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Food and ovipositional preference of oriental fruit fly *Bactrocera dorsalis* Hendel (Diptera: Terphritidae) on different fruit and vegetable hosts

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Abstract:

Oriental fruit fly Bactrocera dorsalis Hendel (Diptera: Terphritidae) is a voracious pest and a reason of economic loss to different fruits and vegetables (Clausen, Clancy, and Chock 1965). It is a major threat to fruit and vegetable industry of the Pakistan. This experiment was performed to evaluate the preferable food source and host for oviposition. Different fruits e.g Banana (Musa sapientum), citrus(Citrus reticulata), apple (Pyrus malus), guava (Psidium guajava), ber (Zizyphus Jujuba) musk mellon (Cucumis melo) and

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vegetables including Bitter gourd (Momordica charantia), Brinjal (Solanum melongena), round gourd (Praecitrullus fistulosus) and chilies (Capsicum annuum) were evaluated. Resulted showed that banana was most favorite food having average adult recovery (15.3) under free choice, while in other experiment guava was most preferred host for egg laying with average pupal recovery of 103.25± 2.56 in free choice of fruits. In the case of vegetables, round gourd got maximum attraction for oviposition among other vegetables with 49.75± 3.79 pupal recovery.

Key words: *Bactrocera dorsalis,* food, ovipositional preference, fruits and vegetables.

Introduction:

Oriental fruit flies (*Bactrocera dorsalis*) are major pests of fruits and vegetables. It has been reported that economic loss caused by the fruit flies species is 5 to 100% in Pakistan (Syed, Ghani, and Murtaza 1970). Fruit and vegetable industry faces 200 million US dollar losses annually in Pakistan at farm level in addition to the retailers, traders and exporters (Stonehouse, Mumford, and Mustafa 1998). Aesthetic value of guava, citrus and some other fruits and vegetables confine their buying due to the infestation of maggots which also leads to increase the post-harvest losses (Abdullah, Akram, and Alizai 2002, Latif 2004). Damage initiated by deposit their eggs just under the skin fruits and vegetables. After hatching, developing larvae consume the flesh of the fruit body (White and Elson-Harris 1992). Due to the possession of various digestive enzyme, it can damage diverse host range (Sohail et al. 2014). Selection of the egg laying site by the fruit fly depends upon host quality (Van Nouhuys, Singer, and Nieminen 2003, DiTommaso and Losey 2003). Female fruit flies decisions about fruit and vegetable to oviposit their eggs based on aptness regarding the performance of the off-springs (Joachim-Bravo et al. 2001, Fontellas-

Brandalha and Zucoloto 2004). Fruits and vegetables may vary with respect to the quality and quantity of nutrients available that can influence the larval and pupal size, weight, developmental time, adult eclosion rate, maturity time of adult bee and their fecundity as well (Hing 1991, Khan, Hossain, and Islam 2007, Kaspi et al. 2002). Fruit fly females use visual and contact cues like shape, size, smell and color of fruits and as well as olfaction to locate the suitable larval host (Alyokhin, Messing, and Duan 2000, Drew, Prokopy, and Romig 2003, Brévault and Quilici 2007).

Eleven species of fruit flies have been described from the different localities of Pakistan, among the most frequent species are *B. dorsalis, B. zonata* and *B. cucurbitae* (Abdullah and Latif 2001, Abdullah, Akram, and Alizai 2002). The most auspicious host for these fruit fly species in the Pakistan are mango (*Mangifera indica*), guava (*Psidium guajava*), apple (*Pyrus malus*), melon (*Cucumis melo*), ber (*Zizyphus jujube*) and bitter gourd (*Momordica charantia*) (Ahmad et al. 2005, Sultan, Sabri, and Tariq 2000).

Present study was conducted to evaluate the food preference of adult female regarding their nutritional requirements and ovipositional preference regarding the nourishment of their young ones. The selection of host for their food and oviposition is a complex phenomenon. Many positive and negative factors associated with the physical and chemical properties of host are actually stimulus for final selection of suitable host (Košťál 1993, Messina 1990). Keeping in mind the host range and mode of injury of *B. dorsalis*, present study was conducted to find the most preferred host for food and oviposition of *B. dorsalis*.

Materials and Methods

Culture maintenance

Newly hatched culture of the *B. dorsalis* was fetched from Centre for Applied Biosciences International (CABI), Rawalpindi, Pakistan to the department of pest warning and quality control, Sargodha, Punjab, Pakistan. Insect culture was reared on the artificial diet containing ingredients viz. banana, sugar, yeast, honey and vitamin B complex in a proper proportion. Fruit fly culture was maintain in the laboratory with temperature 28± 2ºC, 65± 5% relative humidity and 16:10 light and darkness. Furthermore, regular cleaning of rearing cages and changing of diet slides was necessary to avoid any contamination, especially fungus development.

