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Preference and performance of peach fruit fly (*Bactrocera Zonata*) and Melon fruit fly (*Bactrocera Cucurbitae*) under laboratory conditionsMuhammad Saeed ^a, Tanveer Ahmad ^a, Mukhtar Alam ^a, Laila A. Al-Shuraym ^b, Nazeer Ahmed ^{a,*}, Mohammed Ali Alshehri ^c, Hidayat Ullah ^a, Samy M. Sayed ^d^a Department of Agriculture, University of Swabi, Anbar-23561, Swabi-Khyber Pakhtunkhwa, Pakistan^b Biology Department, Faculty of Science, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia^c Biology Department, College of Science, University of Tabuk, Tabuk 71491, Saudi Arabia^d Department of Science and Technology, University College-Ranyah, Taif University, B.O. Box 11099, Taif 21944, Saudi Arabia

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ABSTRACT

In Pakistan and all over the world, the Peach Fruit Fly (PFF), *Bactrocera zonata* (Saunders.) and the Melon Fruit Fly (MFF), *Bactrocera cucurbitae* (Coquillett.) are considered severe and polyphagous insect pests for various fruits and vegetables. The current study was conducted to check the Laboratory preference and performance of *B. cucurbitae* and *B. zonata* on selected Fruits Citrus (*Citrus sinensis*), Apple (*Malus domestica*), Banana (*Musa acuminata*), and vegetable, Sponge gourd (*Luffa aegyptiaca*), Bitter gourd (*Momordica charantia*) Pumpkin (*Cucurbita moschata*) under laboratory conditions. The study showed that Sponge Gourd was the preferable host with the mean pupae resurgence of (242.33), followed by Bitter Gourd (78.333) among selected vegetables. At the same time, among fruits, a banana was the preferable host with mean pupae resurgence (204.33), followed by orange (158.33). The pumpkin and apple was the least preferable host for both *B. cucurbitae* and *B. zonata*, with mean pupae resurgence (35.667) and (79.000), respectively. Furthermore, the study showed that Banana was the preferable host for *B. Zonata* among intact and infested fruits, whereas *B. cucurbitae* showed the most preference to Bitter gourd among intact and infested vegetables showing significantly different results among intact and infested fruits and vegetables. Maximum number of eggs, pupa, female flies, male flies, adult emergence from pupa (flies) and period of pupa of *B. zonata* and *B. cucurbitae* on banana and bitter gourd. While, other fruits and vegetables showed the minimum number of eggs, pupa, female flies, male flies, adult emergence from pupa (flies) and period of the pupa. The current study concluded there is a need to evaluate other host plants against these fruit fly species for effective control.

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1. Introduction

Fruit flies belong to the order Diptera and the family Tephritidae consists of four thousand and five hundred species. Globally as well as in Pakistan, these fruit flies are considered polyphagous pests various horticultural crops. These are mostly attacked on soft bodies' fruits and vegetables such as mangoes, peaches, guava, orange,

Banana, pumpkin and bitter guard. It has been reported that more than seventy species belonging to the genus *Bactrocera* are regarded as a primary pest of crops throughout the world. These pests are attacking fresh vegetables and fruits, resulting in severe crop losses. The economic value of fruits and vegetables can ultimately reduce due to severe attack of these pests. These pests adopt the different climatic conditions throughout the world. These are primarily found in tropical and subtropical regions of the world, which results in severe economic loss and poses an increasing threat of establishment into new areas (Kapoor et al., 1980; Clarke et al., 2005 Mishra et al., 2019).

Farmers currently use spraying pesticides in olive groves for the control of pests and diseases. Not only did these behaviors exacerbate over time the pest rating over, but they also influenced the risks associated with insect killers. If the current plant defense practice continues, Pakistani farmers can find it difficult to export

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their production. Customers are health-conscious, especially in the urbanized world that their governments rely on pesticides. Therefore, there is a need for the period to shift from insect-killing plant protection to integrated pest management to decrease the use of pesticides, mainly in horticultural crops, according to bio-ecological vital assumptions (Stonehouse et al., 2002; Darshane et al., 2017; Ahmed et al., 2018).

It is quite a complicated phenomenon for insect pests to find their best hosts for the oviposition. Females adopt other ways for the selection of suitable host plants and egg-laying. Eggs are laid on those host plants ideal for larval growth and development (Stonehouse et al., 2002; Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019).

