** under temperature of 25°C.

Table (1): Effect of wheat bran and wheat shorts diets on duration periods (days) and survival % on immature stages of *B. zonata* and *C. capitata* under constant conditions (25°C±1.0 and 70 % ±5 R. H%).

Stage	*B. zonata*			*C.capitata*		
	Wheat bran diet	**Wheat shorts diet**	***P<0.05***	**Wheat bran diet**	**Wheat shorts diet**	***P<0.05***
Egg incubation period (days) Mean± S.E Range	2.62±0.13 (2-3)	2.72±0.07 (2-3)	-	2.36±0.11 (2-3)	2.92±0.72 (2-3)	S
Hatchability %	95.40	92.60	-	94.17	81.40	S
Larval duration (days) Mean± S.E Range	9.19±0.46 (8-10)	9.33±0.13 (8-10)	-	6.63±0.28 (6-8)	8.13±0.37 (7-9)	S
Pupation %	92.2	85.8	S	91.60	84.20	S
Pupal duration period (days) Mean± S.E Range	10.22±0.33 (9-11)	12.39±0.27 (11-13)	-	9.29±0.22 (9-10)	11.62±0.42 (11-12)	S
Pupal weight mean (mg)	11.94	11.04	S	8.43	7.62	S
Emergence %	95.80	77.80	S	92.60	76.60	S
Total immature duration (days) Range	22.03 (19-24)	24.44 (21-26)	S	18.28 (17-21)	22.67 (20-24)	S
Total recovery %	84.27	68.16	S	79.87	50.76	S

B.1.a.2. Egg hatchability :

Data in Table (1) reveals that the highest egg hatchability of *B. zonata* (95.40 %) for wheat bran diet was nearly to that of wheat bran shorts (92.60%) without any significant difference between the two diets. While, a significant difference is observed between the average hatchability percentage

of *C. capitata* on the two diets (94.17 and 81.40% on wheat bran and wheat shorts diets, respectively).

The hatchability of *B. zonata* eggs was found to be similar to that reported previously by, **Qureshi *et. al.*, 1993** and **Afia, 2007** (95.04%), contrary to them these results vary with that of **Duyck *et. al.*, 2004** (71%), **El-Naggar, 2004** (77.00) under the same temperature of rearing. Differences maybe due to period of flies adaptation for laboratory rearing for successive generations.

B.1.b. Larval stage :

B.1.b.1. larval duration :

Data in Table (1) indicates that the shortest larval durations of *B. zonata* and *C. capitata* (9.19 days and 6.63 days, respectively) were recording on wheat bran diet .While, the longest larval duration for both flies was recorded on the diet based on wheat shorts (9.33 and 8.13 days, respectively)

Concerning larval duration of *B. zonata*, the present results nearly agree with those reported by **Qureshi *et. al.*, 1974 (9.3 days), Rana *et. al.*, 1992 (9.4 days)**, **El-Minshawy *et. al.*, 1999** (9.7 days) and **Afia, 2007** (8.47 days). While varying with **Tigavatan and Areekul, 1984** (7.4 days)**,** and **Ducyck *et. al.*, 2004**(5.0 days). Regarding results that obtained of *C. capitata*, an approximate agreement could be observed with **Vargas *et. al.*, 2000** and **Afia, 2007** (6.5-7.40) days**.**

B.1.b.2. Pupation percentage :

Data in Table (1) shows that the highest pupation percentage of *B. zonata* (92.20%) and *C. capitata* (91.60%) were resulted from larvae that reared on wheat bran diet. The previously pupation percentages were varied with those obtained for wheat shorts diet (85.80 and 84.20 %, respectively).

The pupation percentage of *B. zonata* larvae was found to be in remarkable variation to that reported by **El-Minshawy *et. al.*, 1999** and **Amin, 2003** (79.21%-85.86%), While, it was near to **Qureshi *et. al.*, 1974** (86.65%)**, Tigavatan and Areekul, 1984** (89.75%)**, Qureshi *et. al.*, 1993** (88.00%)**,** and **Afia, 2007** (94.83%). Differences maybe due to period of flies adaptation for laboratory rearing for successive generations. It should be noticed that the pupation percentages of *B. zonata* on the diet that based on wheat shorts (85. 80%) are similar to that reported by **Qureshi *et. al.*, 1974** (86.65%) for the same diet. The pupation percentage of *C. capitata* was found to be similar to that of **Afia, 2007** (89.42%).

B.1.c. Pupal stage :

B.1.c.1. Pupal duration :

Data in Table (1) indicates that the shortest pupal durations of both *B. zonata* and *C. capitata* on the diet that based on wheat bran were 10.22 and 9.29 days, respectively. For *B. zonata* insignificant variation is observed for this average compared with that obtained from diet based on wheat shorts (12.39), while a significant variation was observed for that of *C. capitata* (11.62 days).

