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Research Article

Study on the Attractiveness of Fruit Flies *Bactrocera* spp. to Mango Fruit's Extract

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ABSTRACT

Fruit fly (*Bactrocera* spp.) is a global major pest species of the fruit export and import activities. The controlling and monitoring strategies based on the ecology of fruit flies were expected to overcome the problem of fruit flies. The study on the attractant compound of fruit flies from mango fruit's extract may provide an alternative to control and to monitor fruit flies, both male or female. This research was aimed to determine the strength of attractiveness (number and type of species) and durability (day) on mango fruit's extract which could attract fruit flies. The experiment was conducted in mango plantation in Sragen Regency using Randomized Complete Block Design (RCBD) with five different locations for setting up the trap, each location consisted of nine treatments. The parameter observations were the number of trapped-fruit flies, the sex of fruit flies, the type of species fruit flies, and the durability of mango fruit's extract. The results revealed that mango fruit's extract could attract the male and female fruit flies with mechanism through the presence of nutrition and oviposition site. Extract of raw Pakel mango had a good ability to attract fruit flies, either male or female of *B. carambolae* and *B. papaya,* and male of *B. albistrigata* with a total of 15 flies per trap in one week.

Keywords: attractant, fruit fly, fruit fly trap, mango fruit's extract

INTRODUCTION

Bactrocera spp. (Diptera: Tephritidae) is an important pest attacking fruit and vegetable crops (Siwi *et al*., 2006). Fruit flies are pests being globally concern in the export and import of fruits (Suputa *et al*., 2006). Good controlling and monitoring could manage the population of fruit flies. The control and monitor technique commonly used is employing an attractant compound, such as methyl eugenol that attracts several male fruit fly species (Siwi *et al*., 2006). Methyl eugenol can not be used to attract female fruit flies, even though the female fruit flies also have a big influence on controlling and monitoring this pest.

There is an important need to find alternative ways to control and monitor of fruit flies. One of them is through a study of several different mango varieties fruit extracts that may have a role to mark the host and oviposition site, and to attract male and female fruit flies. The aroma of guava, orange, starfruit, mango, and apple extracts influence the oviposition preference of *Bactrocera carambolae* in the laboratory (Himawan *et al*., 2013) and orange extract influences the feeding preference of *B. dorsalis* (Sumarmin *et al*., 2011). This study was aimed to determine the strength of attractiveness (number and type of species) and durability of mango fruit's extract (days) which is the effective time of mango fruit's extract to attract fruit flies.

MATERIALS AND METHODS

Materials

The mango varieties used were raw and ripe arum manis, raw and ripe madu anggur, raw and ripe kweni, raw and ripe pakel, and water (as a control). The equipment used in this study was a fruit fly trap modified by Steiner using 600 ml of plastic water bottle (20 cm in height and 5 cm in diameter), paralon pipe, nylon rope, cotton, and a bamboo pole.

Research Design

This study used Randomized Complete Block Design (RCBD) with two factors (the type and the maturity level of mango) in 5 different locations for

setting up the trap. The type of mangoes used is arum manis, madu anggur, kweni, and pakel. The maturity level of mango is raw and ripe, thus the treatments would be 9: Control (K0) = water, M1a = ripe arum manis mango fruit's extract, M1b = raw arum manis mango fruit's extract, M2a = ripe madu anggur mangoes extract, M2b = raw madu anggur mangoes extract, M3a = ripe kweni mango fruit's extract, M3b = raw kweni mango fruit's extract, M4a = ripe pakel mango fruit's extract, M4b = raw pakel mango fruit's extract. Each treatment was repeated 5 times. This research was conducted from September 2017 to November 2017 in the mango plantation in Sragen Regency to collect the data of the attractiveness of fruit flies.

Extraction of Mango

This research was carried out by making extracts from 4 types of mangoes at the level of raw and ripe. The extract was produced using a blender with a ratio of 200 g mango fruit +100 ml water. The extract mango ratio used in this study was higher than reported by Sumarmin *et al*. (2011) and Himawan *et al*. (2013) who made solutions of 100 g of orange fruit extract + 100 ml water, and 100 g of fruit + 600 ml of water, respectively. Because this research was conducted in the field, it required a higher concentration of mango fruit's extract to prevent the aroma from evaporating too quickly.