Fruit flies are not only the national and international pest of various agricultural and horticultural crops but also known as quarantine pests. In Pakistan, many insect pests are considered quarantine pests of various commodities. International trade can also be affected by insect pests, especially maggots of fruit flies in flesh of fruits and vegetables or their attack on the commodity imported from one country to another country. Maggots of these flies become the significant reasons of production losses (Allwood et al., 2001) resulting from the failure of that export.

Fruit flies throughout their lifecycle require adequate resources of food to support reproduction and sustain life. Due to several reasons, fruit plants are considered ideal hosts for fruit fly development (Sarwono, 2000; Chang et al., 2003). Fruit plants contain significant nutritional resources like protein with lipids to produce eggs, a protein needed to attain sexual maturity, honey used to fuel locomotion and flight, sugars from nectar and high water content for metabolism (Nasution and Kuswadi, 2004). Fruit protein and water content come from nutritional sources freely available in the vapor, rain and environment (Meats et al., 2004). An organic compound like Phenylpropanoids play a significant role in the tissue structure of plants, plants protection against the light of UV, predator, and pathogen or provide scents and color which pollinators influence (Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019). Phenylpropanoids are common secondary metabolites in fungi, plants and bacteria derived from tyrosine or phenylalanine. Host selection of fruit fly reflects a preference for the above propanoids and nutrients, signaled by characteristics of fruits like texture, taste, smell and color (Shelly, 2000). Furthermore, host preference, insect biology, and subsequent development are also influenced by the chemical and physical characteristics of plants, which also determine their behavior (Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019). Therefore, to perform pest management in the field, fruit fly species host plant preferences must be observed and studied (Kostal, 1993; Han and McPherson, 1997).

There are various biotic and abiotic factors that affect crop productions and become significant problems such as lack of proper control measures, lack of labor, improper use of sprays and quarantine problems. Among all these problems, all species of fruit flies are severe and destructive quarantine pests, but *B. zonata* and *B. Cucurbitae* becoming the major threat for export of fruits and vegetables in various countries such as India, Australia, Indonesia, China, Japan, Thailand, Taiwan, the Philippines, Pakistan, Malaysia, South America, Brazil, USA and many Asian countries (Kostal, 1993). Both these species are needed to control to prevent crop losses. It has been investigated that both fruit flies can cause about \$200 million annual losses. Small farmers can bear the high crop losses than retailers, exporters and traders. Host status is very significant element of pest risk analysis. It can change with respect to time due to changes in biological situations in that area. The proper control measures such as cultural, biocontrol (Fu et al., 2017), botanicals (Ahmed et al., 2021; Iqbal et al., 2021), entomopathogenic fungi (Saif-Ur-Rehman et al., 2019a,b), bacteria, nema-

todes, viruses, and chemical which is last and most adopted method all over the world against aphids, jassids, whiteflies and fruit flies. Before adopting any measure against these species, the knowledge or information about their host plants is very important. Therefore, keeping in view the objective of this study was to know the laboratory preference and performance of these two pests at different fruits and vegetables (Rauf et al., 2013)

2. Materials and methods

2.1. Study area

The experiments were conducted in the Entomology laboratory at the University of Swabi, Khyber Pakhtunkhwa (KP), Pakistan.

2.2. Collection

The infested fruits and vegetables were collected from different host plants in the surrounding area, including nearby markets (Swabi, Haripur and Kohat) Khyber Pakhtunkhwa (KP), Pakistan. The collection of infested fruits and vegetables containing eggs and maggots of fruit fly were brought to Entomology Laboratory for rearing purposes. The collected adults were shifted into plastic containers with fruits and vegetables for oviposition and obtaining mass culture. The collected infested fruits and vegetables were also placed separately into plastic containers for adult emergence.

2.3. Source of fruits and vegetables

To evaluate the fruit fly ovipositional preference and performance under laboratory condition, three fruits Citrus (*Citrus sinensis*), Apple (*Malus domestica*), Banana (*Musa acuminata*), and three vegetables i.e. Sponge gourd (*Luffa aegyptiaca*), Bitter melon (*Momordica charantia*), and pumpkin (*Cucurbita pepo*), were selected as host plants

2.4. Adult rearing cage

The adults of *Bactrocera zonata* and *Bactrocera cucurbitae* were randomly selected from mass culture and used for the further experiments. For the mating purpose, two hundred (250) pairs of equal sex ratio of fruit flies were shifted from plastic containers to adult rearing cages (1 × 1 × 1 m). The yeast, sugar and water were kept in the cage for the adult diet. Moist cotton was placed in a bowl for maintaining inside humidity. The culture was maintained in the laboratory at controlled conditions (27 ± 1.5 °C, 60 ± 5.5% humidity and 14:10 D:L photoperiod).