At the same temperature, literature varied in which nearly agree with those reported for *B. zonata* by **Qureshi *et. al.*, 1974** (10.81days)**, Tigavatan and Areekul, 1984** (11 days)**,Rana *et. al.*, 1992** (9.4 days), **El-Minshawy *et. al.*, 1999** (9.50 days), **Ducyck *et. al.*, 2004** (10.0 days) and **Afia, 2007** (11.2 days). Concerning the pupal durations that were reported for *C. capitata*, 6.50 days (**Vargas *et. al.*, 2000)** and 9.83 days (**Afia, 2007).**

B.1.c.2. Pupal weight :

For both flies, the pupal weight was seen to significantly effected by type of the diet. For *B. zonata*, the mean pupal weight averaged 11.94 and 11.04 mg when reared on the diet based on wheat bran and wheat shorts, respectively. The average of pupal weights that were reported were 13.0 mg 12.9 mg (**Afia, 2007**).

For *C. capitata*, the mean pupal weight averaged 8.43 and 7.62 mg when reared on the diet based on wheat bran and wheat shorts, respectively. This result goes in line that the diet based on wheat bran provided quality pupae than the other diet. The average of pupal weights that were reported were 8.0 mg (**Afia, 2007**).

B.1.c.3. Percentages of adult emergence:

Data in Table (1) shows that the highest adult emergence percentage of *B. zonata* (95.80%) and *C. capitata* (92.60%) were resulted from larvae that reared on wheat bran diet. While, the percentages of adult emergence for the larvae that reared on diet based on wheat shorts were 77.80 and 76.60 %, for *B. zonata* and *C. capitata*, respectively.

The emergence percentage of *B. zonata* is found to be in remarkable variation to that reported by **El-Minshawy *et. al.*, 1999** (87.10 %), **Qureshi *et. al.*, 1974** (99.0%) **Tigavatan and Areekul, 1984** (92.0 %) **Qureshi *et. al.*, 1993** (97.67%)**,** and **Afia, 2007** (96.51%). Generally, the total immature duration indicated the advantage of the diet that based on wheat bran, for both flies, the lowest of total immature stage of *B. zonata* and *C. capitata* were 22.03 and 18.28 days on the diet based on wheat bran, respectively compared to 24.44 and 22.67 days on the diet based on wheat shorts, respectively.

Moreover, the total recovery percentage ensured the same advantage of the diet that based on wheat bran, for both flies, the highest one of *B. zonata* and *C. capitata* were 84.27 and 79.87% on wheat bran diet compared to 68.16 and 50.76%, respectively on wheat shorts diet.

It could be concluded that the diet based on wheat bran is most preferable for rearing larvae of both fruit flies indicating by the best biological parameters had been obtained; the lowest period of immature stage durations, also the highest percentages of survival, as well as this diet is economic and practicable for laboratory manipulation.

B.2 Effect of modifications of the standard diet on duration and survival percentages of immature stage of *B. zonata* and *C. capitata* :

The nutrition of tephritid in the larval stage is considered very important, qualitatively and quantitatively not only to provide energy and building material for survival, growth and development, but also storage material to be utilized in the pupal stage which required for metamorphosis to adult stage (**Tsitsipis, 1992)**. In order to assess the ability of each flies to complete larval growth on different levels of sugar and yeast as mean sources of carbohydrates and protein, respectively, the sugar and yeast quantities were gradually modified in different quantities 75% (62.25 gm.,), 50 % (41.50 gm.,), 25% (20.75 gm.,) and 0% (0 gm.,) of the standard diet level of sugar and yeast (83 gm.,).

B.2.a. Sugar modifications:

As shown as in Table (2&3) the effect of sugar quantity modification on durations and survival percentages of immature stages of *B. zonata* and *C. capitata*.

B.2.a.1. *B. zonata* :

a-Egg stage :

The tabulated data indicates that the required time for completion embryogenesis of *B. zonata* averaged 2.68, 2.71, 2.70 and 2.76 days on the different levels of sugar modified quantities 62.25, 41.50, 20.75 and 0 gm., respectively in comparison with average of 2.62 days for the standard diet (83gm.,). Statistically, insignificant variation is observed among the mentioned means. Also, the egg hatchability percentages on the different levels of sugar were insignificantly varied. The mean percentages were 94.55, 93.60, 92.80 and 92.40 % on the gradual quantities 62.25, 41.50, 20.75 and 0 gm., respectively in comparison with that recorded on the standard level (95.40%).

Table (2): Effect of modification of the standard diet (sugar changes) on duration periods (days) and survival % in immature stages of *B. zonata* under constant conditions (25°C±1.0 and 70 % ±5 R. H%)

Sugar levels / Immature stages	Standard diet (83 gm)	75% (62.25 gm)	50% (41.50 gm)	25% (20.75 gm)	0% (0 gm)	LSD_{05}
Egg incubation period (days)	2.62	2.68	2.71	2.70	2.76	IN*
Hatchability %	95.40	94.55	93.60	92.80	92.40	IN*
Larval duration (days)	9.19C	10.26B	10.32B	11.02A	9.96B	0.47
Pupation %	92.2A	90.20A	78.40B	66.60C	47.40D	3.56
Pupal duration (days)	10.22B	10.52B	10.42B	11.20A	11.16A	0.53
Pupal weight (mg)	11.94A	11.32A	10.16B	10.39B	7.46C	0.65
Emergence %	95.80A	89.20B	83.45C	79.20D	29.20E	3.78
Total of immature durations (days)	22.03C	23.46B	23.45B	24.92A	23.80B	0.69
Total recovery%	84.27A	75.83B	61.24C	48.95D	12.79E	5.25