Trapping Technique

2.5 ml of mango fruit's extract was dropped in a cotton (1 cm in diameter), placed in a trap made from a 600 ml of used mineral water bottle (contained 200 ml or one-third the size of the bottle), which holed at the top (2 holes facing each other), and attached to a plastic pipe (as a place for fruit flies to enter) (Figure 1). The control treatment was carried out by dropping water on a cotton (1 cm in diameter) and put in a trap bottle. Observation and data collection was conducted over 7 days. The daily observation was employed on trapped-fruit flies, type of species fruit flies and the sex of fruit flies. The durability of mango fruit's extract is the effective time of mango fruit's extract to attract fruit flies (day) by observing the dynamic of trapped-fruit fly per day over 7 days. During 7 days observations, it could be determined how long the mango fruit's extract could attract fruit flies. Fruit fly was identified morphologically using manual dichotomous keys (Siwi *et al*., 2006; Suputa *et al*., 2006).

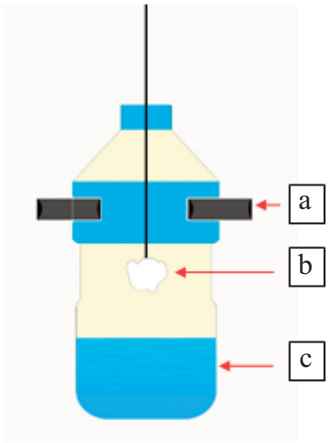

Figure 1. Bottle trap for fruit flies
a. Hole for pipe
b. Cotton
c. Water

Data Analysis

The data were analyzed by ANOVA to determine the influence of four mango fruit extracts with the level of raw and ripe to the preferences of *Bactrocera* spp. A further test was conducted using DMRT (Duncan Multiple Range Test) at a significant level of 0.05. Two ways ANOVA/factorial test was used to determine the interaction of the two factors (mango type and maturity level) on the number of trapped-fruit flies and the durability of mango fruit's extract.

RESULTS AND DISCUSSION

Trap Capture of Fruit Flies

Table 1 showed the number of trapped-fruit flies. ANOVA and DMRT analysis revealed that there were significant difference between treatment and control as follows:

Total number. The extract of ripe arum manis mango, raw arum manis mango fruit's extract, ripe kweni mango fruit's extract, raw kweni mango fruit's extract, ripe pakel mango fruit's extract, and raw pakel mango were significantly different than the control. The ripe madu anggur mango fruit's extract and raw madu anggur mango fruit's extract were not significantly different from controls. Therefore, the treatment of ripe arum manis mango fruit's extract, raw arum manis mango fruit's extract, ripe kweni mango fruit's extract, raw kweni mango fruit's extract, pakel mango fruit's extract, and raw pakel mango fruit's extract may have good potentials in attracting male and female fruit

flies with total trap number of 3.4–15 flies per trap in a week. Factorial analysis data (Table 2) showed that the interaction of mango type and maturity level remained unknown on the total trap number.

Number of trapped-female. Data on the number of trapped-female showed that there were significant different between six treatments (ripe arum manis mango fruit's extract, raw arum manis mango fruit's extract, ripe kweni mango fruit's extract, raw kweni mango fruit's extract, ripe pakel mango fruit's extract, and raw pakel mango fruit's extract) and the control. The ripe madu anggur mango fruit's extract and raw madu anggur mango fruit's extract were not significantly different from the control. Those findings revealed that the six treatments may have good potential in attracting female fruit flies as many as of 2.2–6 flies per trap in a week. Factorial analysis data (Table 2) showed that the interaction of mango type and maturity level remained unknown on the number of trapped-female.

Number of trapped-male. The raw pakel mango extract and ripe pakel mango fruit's extract were significantly different from the control. The arum manis mango fruit's extract, raw arum manis mango fruit's extract, ripe madu anggur mango fruit's extract, raw madu anggur mango fruit's extract, ripe kweni mango fruit's extract, and raw kweni mango fruit's extract were not significantly different from control. These data showed that the raw pakel mango fruit's extract and ripe pakel mango fruit's extract may have the potential to attract male fruit flies with a catch of 4–9 flies per trap in a week. Factorial analysis data (Table 2) showed that the interaction of mango type and maturity level remained unknown on the number of trapped-male.