2.5. Preference of *B. Zonata* and *B. Cucurbitae* on host plants

A colony of 300–450 male and female *B. Zonata* fruit flies and a comparable sized colony of *B. Cucurbitae* fruit flies were each housed in separate 50 cm³ mesh cages (one cage for each colony). To encourage male flies to commence copulation, methyl eugenol was added to the cages. In plastic jars 30 cm in height and 30 cm in diameter, 90–100 inseminated (post-copulation) female fruit flies were inserted. Inside the large jars with the female fruit flies, smaller jars carrying host fruit were inserted. The smaller jars were connected to the bigger jars by plastic tubing 1.5 cm long and 1 cm in diameter, creating an aperture that allowed the aroma of the fruit to escape into the larger jars and the female fruit flies to enter the smaller jars. The 50 cm³ mesh cages were large enough to hold the full apparatus of jars.

2.6. Statistical analysis

Data were put on the excel sheet and arranged. Degree of freedom, MS value and P-Value were calculated by using Statistics. Means were compared by using Tukey test (LSD). The arranged data were statistically analysis by using Origin Pro 2019 software.

3. Results

Results of host ovipositional preference under free choice conditions in which each fruit and vegetable was exposed individually in selected fruits (*Bactrocera zonata*). Data showed that Banana was the preferable host for the development of fruit flies (pupal recovery 204.33 ± 10.09) followed by orange and apple. Among tested fruits, apple was the least preferable host of fruit flies with the least pupal recovery. The statistical analysis showed that sponge gourd has the highest pupae recovery (242.33 ± 10.00), which is significant from the bitter gourd (78.333 ± 6.75) and pumpkin (35.667 ± 2.33). Pumpkin had the least pupae recovery (Table 1). Furthermore, the pupae weight of *Bactrocera zonata* was presented in Table 1, which showed that maximum weight (0.0973 ± 0.003) was recorded on orange, which is significant from Banana (0.0507 ± 0.002) and apple (0.0203 ± 0.001) (Table: 1). The pupae weight of *Bactrocera cucurbitae* was presented in Table 1. The data showed that sponge gourd had given the maximum pupae weight (0.1327 ± 0.002), which is significant from Bitter gourd (0.0417 ± 0.003) and pumpkin (0.0187 ± 0.002) (Table 1). Moreover, the Adult emergence percentage of *Bactrocera zonata* presented in Table 1 was significantly higher in Banana (193.33 ± 9.98) which is significant from orange (140.00 ± 5.55) and apple (60.000 ± 2.33). The adult emergence percentage of *B. cucurbitae*, was significantly higher in Sponge gourd (222.33 ± 10.99), which is significant from bitter gourd (67.000 ± 2.55) and pumpkin (25.333 ± 1.99).

The oviposition of *B. Zonata* and *B. cucurbitae* when different fruits and vegetables were offered revealed that *B. Zonata* was most attracted to Banana for oviposition, whereas *B. cucurbitae* was most attracted to sponge gourd, according to the analysis. In jars holding banana fruit, an average of *B. Zonata* flies entered, but only an average of *B. Zonata* insects entered jars containing pumpkin. Banana was shown to be considerably different from other fruits and vegetables, although orange and bitter gourd was not. Similarly, when *B. cucurbitae* species were given a choice of hosts for oviposition, pumpkin, spongy gourd, and orange showed similar results (Figs. 1 and 2). These findings correlate with the fruit fly species with the most significant number of measured ovipositor injection sites. Banana fruits had the most *B. Zonata* oviposition injection points, while spongy gourds had the most *B. cucurbitae* injection sites (Figs. 1 and 2).

In terms of oviposition, these preferences remained the same. *B. Zonata* favored banana fruit for oviposition, laying the most eggs, whereas pumpkin laid the fewest eggs, showing a substantial difference from other fruits and vegetables. However, the spongy gourd had the highest average number of *B. cucurbitae* eggs, while

Table 1
Pupal recovery, weight and Emergence of *B. Zonata* and *B. Cucurbitae* on six tested hosts.