IN differences among means are insignificant. *

Means followed by the same type of letter for each row are insignificant

b-Larval stage :

Data in Table (2) indicates that the larval durations were 10.26, 10.32, 11.02 and 9.96 days for larvae feeding on diet containing 62.25, 41.50, 20.75 and 0 gm., respectively. While, the shortest larval duration was 9.19 days on the standard quantity of sugar.

Notably, misleading is established for being absence of sugar reduced the larval duration period, in fact, absence of sugar obligated the larvae to pupate earlier before completion their larval stage, thus will be later indicated by larvae failure for pupation and the mean pupal weight.

Data in Table (2) showed that the pupation percentages were 90.20, 78.40, 66.60 and 47.40% for larvae feeding on diet containing 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively. While, the highest one (92.2%) was recorded on the standard level of sugar in the diet. Statistically, significant variations are observed among the mean percentages.

Clearly, the effect of gradual decrease of sugar quantities starts to be significant in the larval stage indicated by extending the larval stage duration from 9.19 to 11.02 day for the standard and 20.75 gm., respectively. Also,

reducing the mean percentage of pupation from 92.20 to 47.40 % for the standard diet and 0 gm of sugar.

c-Pupal stage :

Data of Table (2) indicates the pupal durations were 10.52, 10.42, 11.20 and 11.16 days, for the pupae obtained from diets containing 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively. While, the shortest one (10.22 days) was recorded on the standard level of sugar. Significant variation is observed for these averages.The mean pupal weight was seen affected by gradual reducing of sugar quantity, the mean pupal weight averaged 11.32, 10.16, 10.39 and 7.46 mg for the pupae that fed on the 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively. While the pupal weight of that obtained from standard level was 11.94 gm. Significantly, the means were varied.

Data in Table (2) shows that the highest emergence mean percentage was 95.80% for the standard diet, while, the mean percentages of other modified diets of sugar quantity were 89.20, 83.45 and 79.20 % for the pupae that fed on 62.25, 41.50 and 20.75 gm.,of sugar, respectively. The pupae that obtained from diet being absence of sugar (0 gm) recorded 29.20% as mean percentage of emergence. Significantly, the mentioned emergence percentages were varied.

Concerning the total duration of immature stages, the shortest duration was recorded for the standard diet (22.03 days) followed by those fed on diet free of sugar (0 gm.,) recording 3.80 days. The rest modified diets came as follow, 62.25, 41.50 and 20.75 gm., with mean durations of 23.46, 23.45 and 24.92 days. The total duration for those fed on diet absent of sugar is confused whereas their individuals recorded the significant longest pupal duration (11.16 days) coinciding with the lowest mean percentage of pupation (47.70%) and lowest pupal weight (7.46 mg).

Regarding the mean percentage of total recovery, the highest significantly percentage was recorded for those fed on the standard diet (84.27 %), while the lowest one was belonging to those fed on modified diet without sugar (12.79%). The other mean percentages came in order according to their content of sugar quantity, 62.25, 41.50 and 20.75 gm., of sugar, respectively with respective mean percents of 75.83, 61.24 and 48.95%.

It could be concluded that the immature stages of *B. zonata*, particularly larvae and pupae were influenced by the gradual decrease of sugar quantity modifying of the standard diet based on wheat bran. This affection was reflected by the significant length of larval duration which extending during the pupal stage, consequently, the total immature stages duration was also extended comparing to that recorded on the standard diet. Also, feeding larvae on gradual decrease of sugar affected on survival percentages, particularly pupation and emergence percentages which reduced the total recovery of egg to fly.

B.2.a.2. *C. capitata* :

a-Egg stage :

Data in Table (3) indicates that the means of incubation periods were 2.39, 2.40, 2.38 and 2.41 days on the gradual quantities 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively in comparison with that recorded on the standard level (2.36 days).

Mean percentages of hatchability were 93.40, 92.70, 90.50 and 91.40 % on the gradual decrease of sugar modified quantities 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively in comparison with that recorded on the

standard level (94.17%). Significant differences were observed among the average hatchability percentage on the different levels of sugar .

b-Larval stage :

The larval duration increased gradually as the sugar quantity decreased averaging 7.82, 9.18, 9.33 and 9.95 days for larvae feeding on diet containing 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively, with significantly variation. While, the shortest larval duration (6.63 days) was recorded for larvae feeding on the standard diet.

Data in Table (3) reveals that the mean pupation percentage averaged 90.80, 83.40, 80.60 and 70.20 for larvae that feeding on diets containing 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively. The mean percentage of pupation for larvae feeding on the standard diet was 91.60%. There were significantly variations among the values of larval pupation.

