Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.3, 2014

Effect of Natural and Artificial Diets on the Life History Parameters of Melon Fruit Fly *Bactrocera Cucurbitae* (Coquillett)

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Abstract:

Fruit flies are the noxious pests of fruits and vegetables throughout out the tropical and subtropical regions of the world. The melon fruit fly *Bactrocera cucurbitae* is a polyphagous pest of vegetables and fruits. We evaluated the effect of natural bottle gourd, (*Lagenaria siceraria)* and artificial diets on the life history parameters of *B. cucurbitae* under lab conditions. Results revealed that shortest incubation period (3.0 ± 0.54) was observed on natural diet whereas; lowest hatching % (12.4 ± 2.11) was observed on blotting papers. However, reduced larval duration (5.6 ± 0.24) was observed when maggots were provided with *bottle gourd* as compared with artificial diet (6.6 ± 0.24). Furthermore, significantly ($p < 0.05$) higher pupal recovery, pupal duration and adult emergence were recorded on natural diet. In contrast, statistically higher pupal weight ($p < 0.05$) was observed on artificial diet. In addition, number of deformed adults was higher in natural diet as compared to artificial diet. These findings could be helpful in defining more optimum conditions for the mass rearing of *B.cucurbitae* for use in Sterile Insect Technique (SIT), programmes for various orchards.
Key words: Natural diet, Artificial diet, Incubation period of *B. cucurbitae.*

INTRODUCTION:

The melon fruit fly, *Bactrocera cucurbitae* (Coquillett), previously known as *Dacus cucurbitae*, recently synonymized with genus *Bactrocera* (Drew, 1989). The dipteran family Tephritidae consists of over 4000 species, of which nearly 700 species belong to Dacine fruit flies (Fletcher, 1987). The first report on melon fruit flies was published by Bezzi (1913), who listed 39 species from India. Forty-three species have been described under the genus *Bactrocera* including *cucurbitae, dorsalis, zonatus,diversus, tau, oleae, opiliae, kraussi, ferrugineus, caud atus, ciliatus, umbrosus,frauenfeldi, occipitalis, tryoni, neohumeralis, opiliae, jarvisi, expandens, tenuifascia,tsu neonsis, latifrons, cucumis, halfordiae, cucuminatus, vertebrates, frontalis,vivittatus, amphoratus, binotatus, um beluzinus, brevis, serratus, butianus, hageni,scutellaris, aglaia, visendus, musae, newmani, savastanoi, diversus,* and *minax*, from Asia, Africa, and Australia (Syed, 1969; Cavalloro, 1983;Drew and Hooper, 1983;Munro, 1984; Fletcher, 1987). Amongst these, *Bactrocera cucurbitae* (Coquillett) is a major threat to cucurbits (Shah et al., 1948). Senior-White (1924) listed 87 species of Tephritidae in India. Amongst these, the genus, *Bactrocera* (*Dacus*) causes heavy damage to fruits and vegetables in Asia (Nagappan et al., 1971).

Melon fly, is noxious pest of vegetable crops and common distributed throughout the Oriental and the Pacific regions (Foote *etal.*, 1993). *Bactrocera cucurbitae* is one of the most important pests of vegetables. More than 81 host plants species has been documented which are severely damaged by *B. cucurbitae*. However, it is major pest of cucurbits, tomatoes, and peppers, and some wild plants amongst which, fruits of bitter gourd (*Momordica charantia*), muskmelon (*Cucumis melo*), snap melon (*Cucumis melo* var. *momordica*) snake gourd (*Trichosanthes anguina* and *T. cucumeria*) and bottle gourd, (*Lagenaria siceraria)* are the most preferred hosts.

The egg incubation period on pumpkin, bitter gourd, and squash gourd has been reported to be 4.0 to 4.2 days at 27 ± 1° C (Doharey, 1983), 1.1 to 1.8 days on bitter gourd, cucumber and sponge gourd (Gupta and Verma, 1995), and 1.0 to 5.1 days on bitter gourd (Koul and Bhagat, 1994; Hollingsworth et al., 1997). The larval period lasts for 3 to 21 days (Renjhan, 1949; Narayanan and Batra, 1960; Hollingsworth et al., 1997), depending on temperature and the host. On different cucurbit species, the larval period varies from 3 to 6 days (Chawla, 1966; Chelliah, 1970; Gupta and Verma, 1995). Egg viability and larval and pupal survival on cucumber have been reported to be 91.7, 86.3, and 81.4%, respectively; while on pumpkin these were 85.4, 80.9, and 73.0%, respectively, at 27 ± 1° C (Samalo et al., 1991).