Free choice test for food preference

The study was conducted in the biocontrol laboratory of department of pest warning and quality control, Sargodha, Pakistan. Firstly maze-like structure was built in such a way that six transparent small containers (12x7x6 inches) were attached to the main container (15x10 inches) with the help of transparent tubes (9 x 3 inches). Five fruit host viz. citrus (*Citrus reticulata*), Banana (*Musa sapientum*), apple (*Pyrus malus*), guava (*Psidium guajava*) and musk mellon (*Cucumis melo*), was taken for the experiment. Citrus was taken from the orchard of citrus research institute CRI, Sargodha and rest of the fruits were taken from the local market. Every fruit was peeled and meshed to make the pulpy appearance. Equal amount (50g) of meshed fruit was placed in the each five small containers and one container was fruitless as a control. Smell uniformity

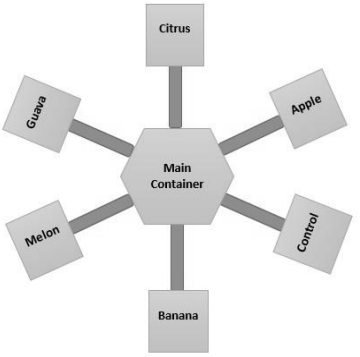

Fig: 1. **Layout for food preference of *Bactrocera dorsalis* on different fruit hosts.**

Meshed fruits were placed in each small container 30 minutes before the release of fruit flies to homogenize the containers with their particular smells. After 12 hours starvation, 50 adult fruit flies were released in main container. Fruit flies were moved towards the particular smell and gathered in the small container over food stuff. No. of flies were recorded after 30 minutes of release. Same experiment was performed 10 times with the different starved fruit flies.

Free choice test for ovipositional preference

This experiment was performed in three phases. In first phase, only different fruits were offered as free choice for oviposition collectively. In second phase, only different vegetables were offered to the flies as free choice for oviposition collectively. While in third phase, two most preferred fruits and two vegetables collectively offered to the fruit flies. Weighed (400g) amount fruits and vegetables were subjected to fruit flies. 15 pairs of fruit flies were released in each insect rearing cage (17x17x120 inches). In first phase, all (four) fruits were collectively subjected to a rearing cage and exposed to fruit flies for 12 hours. In second phase, four vegetables were evaluated.

While in third phase, two most preferred fruits and two vegetables were evaluated for ovipositional preference of *B. dorsalis*. After the copulation, sexually matured female of *B. dorsalis* laid eggs on these fruits and vegetable. After egg laying, each fruit and vegetable was kept separately in the plastic jars (10 x 5 inches) containing the sand at the bottom for pupation. Developed maggots of the fruit fly excited to pupate in the sand bellow. Pupae were collected and counted. Each treatment was repeated four times. Data was recorded as no. of pupae, pupal weight, adult emergence and sex ratio for each treatment. Data was statistically analyzed by using R software.

Results

Data presented in figure 1, shows food preference of fruit fly on different fruits under open choice conditions. Each fruit had equal probability to get the fruit fly population. With the help of chi-square analysis, preference of fruit flies were evaluated. Value of chi-square (141.40) showed that the fruit flies possess significant preference for the selection of food. It was found that on average banana got more fruit flies (15.3 p/f) as compare to other fruits. Apple was next to banana, contain (10.3 p/f). While musk melon had least population (3.9 p/f). Population was varied significantly among all fruits.

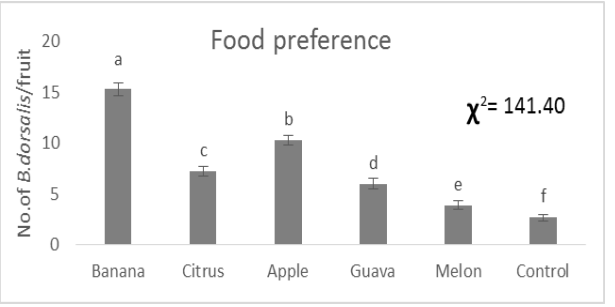

Fig. 2: Food preference of *B. dorsalis* on different fruits

In this open chice test of fruits, table 1 showed that on average guava had the maximum pupal recovery (103.25± 2.56/fruit). while the ber got minimum pupal recovery (20± 1.08 pupae/fruit). All fruit showed highly significant results in comparison with each other. In the case of pupal weight, guava showed the highest (10.14± 0.08 mg) and citrus showed the least (6.44± 0.18 mg). More often, there is a substantial divergence in the pupal weight of fruit fly over the different fruits. Adult emergence percentage was significantly different in all fruits with higher in guava (88.33± 0.84 %) lower in ber (66.03± 0.96%) and melon (60.84± 1.25%). Data regarding the sex ratio was also varied significantly among the fruits. Maximum female percentage was observed in guava (43.15± 0.97%) and citrus (37.88± 1.43%). While the same fruits had utmost share of males as well (guava 40.55± 0.73% & citrus 41.05± 1.46 %). Deformity of emerging fruit flies was least significantly in citrus (0.23± 0.04%). There is no significant difference in percent deformity over rest of the fruits. Likewise, there was significant difference in the percent emergence over all fruits.