Clearly, the effect of gradual decrease of sugar quantities starts to be significant in the larval stage indicated by extending the larval stage duration from 6.63 to 9.95 days for the standard and 0 gm., respectively, also, reducing the mean percentage of pupation from 91.60 to 70.20 % for the standard diet and 0 gm, respectively.

Table (3): Effect of modification of the standard diet (sugar changes) on duration periods (days) and survival % in immature stages of *C. capitata* under constant conditions (25°C±1.0 and 70 % ±5 R. H%)

Sugar levels / Immature stages	Standard diet (83 gm)	75% (62.25 gm)	50% (41.50 gm)	25% (20.75 gm)	0% (0 gm)	LSD_{05}
Egg incubation period (days)	2.36	2.39	2.40	2.38	2.41	IN*
Hatchability %	94.17a	93.40ab	92.70ab	90.50c	91.40bc	2.16
Larval duration (days)	6.63d	7.82c	9.18b	9.33b	9.95a	0.18
Pupation %	91.60a	90.80a	83.40b	80.60c	70.20d	2.73
Pupal duration (days)	9.29d	10.62c	11.73b	11.76b	13.62a	0.42
Pupal weight (mg)	8.43a	8.23ab	7.84b	6.97c	5.77d	0.47
Emergence %	92.60a	89.70a	87.80a	66.84b	52.40c	5.34
Total of immature durations (days)	18.28d	20.83c	23.31b	23.47b	25.98a	0.80
Total recovery%	79.87a	76.07b	67.88c	48.76d	32.47e	3.63

*IN differences among means are insignificant.

Means followed by the same type of letter for each row are insignificant

c-Pupal stage :

Data in Table (3) indicates that the pupal durations averaged 10.62, 11.73, 11.76 and 13.62 days, for the pupae obtaining from the 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively. While, the shortest pupal duration (9.29 days) was recorded for larvae obtained from the standard diet. Significant variation is observed for the mentioned averages. The mean pupal weight averaged 8.23, 7.84, 6.97 and 5.77 mg., for the pupae that fed on 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively, while the pupae

obtained from the standard diet averaged 8.43 mg, the means were significantly varied.

Data in Table (3) shows that the highest emergence mean percent was 92.60 % for the standard diet, while, the rest mean percentages of other modified of sugar quantity were 89.70, 87.80, 66.84 and 52.40% for the pupae that fed on 62.25, 41.25, 20.75 and 0 gm., of sugar, respectively. Significantly, the mentioned emergence percentage were varied .

Regarding the total duration of immature stages, the shortest duration was recorded for the standard diet (18.28 days), the rest modified diets came as follow; 62.25, 41.50 and 20.75 gm with mean durations of 20.83, 23.31 and 23.47 days, respectively, followed by those fed on diet free of sugar (0 gm.,) recording 25.98 days. Concerning the mean percentage of total recovery, the highest significantly, percentage was recorded for those fed on the standard diet (79.87 %), while the lowest one was belonging to those fed on modified diet without sugar (32.47%). The other mean percentages came according to their quantitative content of sugar, 62.25, 41.50 and 20.75 gm. of sugar, respectively, with respective mean percentages of 76.07, 67.88 and 48.76%.

It could be concluded that the immature stages of *C. capitata* somewhat affected for the gradual decrease of sugar quantity modifying of the standard diet based on wheat bran. This effect was reflected by the significant length of larval duration which extending during the pupal stage, consequently, the total immature stages duration was also extended comparing to that recorded on the standard diet. In addition, feeding larvae on gradual decrease of sugar affected on survival percentages, particularly pupation and emergence percentages that reduced relatively the total recovery of egg to fly.

Generally, the gradual decrease of sugar quantity by modifying the standard diet that based on wheat bran affected significantly the total duration period of immature stages and total recovery percentages of *B. zonata* and C. *capitata*. Regardless the minimum percentages of recovery that resulting from absence of sugar as main source of carbohydrates, *C. capitata* seems to be more tolerant for such absence. Probably, the wide host range of *C. capitata* genetically provides such adaptation.

B.2.a. Yeast modifications:

As shown as in Table (4&5) the effect of yeast quantity modification on durations and survival of immature stages of *B. zonata* and *C. capitata*.

B.2.a.1 *B. zonata* :

a. Egg stage :

The tabulated data indicates that the means of incubation periods of *B. zonata* averaged 2.59, 2.67, 2.68 and 2.70 days on the different levels of yeast quantity 62.25, 41.50, 20.75 and 0 gm., respectively in comparison with average of 2.62 days for the standard diet (83 gm). Statistically, insignificant variation is observed among the mentioned means.