The full-grown larvae come out of the fruit by making one or two exit holes for pupation in the soil. The larvae pupate in the soil at a depth of 0.5 to 15 cm. The depth up to which the larvae move in the soil for pupation, and

survival depend on soil texture and moisture (Jackson et al., 1998; Pandey and Misra, 1999). Doharey (1983) observed that the pupal period lasts for 7 days on bitter gourd and 7.2 days on pumpkin and squash gourd at 27 ± 1° C. In general, the pupal period lasts for 6 to 9 days during the rainy season, and 15 days during the winter (Narayanan and Batra, 1960). Depending on temperature and the host, the pupal period may vary from 7 to 13 days (Hollingsworth et al., 1997). On different hosts, the pupal period varies from 7.7 to 9.4 days on bitter gourd, cucumber, and sponge gourd (Gupta and Verma, 1995), and 6.5 to 21.8 days on bottle gourd (Koul and Bhagat, 1994; Khan et al., 1993).

The magnitude of losses varies from species to species which may range 30-100%, depending on the cucurbit species and season as well. Its abundance augments when the temperature falls below 32 °C and the relative humidity ranges between 60-70% (Dhillon et al., 2005). Above all, in Pakistan, cucurbit flies inflict around 7 million Rupees per annum (Khan et al., 1999).

In this study, we evaluate diet suitable for the mass rearing of *B. cucurbitae* under laboratory conditions, also to study the effect of natural and artificial diets on the life history parameters of *B.cucurbitae.*

MATERIALS AND METHODS:

An experiment on "Effect of Natural and Artificial diets on the life history parameters of Melon fruit flies *Bactrocera cucurbitae,*"was carried out in the Department of Zoology University of Sindh, Jamshoro under laboratory conditions at 27±2^{0}C and relative humidity 62 -65 %. Eggs of *B. cucurbitae* were collected from the adult fruit flies reared in the Laboratory Plant Protection Division, Nuclear Institute of Agriculture (NIA), Tandojam. Eggs were collected through egg laying receptacles Eggs were removed from the receptacles very gently with the help of camel hair brush and seeded over the blotting papers, natural and artificial diets as described below.

1. BLOTTING PAPER:

Blotting papers were cut round shaped and ≈ 1 mm hole with pencil were made in each paper. Afterwards, blotting papers were kept in Petri dishes (11 × 11.2 cm). Thirty holes were made in each round shaped blotting paper in order to put eggs in each. This was replicated five times. The blotting papers were moistened with tap water up to the hatching of the eggs.

2. NATURAL DIET:

Fresh *bottle gourd*s (*Lagenaria siceraria)* were brought from the Jamshoro city. The *bottle gourd* was cut into round pieces. Each piece of pumpkin was weighed ≈ 250 grams. 100 eggs of *B. cucurbitae* on each piece of *bottle gourd* were transferred. Seeded pumpkins were kept in beaker (1000 ml) and slight layer of saw dust was kept as pupation substrate inside the beaker. Afterwards, beakers were covered with muslin cloth. This part of experiment was repeated five times. After 4th day of larval emergence, an additional amount of fresh *bottle gourd*s were provided to maggots. Full grown larvae popped out from the *bottle gourd* and pupated in pupal substrate. Observation on incubation period and hatching percentage was recorded. Pupae were sieved with iron mesh (18 meshes) and collected and weighed. Emerged adults of *B. cucurbitae* were shifted into plastic cages (30 × 25 × 11cm). Adults of melon flies were supplied with protein hydrolysate, casein, sugar and 1: 3 soaked cotton.

3. ARTIFICIAL DIET:

The following ingredients of artificial larval diet were prepared in diet mixing kettle.

Diet was offered to hatchlings.

Ingredients of larval diet:

Wheat shorts	1000 grams
Sugar	500 grams
Troula yeast	200 grams
Methyl. P. Hydroxy Benzoate	3 grams
Sodium Benzoate	6 grams
Hcl	10 ml
Tap water	3 litres

Diet was kept in Petri dishes (11 × 11.2 cm) to a depth of 2 cm. 100 eggs were seeded in the Petri dish over the diet. Each Petri dish was placed in the plastic cage. ≈1 cm depth of pupation substrate was kept under each Petri dish.

Incubation period, hatching percentage and weight of fresh pupae were recorded. Newly emerged flies were provided with adult food as described for adults of natural diet.

This part of experiment was replicated five (5) times.