Treatment	Recovery Mean ± SE	Weight Mean ± SE	Emergence Mean ± SE
Banana	204.33 a ± 10.09	0.0507 ab ± 0.002	193.33 a ± 9.98
Orange	158.33 a ± 8.88	0.0973 a ± 0.003	140.00 b ± 5.55
Apple	79.000 a ± 6.76	0.0203 b ± 0.001	60.000 c ± 2.33
Bitter gourd	78.333 b ± 6.75	0.0417 b ± 0.003	67.000 b ± 2.55
Sponge gourd	242.33 a ± 10.00	0.1327 a ± 0.002	222.33 a ± 10.99
Pumpkin	35.667 b ± 2.33	0.0187 b ± 0.002	25.333 c ± 1.99

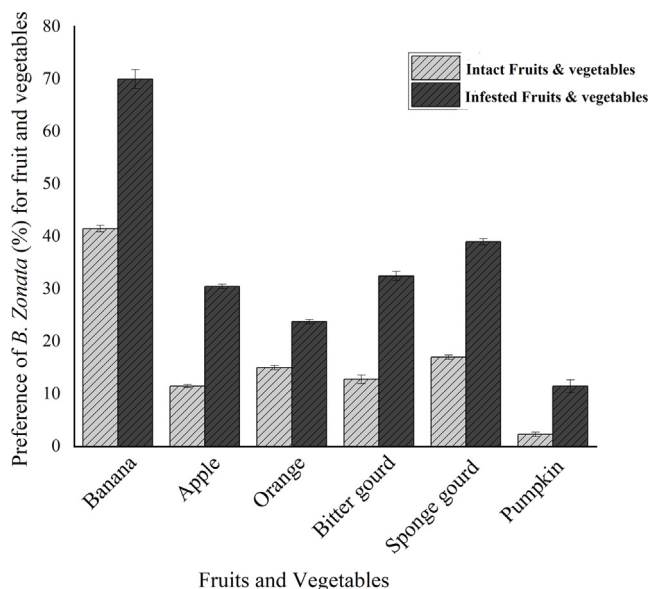


Fig. 1. Preference of *B. Zonata* for fruit and vegetables hosts in the laboratory.

orange had the lowest, indicating that the two fruits and vegetables are significantly different (Fig. 3). Nevertheless, the eggs developed into pupa, number of pupae, female flies and male flies were found to be the greatest numbers of *B. Zonata* in banana fruit and the lowest numbers in pumpkin respectively (Fig. 4). Similarly, For *B. cucurbitae*, the number of pupae, female and male flies was found to maximum on bitter gourd and the minimum was recorded on orange and apple (Fig. 5). However, the proportion of *B. Zonata* pupae that survived to adulthood was highest in the group reared with banana fruit and lowest in the populations reared with orange and pumpkin (Fig. 6). The success percentage of *B. cucurbitae* pupae reaching adulthood was highest in populations raised with spongy gourd and lowest in communities increased with orange (Fig. 7). Each species appears to have a preferred host, and the presence of that host has a beneficial impact on population formation and growth.

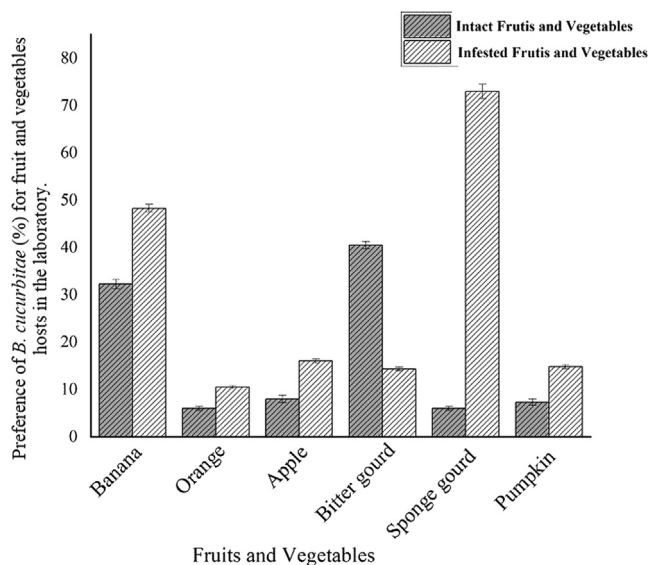


Fig. 2. Preference of *B. cucurbitae* (%) for fruit and vegetables hosts in the laboratory.