Data in Table (4) reveals that egg hatchability percentages on the different levels of yeast were insignificantly varied between them and significantly varied with the standard diet. The mean percentages were 92.60, 92.34, 92.80 and 92.56 % on the gradual quantities 62.25, 41.50, 20.75 and 0 gm., respectively in comparison with that recorded on the standard diet of yeast (95.40%).

b. Larval stage :

Data in Table (4) indicates that the shortest larval durations was 9.19 days on the standard level of yeast, while the other yeast levels recorded 9.48, 9.80, 9.82 and 9.69 days on the modified diets containing 62.25, 41.50, 20.75 and 0 gm of yeast, respectively. Notably and statistically, significant difference is observed between those larvae fed on the standard level of yeast and those fed on diet free of yeast.

Data in Table (4) shows that the highest pupation percentage of (92.88%) was recorded on the level of 62.25 gm. The rest percentages were 91.23, 92.03 and 92.76 % for larvae feeding on the diets containing 41.50, 20.75 and 0 gm., of yeast, respectively. While, it was 92.20% for larvae feeding on the standard quantity of the diet. Statistically, insignificant variations are observed among the mean percentages.

Clearly, the effect of gradual decrease of yeast quantities seems to be inefficient for the larval stage. Although, significant variation, this variation is still minimal degree (LSD_{05}= 0.21) Also, the mean percentage of pupation were not affected by such changes of modified yeast quantities.

c-Pupal stage :

Data in Table (4) indicates that the pupal durations of *B. zonata* were 10.31, 10.29, 10.41 and 10.48 days, for the pupae obtaining from 62.25, 41.50, 20.75 and 0 gm., of yeast, respectively, comparatively to 10.22 days for larvae that fed on the standard. Insignificant variation is observed among these averages.

Table (4): Effect of modification of the standard diet (yeast changes) on duration periods (days) and survival % in immature stages of *B. zonata* under constant conditions (25°C±1.0 and 70 % ±5 R. H%)

Yeast levels / Immature stages	Standard diet (83 gm)	75% (62.25 gm)	50% (41.50 gm)	25% (20.75 gm)	0% (0 gm)	LSD_{05}
Egg incubation period (days)	2.62	2.59	2.67	2.68	2.70	IN*
Hatchability %	95.40A	92.60B	92.34B	92.80B	92.56B	1.58
Larval duration (days)	9.19C	9.48B	9.80A	9.82A	9.69A	0.21
Pupation %	92.2	92.88	91.23	92.03	92.76	IN*
Pupal duration (days)	10.22	10.31	10.29	10.41	10.48	IN*
Pupal weight (mg)	11.94	11.87	11.81	11.93	11.83	IN*
Emergence %	95.80A	92.70B	92.94B	91.93B	91.81B	1.58
Total of immature durations (days)	22.03C	22.38B	22.76A	22.91A	22.87A	0.29
Total recovery%	84.27A	79.70B	78.29B	78.53B	78.83B	2.81

*IN differences among means are insignificant.

Means followed by the same type of letter for each row are insignificant

Also, the mean pupal weight was seen to be influenced by gradual reducing of yeast quantity, the mean pupal weight averaged 11.87, 11.81, 11.93 and 11.83 mg., for the pupae that fed on the levels of 62.25, 41.50, 20.75 and 0 gm., of yeast, respectively, while the pupae resulted from

standard diet feeding averaged 11.94 mg. Insignificantly, the means were varied .

Data in Table (4) shows that the highest percentage of emergence was 95.80 % for the standard diet, while, the mean percentages of other modified of yeast quantity were 92.70, 92.94 and 91.93 % for the pupae that fed on 62.25, 41.50 and 20.75 gm.,of yeast, respectively. Although, the pupae that obtained from diet being absence of yeast (0 gm.,) recorded 91.81 % as mean percentage of emergence. Significantly, the mentioned emergence percentages were varied.

Concerning the total duration of immature stages, the shortest duration (22.03 days) was recorded for the standard diet (83 gm.,) followed by those fed on diet modified with 62.25 gm., of yeast recording 22.38 days, the rest modified diets came as follow 41.50, 20.75 and 0 gm., with mean durations of 22.76, 22.91 and 22.87 days . The total duration for larvae fed on diet absent of yeast is approximated to that fed on 20.75 gm., of yeast, although a significant variation is observed, this variation is so critical (LSD_{05}=0.29)

Regarding the mean percentage of total recovery, the highest significantly percentage was recorded for larvae fed on the standard diet (84.27 %), while the lowest one was belonging to those fed on modified diet without yeast (78.83%). The other mean percentages came in order to their content of yeast quantity, 62.25, 41.50 and 20.75 gm., of yeast with respective mean percentages of 79.70, 78.29 and 78.53% .

It could be concluded that the immature stages of *B. zonata* were not affected severely by the gradual decrease of yeast quantity modifying of the standard diet based on wheat bran. Such affection was reflected by the critical significant length of larval duration and significant length of pupal duration. Consequently, the total immature stages duration was also similar somewhat comparing to that recorded on the standard diet. Also, feeding larvae on gradual decrease of yeast were not affected greatly on survival percentages, particularly pupation and emergence percentages which effected the total recovery of egg to fly.