STATISTICAL ANALYSIS:
The data of all tested parameters was analyzed by the Statistical software. Statistix® Version 8.1, Analytical Software. (Steel *et al*. 1997).

RESULTS

Effects of different diets on incubation duration and hatching percentage (%), Of *B. cucurbitae.*

Results of present study confirmed that the eggs which were kept on artificial diet took longer time to hatch (4.8±0.37). However, lowest incubation period was observed on natural diet (3.0±0.54) followed by eggs kept on blotting paper (4.0±0.44). Similarly, hatching percentage was significantly 6% affected on blotting papers. Whereas, 49 - 45% hatchling was observed on natural and artificial diets, respectively. (Table.1).

Effects of natural and artificial diets on larval duration and larval survival (Pupal recovery) of *B.cucurbitae* .

Likewise, reduced larval period (5.6± 0.24 days) was recorded on natural diet whereas; increased larval period (6.6± 0.24 days) was recorded on artificial diet. Nevertheless, maximum larval survival (99.4± 0.4) was observed on natural and minimum larval survival (80.0± 0.63) was recorded on artificial diet. (Table.2).

Effects of natural and artificial diets on pupal weight, pupal duration and pupal survival (No of adult emergence) of *B.cucurbitae.*

Furthermore, results revealed that higher pupal weight (gram), (0.56 ± 0.03) were observed on artificial diet as compare with natural diet (0.48± 0.02) and reduced pupal duration (8.8± 0.37) was observed on natural diet and increased pupal period (10.6±0.24) was recorded on artificial diet. Moreover, results depicts that maggots provided with artificial diet, their pupal survival, (69.0 ± 2.64) were significantly affected as it was compared with natural diet (86.4 ± 2.24) respectively. (Table.3).

Effects of natural and artificial diets on total adult emergence of *B.cucurbitae.*

Likewise, artificial diet also negatively affected on sex ratio (27.2 ± 2.57, 41.8 ± 0.73) male and female respectively, as compared with natural diet (39.4 ± 1.32, 47.2 ± 1.06) respectively. Moreover artificial diet also affected half emergence and deformed emergence (0.4± 0.04, 6.4±1.28) as compared to natural diet (4.0±2.28, 9.6±1.28) respectively. (Table.4).

DISCUSSION:
It has been widely documented that food is positively correlated with the biological parameters of the insects. Similarly, in our study artificial diet significantly affected the pupal duration, pupal survival and adult emergence of *Bactrocera cucurbitae.* Our results are similar with the studies carried out by (Hollingsworth et al., 1997), who reported substantial difference in the pupal period and their survival and also adult emergence, when they provided them different diets. Similarly on different cucurbit host pupal duration and pupal survival fluctuated, (Gupta and Verma, 1995). Interestingly, the pupal weight was affected when maggots were provided with artificial diet, is similar with results were reported by (Chiou et al., 2003). Furthermore, in this experiment, reduced larval duration was recorded when the maggots were provided with bottle gourd. Reduced larval growth was reported by (Koul and Bhagat, 1994), who provided maggots *bottle gourd*. Similarly lowest incubation period was demonstrated by (Manzar and Srivastava, 2003), who provided *B. Cucurbitae* eggs with *Lagenaria siceraria.*

Our results are in line with the studies carried out by (Dohrey, 1983), who reported lowest incubation period and reduced larval growth when they provided *B. cucurbitae* with bottle gourd. Similarly, Egg viability was not affected when provided with natural diet. Correspondingly, higher survival and egg viability was recorded by (Samalo et al., 1991) when they fed *B. cucurbitae* with *bottle gourd* However, egg hatchability was significantly affected when they were kept on blotting papers, might be suggesting the physiological effects emitted by fruit odor which was not in blotting paper.

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Table1. Showing incubation duration and hatching percentage (%), of *B. cucurbitae* eggs reared on different diets.

Diets	**Incubation duration (days)**	**Hatching (%)**
Blotting paper	4.0 ± 0.44	12.4± 2.11 (6%)
Natural diet	3.0± 0.54	100.0 ± 0.00 (49%)
Artificial Diet	4.8±037	92.0 ± 3.33 (45%)

Table. 2. Showing larval duration and larval survival (Pupal recovery) of *B.cucurbitae eggs reared* on natural and artificial diets.