Extract durability. Raw pakel mango fruit's extract has better durability compared to other treatments and control (Table 3). The raw pakel mango fruit's extract was still able to attract fruit flies from 1st–7th days with the trap number, which were significantly different from control and other treatments on day 1, day 4, day 6 and day 7. Factorial analysis data (Table 2) showed that the interaction of mango type and maturity level remained unknown on the durability of mango extracts in attracting fruit flies.

Table 1. Trapping of fruit flies

Treatment	Total (flies)	Total female (flies)	Total male (flies)
Control (water)	0.0 ± 0d	0.0 ± 0d	0.0 ± 0c
Ripe arum manis mango fruit's extract	4.2 ± 1.6bc	2.8 ± 0.9bc	1.4 ± 0.7bc
Raw arum manis mango fruit's extract	6.0 ± 3.6bc	3.0 ± 1.2bc	3.0 ± 2.5bc
Ripe madu anggur mango fruit's extract	2.8 ± 1.0cd	1.8 ± 0.6bcd	1.0 ± 0.5bc
Raw madu anggur mango fruit's extract	1.8 ± 1.4cd	0.8 ± 0.5cd	1.0 ± 1.0bc
Ripe kweni mango	3.4 ± 0.6bc	2.2 ± 0.2bc	1.2 ± 0.5bc
Raw kweni mango	4.2 ± 1.0bc	2.2 ± 0.5bc	2.0 ± 0.7bc
Ripe pakel mango	7.8 ± 1.8b	3.8 ± 1.2ab	4.0 ± 0.9b
Raw pakel mango	15.0 ± 1.6a	6.0 ± 1.9a	9.0 ± 1.7a

Remarks: Means followed by the same letter in the same column were not significantly different according to DMRT at the significance level of 5%.

Table 2. Factorial analysis (the type of mango and level of maturity) on the trapping of fruit flies and the durability of mango fruit's extracts

Factor	Total (flies)	Total female (flies)	Total male (flies)	Extract durability (day)
Mango type	P = 0.07ns	P = 0.09ns	P = 0.06ns	P = 0.45ns
Maturity	P = 0.30ns	P = 0.72ns	P = 0.14ns	P = 0.74ns
Interactions	ns (not significant)	ns (not significant)	ns (not significant)	ns (not significant)

Remarks: Two Way Anova test at the significance level of 5%. Factor 1: type of mango (arum manis, anggur madu, kweni and pakel). Factor 2: type of maturity (ripe and raw).

Table 3. The durability of mango fruit's extract (trap dynamic over seven days)

Treatment	Day (s)						
	1 (flies)	2 (flies)	3 (flies)	4 (flies)	5 (flies)	6 (flies)	7 (flies)
Control (water)	0.0 ± 0.0c	0.0 ± 0.0a	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Ripe arum manis mango fruit's extract	0.6 ± 0.4c	1.8 ± 0.5a	1.2 ± 1.0a	0.6 ± 0.6b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Raw arum manis mango fruit's extract	3.2 ± 1.1ab	2.6 ± 2.4a	0.2 ± 0.2a	0.0 ± 0.0b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Ripe madu anggur mango fruit's extract	0.4 ± 0.2c	1.4 ± 0.7a	0.4 ± 0.2a	0.6 ± 0.4b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Raw madu anggur mango fruit's extract	0.4 ± 0.2c	0.8 ± 0.6a	0.6 ± 0.6a	0.0 ± 0.0b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Ripe kweni mango	1.2 ± 0.6bc	1.2 ± 0.2a	0.0 ± 0.0a	0.4 ± 0.2b	0.6 ± 0.4a	0.0 ± 0.0b	0.0 ± 0.0b
Raw kweni mango	3.0 ± 0.6ab	0.2 ± 0.2a	1.0 ± 0.6a	0.0 ± 0.0b	0.0 ± 0.0a	0.0 ± 0.0b	0.0 ± 0.0b
Ripe pakel mango	4.6 ± 1.4a	2.6 ± 0.9a	0.4 ± 0.4a	0.0 ± 0.0b	0.0 ± 0.0a	0.0 ± 0.0b	0.2 ± 0.2a
Raw pakel mango	4.6 ± 0.7a	2.8 ± 0.9a	1.6 ± 1.1a	2.2 ± 1.0a	1.8 ± 1.0a	1.0 ± 0.5a	1.0 ± 0.5a

Remarks: Means followed by the same letter in the same column were not significantly different according to DMRT at the significance level of 5%.