B.2.a.2. *C. capitata* :

a-Egg stage :

Concerning the incubation period of *C. capitata*, the averages were insignificantly varied recording 2.41 days on the gradual quantities 62.25, 41.50, and 0 gm., respectively, and 2.43 days for 20.75 gm., of yeast in comparison with that recorded on the standard level (2.36 days).

Percentages of hatchability, were 93.60, 92.40, 93.20 and 91.80 % on the gradual quantities 62.25, 41.50, 20.75 and 0 gm., respectively in comparison with that recorded on the standard level (94.17%). Insignificant differences were observed among the average hatchability percentage.

Table (5): Effect of modification of the standard diet (yeast changes) on duration periods (days) and survival % in immature stages of *C. capitata* under constant conditions (25°C±1.0 and 70 % ±5 R. H%)

Yeast levels / Immature stages	Standard diet (83 gm)	75% (62.25 gm)	50% (41.5 gm)	25% (20.75 gm)	0% (0 gm)	LSD_{05}
Egg incubation period (days)	2.36	2.41	2.41	2.43	2.41	IN*
Hatchability %	94.17	93.6	92.40	93.20	91.80	IN*
Larval duration (days)	6.63	6.68	6.71	6.65	6.71	IN*
Pupation %	91.60	92.20	91.56	91.40	90.80	IN*
Pupal duration (days)	9.29d	9.36c	9.40bc	9.41ab	9.45a	0.04
Pupal weight (mg)	8.43 **a**	8.42ab	8.40b	8.36c	8.33d	0.02
Emergence %	92.60abc	92.80ab	93.20a	91.20bc	90.84c	1.74
Total of immature durations (days)	18.28b	18.44a	18.51a	18.48a	18.54a	0.12
Total recovery%	79.87a	80.09a	78.85a	77.69ab	75.72b	2.69

*IN differences among means are insignificant.

Means followed by the same type of letter for each row are insignificant

b-Larval stage :

The mean larval duration averaged 6.68, 6.71, 6.65 and 6.71 days for larvae feeding on diets containing 62.25, 41.50, 20.75 and 0 gm., of yeast, respectively. The shortest larval duration was 6.63 for larvae feeding on the standard diet. Insignificant variation is shown among the mentioned means.

Data in Table (5) reveales that the mean pupation percentages averaged 92.20, 91.56, 91.40 and 90.80 for larvae that feeding on diets containing 62.25, 41.50, 20.75 and 0 gm., of yeast, respectively. The pupation percentage of the standard diet was 91.60%. Statistically, insignificant variations are observed among the mean percentages.

Obviously, the effect of gradual decrease of yeast quantities starts to be insignificant in the larval stage of *C. capitata* indicated by relative steadying the larval stage duration from 6.63 to 6.71 days as a range for the standard diet, 62.25, 41.50, 20.75 and 0 gm., of yeast. Also, the mean percentage of pupation was not affected whereas ranged between 90.80 and 92.20% for larvae that feeding on the diets containing standard quantity, 62.25, 41.50, 20.75 and 0 gm., of yeast.

c-Pupal stage :

Data in Table (5) indicates that the pupal durations averaged 9.36, 9.40, 9.41 and 9.45 days, for the pupae obtained from diets containing 62.25, 41.50, 20.75 and 0 gm., of yeast, respectively. While, the shortest pupal duration was 9.29 days for the pupae resulting from the standard diet feeding. Significant variation is observed for the mentioned averages.

The mean pupal weight averaged 8.43 mg., for that obtained from standard diet feeding, while, it averaged 8.42, 8.40, 8.36 and 8.33 mg., for the

pupae that obtained from larvae fed on diets containing 62.25, 41.50, 20.75 and 0 gm., of sugar, respectively, the means were significantly varied.

Data in Table (5) shows that the percentage of emergence means were 92.60, 92.80, 93.20, 91.20 and 90.84 % for the standard diet, 62.25, 41.25, 20.75, and 0 gm., of yeast, respectively. Significantly, the mentioned emergence percentage were varied.

Regarding the total duration of immature stages, the durations were as follow; 62.25, 41.50, 20.75 and 0 gm., with mean durations of 18.44, 18.51, 18.48 and 18.54 days, respectively. While the shortest one was 18.28 days on the standard diet.

Concerning the mean percentage of total recovery, the highest significantly, percentage was recorded for those fed on diet content of yeast quantity 62.25 gm., (80.09 %), while the lowest one was belonging to those fed on modified diet without yeast(75.72%). The other mean percentages came in order according to their content of yeast quantity, 62.25, 41.50 and 20.75 gm of yeast with respective mean percentages of 80.09, 78.85 and 77.69%.

It could be concluded that the immature stages of *C. capitata* were not influenced by the gradual decrease of yeast quantity modifying of the standard diet based on wheat bran. Such reaction was evaluated by stability of larval duration and pupal stage, consequently, the total immature stages duration was also stable comparing to that recorded on the standard diet. In addition, feeding larvae on gradual decrease of yeast was not affected on survival percentages, particularly pupation and emergence percentages that reduced relatively the total recovery of egg to fly. Clearly, yeast quantity for such larval diet should be reviewed to minimize the cost.