Diets	**Larval duration (days)**	**Larval survival (Pupal recovery)**
Natural diet	5.6 ± 0.24	99.4± 0.40
Artificial Diet	6.6± 0.24	80.0± 0.63

Table. 3. Showing pupal weight, pupal duration and pupal survival (No of adult emergence) of *B.cucurbitae eggs reared on different diets.*

Diets	**Pupal weight (grams)**	**Pupal duration (days)**	**Pupal survival / No of adult emergence**
Natural diet	0.48± 0.02	8.8± 0.37	86.4 ± 2.24
Artificial Diet	0.56 ± 0.03	10.6±0.24	69.0 ± 2.64

Table. 4. Showing effect of natural and artificial diets on total adult emergence of *B.cucurbitae.*

Diets	Male	Female	Half emergence	Deformed emergence
Natural diet	39.4 ± 1.32	47.2 ± 1.06	4.0 ± 2.28	9.6 ± 3.00
Artificial Diet	27.2± 2.57	41.8 ± 0.73	0.4 ± 0.40	6.4 ± 1.28

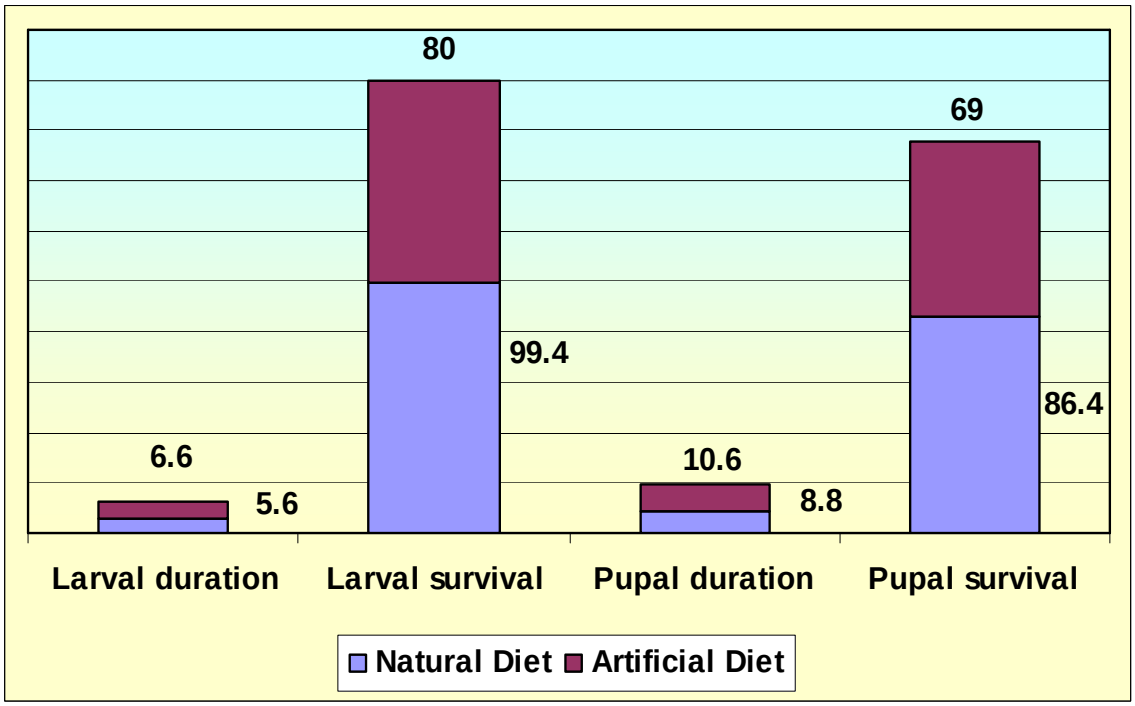

Figure 1. Showing graph larval duration, larval survival, pupal duration and pupal survival Of B.cucurbitae eggs reared on natural and artificial diets.