Species of Trapped-Fruit Flies

The trapped-fruit flies were identified using manual dichotomous keys (Siwi *et al*., 2006; Suputa *et al*., 2006). Morphological characteristics of the fruit flies for key identification are spot shape on the face; mesonotum color; the presence or absence of yellow bands on both lateral and middle thorax; color, pattern and number of hairs on the scutellum; the pattern on the wing vessels (costal band); the shape and pattern of the abdomen; the color and spot on the legs. There are three species of *Bactrocera* fruit flies obtained from the morphological identification: *B. carambolae*, *B. papayae*, and *B. albistrigata*. All mango fruit's extract treatments could attract male and female fruit flies of *B. carambolae* and *B. papayae*, and only raw Pakel mango fruit's extract could attract male of *B. albistrigata*.

Discussion

The attractancy mechanism of *Bactrocera* spp. against mango extracts in traps might be influenced by the nutrient of mango fruit extracts and the egg-laying by female fruit flies.

Nutrition Preference

The attractiveness of *Bactrocera* spp. against mango extracts are due to the visual orientation of the fruit flies on the bait and the olfactory response of the flies to certain odour (Bernays & Chapman, 1994). The source of odour is a volatile compound derived from the mango fruit's extract evaporates to form pockets of odour carried away from its source by air. The pockets of odour are caught by the sensory antennae of the fruit flies (*Bactrocera* spp.). Each mango fruit's extract emits a different characteristic odour that causes different attractiveness to the fruit flies. *Bactrocera* spp. attracted to certain mango extracts will fly in the vicninity of the trap and may enter the trap, while the control treatment (KO) which does not emit odour, causing small or no attractancy to the fruit flies.

The adult fruit flies require adequate nutrition to sustain their lives for kinetic energy and mating. These nutrients include protein, carbohydrates (mainly sucrose), water, minerals and B (complex) vitamines (Putra & Suputa, 2013). The required nutrients are also found in the mango fruit, hence *Bactrocera* spp. both male and female, in this study are attracted to the mango extracts. This is similar to the study done by Indriyanti *et al*. (2008), which reported that *B. carambolae* tends to be more attracted in waste containing protein because the protein is required by male and female fruit flies. Mangoes also contain protein nutrition content with a percentage of 0.7% in raw fruit and 0.6% in ripe fruit (Pracaya, 2006). *Bactrocera* spp. in this study approached, searched, and entered the source of the odour from the mango fruit's extract in the trap. *Bactrocera* spp. approached the odour source of mango fruit's extract to obtain nutritions. This is indicated by the presence of both male and female fruit flies (*Bactrocera* spp.) attracted to mango fruit's extracts, and the trap could also attract

the type of fruit flies that are not the pest of mangoes, i.e. *B. albistrigata.*

Egg-laying

Besides being influenced by the nutrient content required by fruit flies, the attractiveness of fruit flies against mango extracts is also caused by the egg-laying behaviour of the female fruit flies. A female would recognize the volatile compounds released by the fruit (kairomone) to determine the quality or the compatibility of the host (Prokopy & Roitberg, 1984 *cit.* Putra & Suputa, 2013). Furthermore, after arrives at the host habitat (tree), the female begins to detect the shape and color of the host (fruit). After the host is found by the stimulation of odour received by fruit flies, and find it compatible on its nutritional quality, detect no harmful compounds in the host, have no competition with other insects, and no signs of natural enemies around the host, the female fruit flies will lay their eggs on the host (Putra & Suputa, 2013). That observation was similar to the result of this study, which showed that the mango fruit's extract could attract fruit flies, especially females, where the mango plants become a host for fruit flies, *B. carambolae* and *B. papayae*. This same finding was also reported by Carde & Bell (1995), who wrote that insects are able to detect special odour associated with essential elements of their host. Furthermore, Miller (1986) stated that in the mechanism to find the odour sources, insects were able to stop near the odour source, thus the insects would stay for a long time at that odour source.