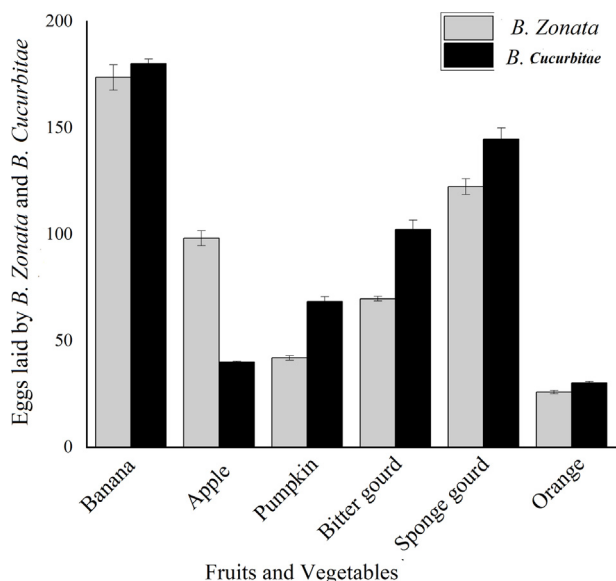


Fig. 3. Eggs laid by *B. Zonata* and *B. Cucurbitae* in fruits and vegetables hosts.

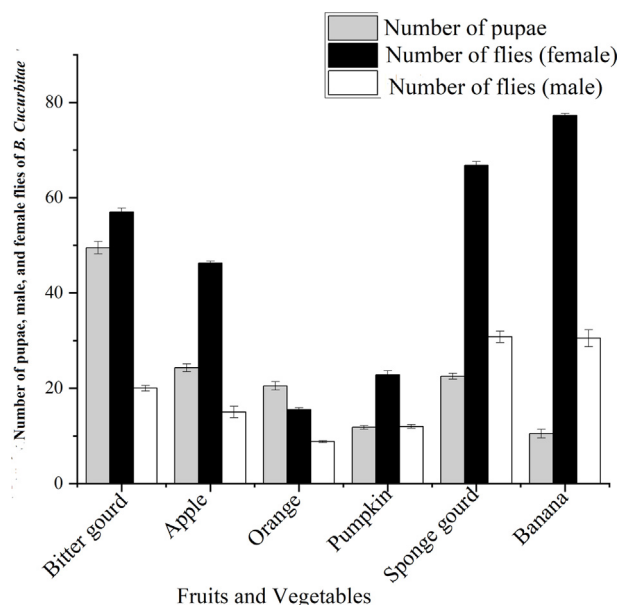


Fig. 5. No. of pupae, male, and female flies of *B. Cucurbitae*.

4. Discussion

Fruit fly species *B. Zonata* and *B. Cucurbitae* reared populations revealed distinct (but differing) preferences for fruit host plant types. Adult wild-collected *B. Zonata* were most attracted to Banana fruit, while *B. cucurbitae* were most drawn to Bitter gourd, according to the results of our experimental treatment done in our “jar within a jar” device with fans. Fruit fly host preference for oviposition is primarily influenced by the color, smell, taste, and texture of the fruit, as well as the nutritive value of the fruit, which serves as a source of energy and sustenance for fruit flies throughout their development toward adulthood (Shelly, 2000; Alias, 2005). Insects that are first introduced to a host will be influenced by these factors, as well as the underlying chemical properties represented through such properties, and will choose their preferred host based on this information (Koyama et al., 2004; Akol et al.,

2013; Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019). Our research showed that the number of fruit flies entering the host fruit jars was associated with the number of ovipositor injections on the fruit in question, implying that initial attraction to a host fruit leads to oviposition.