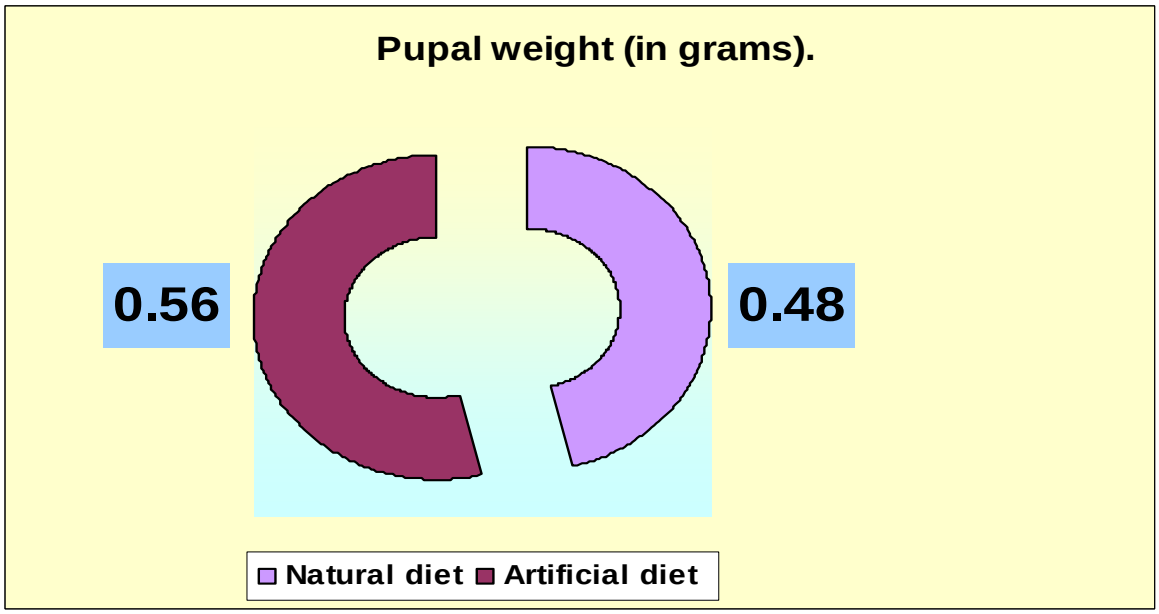

Figure 2. Showing graph, Effect of natural and artificial diets on pupal weight

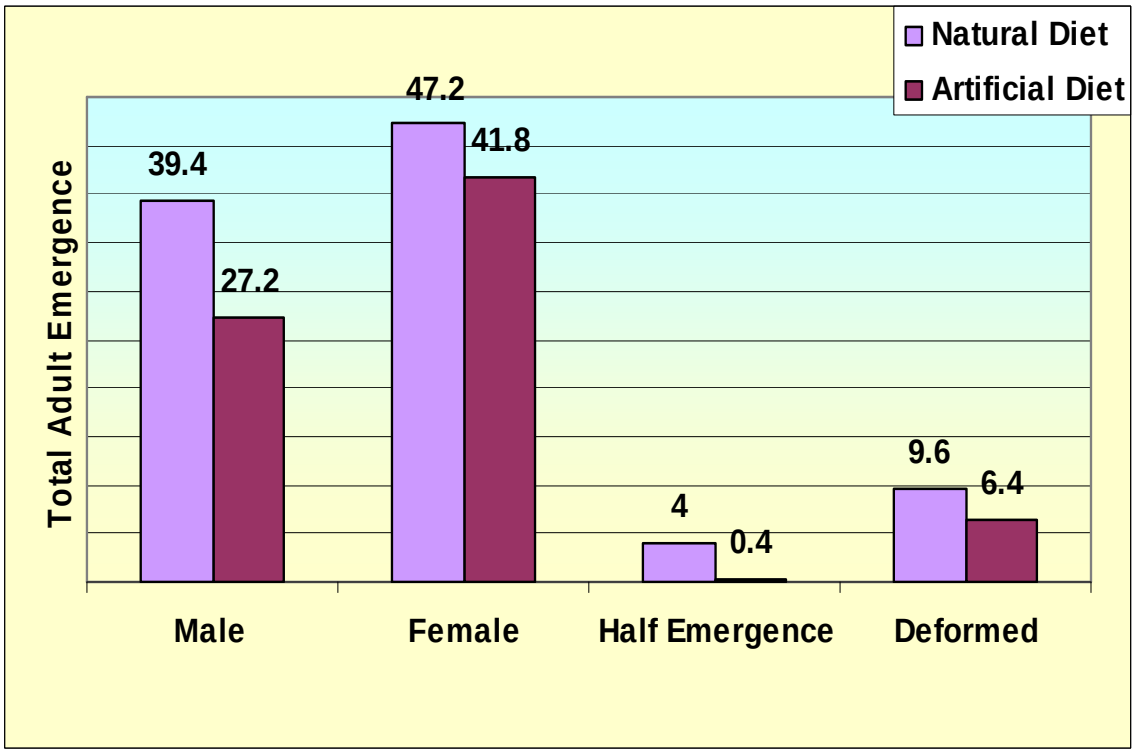

Figure 3. Showing graph, effect of natural and artificial diets on total adult Emergence of B.cucurbitae.