Naturally, fruit flies vary in their requirements of protein in its larval stage, although most of their favorable hosts are poor of protein quantity. **Cangussu and Zucoloto, (1997)** indicated that protein deficiency during the immature stage increased the duration of the larval stage. **Cocareli *et. al.*, (1988)** determined the minimum amount of brewers' yeast required to produce the best development of the tephritid *C. capitata*, the appropriate range of yeast is about 4.0 to 4.5 gm/150 ml of diet.

Wheat bran which representative in the diet as a bulking agent contains a considerable amount of protein that maybe supplied larvae with its requirement of protein. In mean time, the gradual decrease of yeast was associated with a gradual decrease of sugar as ratio, thus maybe maximizing the role of sugar to be responsible for such results.

Generally, the gradual decrease of yeast quantity by modifying the standard diet that based on wheat bran affected significantly the total duration period of immature stages and total recovery percentages of *B. zonata* and C. *capitata*. Yeast content as a rich source of protein maybe play an important role for larval development, but in minimal rates. Such rates of protein should be supplied in minimal requirements to save coast of added yeast without significant beneficial.

B.4 Adult stage studies :

B.4.a. Effect of food attractant feeding on fecundity and longevity of *B. zonata* adults:

Table (6) shows the effect of feeding *B. zonata* flies on food attractant (Cable star) under constant temperature of 25±1.0° C and mean R. H of 70-75

%. The food attractant contains a protein hydrolysate in a liquid form and locally produced by Central Laboratory of Pesticides, ARC.

Regarding the pre-oviposition period, the female flies were insignificantly varied; they stared to deposit eggs after averages of 15.80 and 14.80 days, for flies that fed on food attractant and protein hydrolysate, respectively. The obtained results are in agreement with those reported by **Qureshi *et. al.*, 1974** (14.2 days), **Rana *et. al.*, 1992** (15.2 days), and **Afia, 2007** (16.31 days) while, it disagree with those reported by **El-Minshawy *et. al.*, 1999** (45-60 days).

Table (6) : Effect of food attractant (Cable star) feeding on fecundity and longevity of *B. zonata* comparing with protein hydrolysate under conditions of 25±1.0 C° and 70±5 % R. H.

Longevity		Flies fed on solution of protein hydrolysat	Flies fed on Standard food (Protein hydrolysate)	*P<0.05*
Preoviposition period (days)		15.80±0.58	14.80±0.37	-
Oviposition period (days)		24.80±0.37	32.60±0.37	S
Post-oviposition period (days)		16.40±0.58	17.20±0.32	S
Longevity	♂	59.48	62.35	-
	♀	63.85	67.60	-
Mean daily eggs/ female		6.38	32.33	S
Total eggs / female		127.65	517.35	S
Hatchability%		91.82	93.76	-

Concerning the ovipositioin period, the females that fed on food attractant last for 24.80 days, while those fed on protein hydrolystae last in average of 32.60 days. Significant difference was observed between the two types of feeding.

The mentioned result disagree with such results reviewed, the oviposition period was reported to vary from 70-90 days by **El-Minshawy *et. al.*, (1999**), while it was 14.8 days as recorded by **Rana *et. al.*, (1992).** In addition, the post-oviposition periods were significantly varied which averaged 16.40 and 17.20 days for females fed on the food attractant and protein hydrolysate, respectively. These result agree with that reported by **El-Minshawy *et. al., (*1999)** 12-16 days**,** while it disagree with **Rana *et. al.*, 1992** (8.4 days), and **Afia, 2007** (5.84 days).

B.4.a. Adult longevity :

Regarding the longevity of both flies, the adult were insignificantly influenced by the type of feeding, the longevity of males and females feeding on the food attractant averaged 59.48 and 63.85 days for male and female, respectively, and averaged 62.35 and 67.60 days for those flies feeding on protein hydrolysate.

Longevity of *B. zonata* was reported by some authors; **Qureshi *et. al.*, (1974)** 56.3 and 48.8 days for female and male, respectively, **Rana *et.al.*, (1992)** male and female adult was 44.3 and 58.2 days, respectively at 28 ± 2^{o}C

and 70% RH. **Rana *et. al.*(1993)** female longevity 52.7 days. **Amin, (2003)** male and female 39.55 and 43.20 days, respectively. **Afia (2007)** female and males were 76.78 and 64.16 days respectively. **El- Minshawy *et. al.* (1999)** was 100 to 145 days. Differences of reported longevity maybe attributed to the type of food during larval stage and mainly the adult stage feeding, flies that reared on protein hydrolysate seem to be more aging than other feeding.

B.4.a. Adult fecundity:

Protein hydrolysate feeding was reflected significantly, females that fed on food attractant deposit 127.65 eggs/ female with a daily mean of 6.38 eggs/ female/ day, while those fed on protein hydrolysate deposit 517.35 eggs/ female with a daily mean of 32.33 eggs/ female/ day. Altough, the hatchability percentages of both flies feeding were insignificantly varied.