Table 1. Some biological parameters of *B. dorsalis* resulted from infestation of different fruits under free choice test.

Fruits	Total no. of pupae/fruit	Pupal weight (mg)	Sex ratio (%)		Deformity (%)	Adult emergence (%)
			Male	Female		
Guava	103.25± 2.56a	10.14± 0.08a	40.55± 0.73a	43.15± 0.97a	4.63± 1.13ab	88.33± 0.84a
Citrus	70.75± 3.35b	6.44± 0.18d	41.05± 1.46a	37.88± 1.43b	0.23± 0.04c	79.16± 2..46b
Ber	20± 1.08d	7.53± 0.09c	35.06± 1.39b	28.07± 1.30c	2.91± 0.75b	66.03± 0.96c
Melon	53.75± 2.02c	9.17± 0.09b	24.41± 1.44c	30.90± 1.28c	5.53± 0.93a	60.84± 1.25d

Means followed by the same letters, within a column, do not significantly differ at the 5% level according to the LSD test.

Table 2. Some biological parameters of *B. dorsalis* resulted from infestation of different vegetables under free choice test.

Vegetables	Total no. of pupae/fruit	Pupal weight (mg)	Sex ratio (%)		Deformity (%)	Adult emergence (%)
			Male	Female		
Bitter gourd	19.00± 1.29c	4.81± 0.08b	28.31± 0.05a	21.07± 0.92b	4.45± 0.57a	53.83± 1.59b
Round gourd	49.75± 3.79a	5.69± 0.09a	29.44± 1.62a	36.35± 1.54a	4.14± 0.82a	69.92± 1.46a
Brinjal	41.25± 2.56b	5.77± 0.07a	22.83± 0.94b	16.94± 1.48c	4.38± 0.20a	44.15± 1.10c
Chilies	0.00± 0.00d	0.00± 0.00c	0.00± 0.00c	0.00± 0.00d	0.00± 0.00b	0.00± 0.00d

Means followed by the same letters, within a column, do not significantly differ at the 5% level according to the LSD test.

Table 2 shows results of oppositional response and other biological characters e.g. pupal weight, sex ratio percentage adult emergence and deformity, when offered different vegetable as free choice. Among all the vegetable, *B. dorsalis* prefers laying eggs in round gourd which showed maximum pupal recovery (49.75± 3.79 p/f) followed by brinjal (41.25± 2.56 p/f). The least pupal recovery was recorded from Chilies (0.00). In case of pupal weight, weigh of pupa resulted from round gourd and brinjal are 5.69± 0.09 and 5.77± 0.07 mg, respectively. They were the highest significant as compared to other treatments. There was significant difference observed in sex ratio among all treatments. There was no significant difference observed in deformity between all vegetables. Maximum emergence was observed in round gourd (69.92± 1.46 %) followed by Bitter gourd (53.83± 1.59 %) which was significantly higher than brinjal.

Table 3. Some biological parameters of *B. dorsalis* resulted from infestation of different fruits and vegetables under free choice test.

fruits & vegetables	Total no. of pupae/fruit	Pupal weight (mg)	Sex ratio (%)		Deformity (%)	Adult emergence (%)
			Male	Female		
Guava	130.75± 3.88a	8.97± 0.11a	45.24± 1.46a	38.67± 1.71a	5.05± 0.97a	88.96± 1.37a
Citrus	101.5± 2.75b	5.74± 0.13b	34.01± 1.00b	31.51± 0.94b	0.65± 0.14a	66.16± 1.30c
Round gourd	17.00± 1.58c	5.73± 0.09b	37.95± 0.51b	30.68± 1.21b	3.83± 2.19a	72.45± 0.85b
Brinjal	16.25± 1.70c	4.32± 0.08c	23.86± 1.84c	21.36± 1.83c	3.24± 1.87a	48.45± 1.77d

Means followed by the same letters, within a column, do not significantly differ at the 5% level according to the LSD test.