In comparison to all other host species, the number of *B. Zonata* ovipositor injections on Banana fruit and *B. Cucurbitae* injections on bitter gourd were higher. According to the results, there was a link between the number of ovipositor injections and the number of eggs laid. This indicates that the Banana fruit and bitter gourd offered were the best places for *B. Zonata* and *B. cucurbitae* to deposit eggs. *B. Zonata* had the highest fecundity with Banana fruit and guava, laying an average of 173.0 eggs and 122.5 eggs, respectively; however, bitter gourd had the lowest fecundity (26.0 eggs). The average number of eggs deposited by *B. cucurbitae* was highest on the bitter gourd and lowest on orange. Fruit flies are known to be particularly attracted to Banana fruit and bitter gourd. Fruit flies like fruits with a high surface area, soft skin texture, and complete nutrition content could explain why they choose them. As a media

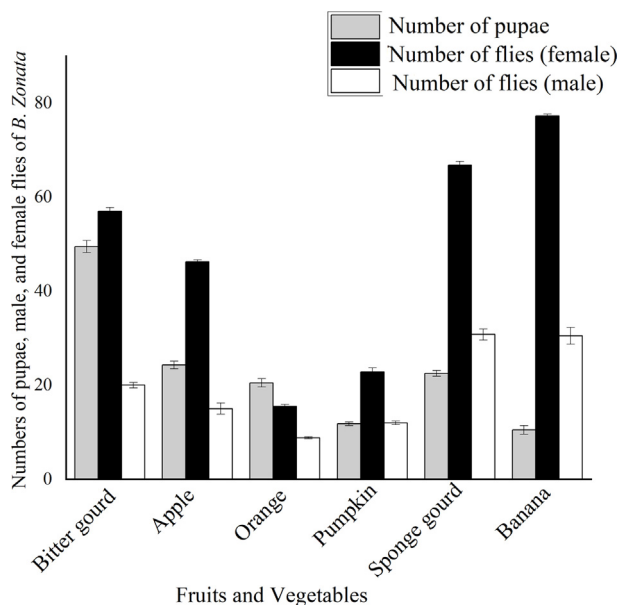


Fig. 4. Numbers of pupae, male, and female flies of *B. Zonata*.

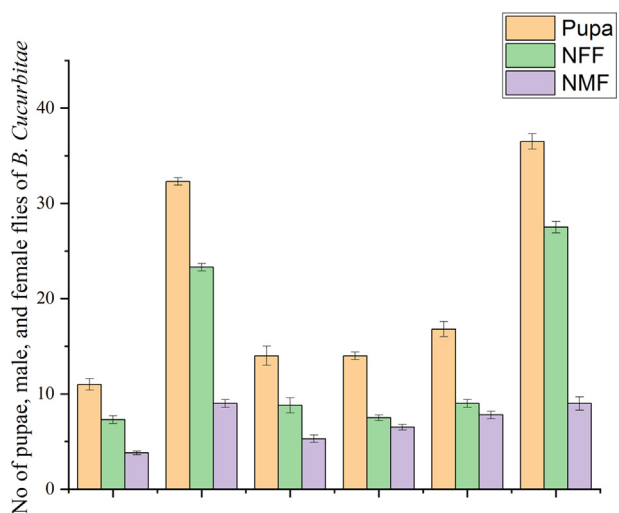


Fig. 6. Survivorship of *B. Zonata* from pupae to adult.

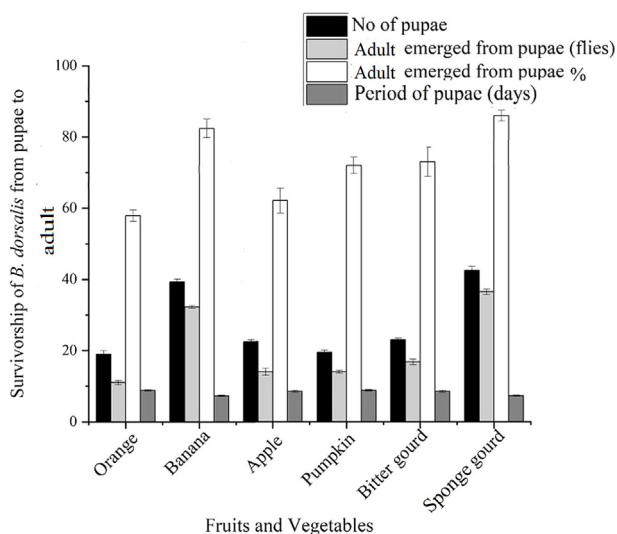


Fig. 7. Survivorship of *B. Cucurbitae* from pupae to adult.

for laying eggs, *B. Zonata* and *B. cucurbitae* were used. Fruit fly oviposition is dependent on finding a fruit host that is ideal for egg inoculation and nutritional support of the growing offspring, according to Fontellas-Brandalha and Zucoloto (2004). According to Alies (2005), larger fruit with an appealing fragrance, color, and shape are more easily affected by fruit flies. The local availability of diverse hosts influences insect oviposition host selection (Rauf et al., 2013). Fruit plants that are abundant or densely represented in a given region are more likely to be visited by fruit flies. In contrast, fruit flies may only visit fruit plants that are sparsely represented in a given area may only visit fruit plants that are sparsely represented in a given area on rare occasions.