These results agree with those reported by **El-Minshawy *et. al.*, 1999** (480.4 eggs / female) and **Afia, 2007** (587 eggs / female)**,** while disagree with **Qureshi *et. al.*, 1974 (**212**.** eggs / female) and **Rana *et. al.*, 1993** (245.3 eggs / female).

Naturally, nutrients in the adult stage of tepheritids are required for survival and reproduction. Protein hydrolysates are a good source for vitamins and minerals, beside being rich in amino acids, as a result, fecundity of females increased greatly. Protein greatly improved fecundity and it was required for males for mating, but it could not be utilized unless mineral salts were present. Vitamins were indispensable for egg fertility (**Tsitsipis, 1992).** Thus, explaining the significant differences between females that fed on food attractant and those fed on protein hydrolysate, although the food attractant contains protein hydrolysate, it seems to be a poor in its quantity which reflecting in the period of oviposition and total produced eggs for each female. However, food attractant should be improved in order to save a local protein source.

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بعض المعالم البيولوجية لذبابتي ثمار الخوخ وفاكهة البحر الأبيض المتوسط المربأة على بيئات صناعية

اسماعيل يوسف أمين شرارة[١] و علي أحمد أمين[٢]

١- قسم وقاية النبات - كلية الزراعة – جامعة الفيوم - مصر

٢- معهد بحوث وقاية النباتات – مركز البحوث الزراعية - مصر

تعد ذبابتا ثمار الخوخ وفاكهة البحر الأبيض المتوسط من اخطر الآفات على ثمار الفاكهة في مصر ، وتناول هذا البحث عدداً من الدراسات البيولوجية وتم تقييم بيئتا **Awadallah, (1978)** و **Qureshi *et. al.*, (1974)** لتربية يرقات الذبابتين معملياً وانتهت الدراسة إلى أفضلية بيئة **Awadallah, (1978)** لتربية يرقات الذبابتين معملياً لكونها أعطت أقصر فترات نمو و أعلى نسبة تكشف للأطوار الغير كاملة علاوةً على سهولة استخدامها معملياً وقلة التكلفة الاقتصادية لها. وفي دراسة مقارنة بتعديل الكميات المضافة من السكر والخميرة خلافاً لكمياتها في البيئة القياسية في مستويات تدريجية ٧٥٪ (٦٢.٢٥ جم) و ٥٠٪ (٤١.٥٠جم) و ٢٥٪ (٢٠.٧٥ جم) و ٠٪ (صفر جم) مقارنة بالمستوى القياسي للسكر والخميرة (٨٣ جم) وقد خلصت النتائج إلى أن الانخفاض التدريجي للسكر والخميرة قد أدى معنوياً الى إطالة فترات نمو الأطوار الغير كاملة وانخفاض النسب المئوية للتكشف الكلي لكلتا الذبابتين ، وبصرف النظر عن الانخفاض في النسبة المئوية للتكشف الكلي لذبابة فاكهة البحر المتوسط في البيئة الخالية من السكر فإنها قد تبدو أكثر تحملاً لغياب السكر.

كما درس تأثير التغذية للطور الكامل لذبابة الخوخ على الجاذب الغذائي (كابل ستار) والمنتج محلياً مقارنة مع البروتين المتحلل ، و لم تختلف فترة ما قبل وضع البيض معنوياً للإناث المغذاة على الجاذب الغذائي مقارنة مع تلك مغذاة على البروتين المتحلل (١٥.٨٠ و ١٤.٨٠ يوم على الترتيب). بينما كان هناك اختلافاً معنوياً في فترة وضع البيض حيث ظلت الإناث المغذاة على الجاذب الغذائي في وضع البيض لمدة ٢٤.٨٠ يوم مقارنة بتلك المغذاة على البروتين المتحلل (٣٢.٦٠ يوم) .وكذلك وجد فرقاً معنوياً في فترتي ما بعد وضع البيض حيث كانت ١٦.٤٠ و ١٧.٢٠ يوم للإناث في طريقتي التغذية على الترتيب، ووضعت الإناث المغذاة على الجاذب الغذائي في المتوسط ١٢٧.٦٥ بيضة / أنثى بمعدل ٦.٣٨ بيضة / يوم طيلة حياتها مقابل ٥١٧.٣٥ بيضة / أنثى بمعدل يومي ٣٢.٣٣ بيضة / يوم للإناث المغذاة على البروتين المتحلل ولم تختلف النسبة المئوية لفقس البيض الناتج عن كلتا طريقتي التغذية معنوياً . ولم تتأثر مدة الحياة الكلية معنوياً بنوع التغذية حيث كانت ٥٩.٤٨ و ٦٣.٨٥ يوم على الترتيب للذكور والإناث على الترتيب للذباب المغذى على الجاذب الغذائي، بينما كان متوسط طول العمر ٦٢.٣٥ و ٦٧.٦٠ يوم للذكور والإناث على الترتيب المغذاة على البروتين المتحلل بينما كان ٥٩.٤٨ و ٦٣.٨٥ يوم للذكور والإناث على الترتيب المغذاة على الجاذب الغذائي.