The chemical signals that were able to attract fruit flies and made them approach the hosts are in the form of volatile compounds (aromas) produced by the fruit (Alyokhin *et al*., 2000). According to Fletcher and Prokopy (1991) *cit.* Indriyanti (2011), fruit flies will respond to the aroma from plants and approach the host plant. The typical aroma of the host plant is generally in the form of low molecular weight volatile compounds which generally act as initial triggers for fruit flies to come to the plant. The behaviors of fruit flies, such as finding food, laying eggs, and mating is controlled and stimulated by semiochemicals, i.e. kairomone. Kairomone is an attractant derived from plants that can affect insect sensing (olfactory senses) (Kardinan 2003).

CONCLUSION

Raw pakel mango fruit's extract has good potential in attracting male and female fruit flies of *B. carambolae* and *B. papayae*, and male fruit flies of *B. albistrigata* with a total trap number of 15 flies/trap in a week.

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LITERATURE CITED

Alyokhin, A.V., R.H. Messing, & J. Jian. 2000. Visual and Olfactory Stimuli and Fruit Maturity Affect Trap Captures of Oriental Fruit Flies (Diptera: Tephritidae). *Journal of Economic Entomology*. 93: 644–649.

Bernays, E.A. & R.E. Chapman. 1994. *Host Plant Selection by Phytophagous Insect*. Chapman & Hall. An International Thomson Publishing Company, New York. 312 p.

Carde, R.T. & W.J. Bell .1995. *Chemical Ecology of Insect*. Springer, Boston. 433p.

Himawan, T., P. Wijayanto, & S. Kardinah. 2013. Pengaruh Beberapa Aroma Buah terhadap Preferensi Oviposisi *Bactrocera carambolae* Drew and Hancock (Diptera: Tephritidae). *Jurnal HPT* 1: 72–79.

Indriyanti, D.R., E. Martono, Y.A. Trisyono, & Witjaksono. 2008. Ketertarikan *Bactrocera carambolae* (Diptera: Tephritidae) pada Berbagai Limbah yang Mengandung Protein. *Jurnal Perlindungan Tanaman Indonesia*. 14: 86–91.

Indriyanti, D.R. 2011. Identifikasi Senyawa Volatil dalam Olahan Limbah Kakao sebagai Potensi Atraktan *Bactrocera carambolae* (Diptera: Tephritidae). *Sainteknol*: 9: 11–20.

Kardinan A. 2003. *Tanaman Pengendali Lalat Buah*. Agromedia Pustaka, Depok. 78 p.

Miller, J.R. & T.A. Miller (Eds.). 1986. *Insect-Plant Interactions*. Springer Verlag, New York. 342 p.

Pracaya. 2006. *Bertanam Mangga*. Penebar Swadaya, Jakarta. 144 p.

Putra, N.S. & Suputa. 2013. *Lalat Buah, Bioekologi dan Strategi Tepat Mengelola Populasinya*. SMARTANIA Publishing, Yogyakarta. 101 p.

Siwi, S.S., P. Hidayat, & Suputa. 2006. *Taksonomi dan Bioekologi Lalat Buah Penting di Indonesia* (*Diptera: Tephritidae*). Edisi Revisi. Balai Besar Penelitian dan Pengembangan Bioekologi dan Sumberdaya Genetik Pertanian dan Departement of Agriculture, Fisheries and Forestry Australia, Bogor. 65 p.

Sumarmin, R., U. Syukur, & E.D. Setiawan. 2011. Pengaruh Kombinasi Petrogenol dan ekstrak Jeruk terhadap Feeding Strategy Lalat Buah (*Bactrocera dorsalis*). *Jurnal Sainstek* 3: 70–77.

Suputa, Cahyanti, A. Kustaryati, M. Railan, Issusilaningtyas, & W.P. Mardiasih. 2006. *Pedoman Identifikasi Lalat Buah* (*Diptera: Tephritidae*). Direktorat Perlindungan Tanaman Hortikultura. Direktorat Jenderal Hortikultura. Departemen Pertanian Indonesia, Jakarta. 49 p.