Data presented in table 3 showed the results of host preference under free choice conditions over different fruits and vegetables. Statistical analysis showed that on average guava had the maximum pupal recovery (88.96± 1.37/fruit) followed by the citrus (101.5± 2.75/fruit). There was no significant difference in pupal recovery among the vegetables. In the case of pupal weight, guava showed the highest (8.97± 0.11 mg) and brinjal showed the least (4.32± 0.08 mg). More often, there is a substantial divergence in the pupal weight except between citrus and round gourd. Adult emergence percentage was

significantly different in all fruits and vegetable with higher in guava (88.96± 1.37 %) lower in brijal (48.45± 1.77 %). Data regarding the sex ratio was also varied significantly among the guava and brinjal, but not between citrus and round gourd. Maximum male and female percentage was observed in guava (45.24± 1.46 %), (38.67± 1.71 %) respectively. Deformity of emerging fruit flies was non-significant among all fruits and vegetables. Likewise, there was significant difference in the percent emergence over all fruits.

Discussion:

Results of present study revealed that there were the significant difference between fruit flies attraction for all fruits but B. *dorsalis* flies were more attracted to the banana, the response were significantly different of the apple, citrus, guava and melon. As it is documented that volatiles from different fruits odor have also been investigated as attractants for fruit flies(Robacker and Heath 1996, Prokopy and Reynolds 1998). Some secondary compounds possess by the fruit, may act as attractant or deterrent compounds, with respect to their concentration (Bernays and Chapman 2000). This is because of the reason that particular aroma of banana make it more attractive for food (Li-Li et al. 2008). So due to specific pong banana attract the maximum population of fruit flies. It can also be used as cheap trap for the adults.

But as far as the ovipositional preference is concern, the B. *dorsalis* showed maximum oviposition on guava than other fruits. It has been reported that the ovipositional preference of fruit flies depend upon the type of host which must facilitate the growth and development of their offsprings (Fontellas-Brandalha and Zucoloto 2004, Joachim-Bravo et al. 2001). Color, odor and shape of the host also affect the host selection and egg laying of the fruits flies (Li-Li et al. 2008). Amro &

Abdel-Galil (2008) reported that guava is the best suited host for *Bactrocera sp*.

Sauers-Muller (2005) also published their research, that shape and size have greater influence over the selection of the host fruits specially in the case of guava. Larger is the size of fruit, greater is the infestation. We may also suppose that it is the reason for the "Ber" to get less infestation of fruit flies. In another studies scientist prove that the fruits (e.g guava) which have lime green color are most susceptible to the fruit flies (López-Guillén et al. 2009, Robacker et al. 1990). In the case of vegetable round gourd received maximum eggs as compared to bitter gourd and brinjal. This may also be the reason that round gourd have lime green color unlike bitter gourd (dark green) and brinjal (purple).

Pupal recovery on guava in both cases, with fruits and with vegetables was high. However significant difference was recorded in the pupal weight, deformity and adult emergence percentage, which is comparatively than other fruits and vegetables. It is supposed that when population density increases, competition for food and space also increases (Khaliq et al. 2014). So might be, due to higher population, space and food shortage some sort of deformities may occur in fruit flies. Results are similar to the studies conducted by Rauf et al., (2013).

Results of this study revealed that the pupal recovery in citrus was the second after guava with less pupal weight and less emergence percentage in both table 1 and table 3 but the deformity was minimum in both cases. This is because of the reason that delicate skin and particular aroma make it a suitable host (Li-Li et al. 2008) to attract the fruit flies. Our results are also agreed with Rajaganapathi & Kathiresan (2002). The fruit fly activities like pupal weight and emergence was at good level at ber, however, a significant variation was observed in case of pupal recovery. This may be because low egg

laying over ber. According to a study, it have been reported that in *B. dorsalis, A. ludens,* and *A. suspensa*, were more attracted to the biggest spheres than to the smallest spheres evaluated (Sivinski 1990, Cornelius, Duan, and Messing 1999). Melon got the significant eggs form the females and provided good food to the off-springs as they have significant high pupal weight. While deformity percentage is high than others.

In the case of vegetables, there were a significant difference in the pupal recover. No pupa found in the case of chilies. There may be two possibilities, first no egg laying was taken place. Second, there was done but during larval period all off-springs has been expired. It might be due to the presence of capsaicin in the chilies with may lead to the skin irritation (Nagabhushan and Bhide 1985, Lawless, Rozin, and Shenker 1985). Round gourd and brinjal got maximum pupal recovery when placed along with vegetable, but pupal recovery decreased when offered with guava and citrus. It seems that fruit flies preferred to lay eggs on the fruits as compare to vegetables. It may be due to the sweetness of fruits. Because according to Sauers-Mulle (2005) sweet fruits are more prone to the infestation of fruit flies. Likewise, bitter gourd got minimum pupal recovery than other vegetables. it is suppose that this due to its hard and irregular out skin and presence of momordicine which develop bitter taste (Behera et al. 2010). We can also say that choice of a host over another, the preference for suitable host remains the same but can be decreased in terms of percent. Certain fruit properties especially the nutritional status of fruit also plays a vital role in supporting the larval activities. However, the biochemical analysis can further exploit this actual relationship.

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