Inoculated fertilized eggs will hatch into larvae, which will eventually grow into a pupa. Our findings revealed that pupae have high survival rates, with the quantity of eggs essentially proportionate to the number of the pupa. These findings, however, were not statistically significant. On Banana fruit and pumpkin, the average number of *B. Zonata* pupae was 49.5 and 24.3 pupae, respectively, whereas, on orange, the average number was 10.5 pupae. The highest average number of *B. cucurbitae* pupae was found on bitter gourd and pumpkin, with 42.5 and 39.3 pupae, respectively; the lowest average number of pupae was found on apple fruit 19.0 pupae. On banana and apple fruit, the most significant proportions of *B. Zonata* pupae successfully reached the adult stage (adulthood) were 90.4 percent and 79.4 percent, respectively. In comparison, pupae housed on orange had the lowest proportion at 57.4 percent. The proportion of *B. cucurbitae* pupae that survived to adulthood was highest for those housed on bitter gourd and spongy gourd, with survival rates of 86.0 percent and 82.4 percent, respectively, and lowest for those hosted on orange fruit, with a survival rate of 62.1 percent (Fig. 7).

In order for the largest number of eggs to survive to adulthood, fruit hosts must feed all phases of the fruit fly's life cycle. Different hosts may be better suited to certain stages of life than others. As a result, we looked at the survival rates of fruit flies at several stages of their lives, including oviposition, larval transition into pupae, and pupae survival to the adult stage. A host fruit may be more or less suited as a host at each stage (as reflected by survival rates to the next phase). These findings reveal a strong link between the quantity of deposited eggs, fully formed pupae, and successfully emerging adults, implying that fruit is generally suitable or unsuitable for all stages of development. Both *B. Zonata* and *B. cucurbitae* showed clear—but distinct—preferences for host fruit species as oviposition sites.

Fruit fly host plant preferences and the ability of selected plants to support fruit fly growth through adulthood may be affected by various circumstances. The physical and chemical properties of plants may influence insect preference for specific plants as hosts and the development and biology of fruit flies in their host (Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019). These features may influence insect behaviour in the following ways (Dhillon et al., 2005). Plant chemicals can influence fruit fly spread, mating location, and oviposition. According to Papadopoulou et al. (2006), male accessory gland secretions include chemicals that cause the observed alteration in behavior. Because insects interact with fruit hosts differently depending on a variety of ecological, physical, and chemical factors, there may be a high degree of specificity in insect species' host plant selection, favoring plants that are uniquely suited to support the development and regeneration of their offspring (Drew et al., 2008; Darshane et al., 2017; Ahmed et al., 2018; Ahmed et al., 2019).

We found no significant differences in pupal survival rates between *B. Zonata* and *B. cucurbitae* pupae are grown on different host plants during the pupal stage. For both fruit fly species, survival rates from pupa to adult were equal on all host species. During the pupal stage, the environmental temperature has the most significant impact on development (Hollingsworth et al., 1997). The temperature was controlled and adjusted to a standard level in the laboratory for this investigation, ensuring that pupae from all study groups were exposed to the same ambient temperature. *B. cucurbitae* pupae reared in cucumber lasted 7.7–9.4 days, while pupae raised in pumpkin fruit lasted 7.0–7.2 days, according to Gupta and Verma (1995).

Regardless of which host plant was used, *B. Zonata* and *B. cucurbitae* produced a higher proportion of female than male progeny throughout this investigation (Banana, orange, apple, bitter gourd, sponge gourd and pumpkin). This has also been found in previous studies on *B. cucurbitae* species, including infestations of cucumber plants and melon plants (Prokopy et al., 2003; Barry et al., 2006).

The effect of light or chemical cues on the insect nervous system influences insect host selection for sustenance or reproduction. Long-term development of the chemosensory system can change the susceptibility of fruit fly species to sensory signals found in their hosts, according to Schoonhoven et al. (2005). *B. Zonata* prefers Banana fruit, while *B. cucurbitae* prefers bitter gourd, indicating that Banana and bitter gourd are significant host plants for *B. Zonata* and *B. cucurbitae*. According to earlier research, some host plant species, such as guava, E. aqua, Banana fruit, and papaya have been discovered infested by *B. Zonata* and *B. dorsalis* (Allwood et al., 1999).

Flies that eat fruit for multiplication, *B. Zonata* preferred Banana fruit and apple, while *B. cucurbitae* chose bitter gourd and spongy gourd. Both *B. Zonata* and *B. cucurbitae* preferred banana fruits as their second favorite fruit. Although our findings revealed that each of the studied fruit fly species has distinct host fruit preferences, it should be noted that laboratory conditions do not reflect natural conditions, and thus do not account for biotic and abiotic environmental factors such as natural enemies' suppression of fruit fly populations or climatic conditions.

Tephritid fruit flies belong to Diptera order and family Tephritidae) are widely distributed in all apricot, peach, mango, guava, fig, citrus and various vegetables growing areas of the world, including Pakistan. These flies can, directly and indirectly, causing fruit and crop losses throughout the globe. There are various species of fruit flies such as peach fruit fly (PFF), *Bactrocera zonata*, Mediterranean fruit fly, *Ceratitidis capitata*, *Bactrocera Cucurbitae* (pumpkin, cucumber and citrus), *Bactrocera Cucurbitae* (cucumber & mango), *Bactrocera Oleae* and many other destructive species found in the world. There are various host plants of each species according to their availability. These are polyphagous species (Muthuthantri and

Clarke, 2012) and according to estimation, fruit flies cause \$100 million losses annually. The size, shape and color of host plants are the most preferable factors for the attraction of fruit flies (FAO, 2001; El-Gendy and El-Saadany, 2012).

Bactrocera zonata (Saunders.) and *Bactrocera cucurbitae* (Coquillett.) are severe and polyphagous insect pests of various fruits and vegetables worldwide, including Pakistan. Both these fruit flies have been causing severe economic losses in Pakistan since many years. The current study was conducted to check the ovipositional preference and performance of *B. cucurbitae* and *B. zonata* on selected vegetables (Bitter gourd, Sponge Gourd and Pumpkin) and fruits (Apple, Orange and Banana) under laboratory conditions.

Delrio and Cocco (2010) reported that Pakistan's economy depends on agriculture because agriculture is the backbone and significant major economy of Pakistan. The various studies regarding feeding behavior and many other related studies had been conducted by many previous or early researchers worldwide, including Pakistan. Díaz-Fleischer and Aluja (1999) had reported the reproductive and feeding behavior studies on fruit flies. It has been reported that bacterial odor is the most beautiful materials for fruit fly, which directly or indirectly affects fruit flies' behavior. Another study was conducted to check the most preferable host among tested hosts (mango, guava, strawberry and orange) of fruit flies under laboratory conditions (El-Gendy and El-Saadany, 2012; Draz et al., 2016).

It has been reported that fruit flies lay eggs on their preferable host plants. Many researchers have reported similar results (Joachim-Bravo et al., 2001; Fontellas-Brandalha and Zucoloto, 2004). Many factors can involve their oviposition preference such as sites, location, climate, size, color and odor of fruits or vegetables (Li-Li et al., 2008).

According to the current study findings, Banana was the preferable host as compared to all other tested fruits under laboratory conditions. Our results are in line with the previous studies' findings. They reported a similar conclusion (Clarke et al., 2005; Sarwar, 2006; Navarro-Campos et al., 2011). It has been recorded that the developmental period of larvae was shortest on banana fruits as compared to guava and apple. Apple was found the least preferable host due to having hard skin as compared to guava and Banana.

The study showed that Sponge Gourd was the preferable host with the mean pupae resurgence of 242.33 followed by Bitter Gourd 78.333 among selected vegetables. At the same time, among fruits, Banana was the preferable host with mean pupae resurgence, 204.33 followed by orange 158.33. The pumpkin and apple were the least preferable host of both *B. cucurbitae* and *B. zonata*, with mean pupae resurgence 35.667 and 79.000, respectively.

5. Conclusion

Our findings revealed that each of the studied fruit fly species has distinct host fruit preferences. However, laboratory conditions do not reflect natural conditions. They thus do not account for biotic and abiotic environmental factors such as natural enemy suppression of fruit fly populations or climatic conditions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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