Attractancy of Synthetic Compounds Related to Methyleugenol for Oriental Fruit Fly and Melon Fly*

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Sixty compounds structurally related to methyleugenol, which is believed to be one of the most powerful attractant for male oriental fruit fly (*Dacus dorsalis* Hendel) were tested for their attractiveness against this insect with a specially designed olfactometer. No definite correlation between the structure and activity was found, but some tendency was observed. Methyloisoeugenol, veratric acid, methyleugenol and eugenol were the most effective attractants among these compounds tested. A part of these synthetic compounds were also tested against melon fly (*Dacus cucurbitae* Coquillett). None of the chemicals tested was found to be significantly attractive for this insect.

INTRODUCTION

The attractiveness of methyleugenol to male oriental fruit fly was first reported in 1915 by Howlett.¹⁾ This compound is still considered to be one of the most powerful attractant for male oriental fruit fly.²⁻⁴⁾ In 1963, Beroza and Green compiled the Agriculture Handbook in which 4,108 compounds were tested as insect attractants and oriental fruit fly and melon fly were included as test insects in this literature.⁴⁾

In order to study the effect of changes in structure on attractiveness to the fruit fly and to seek further for compound of higher activities, 60 compounds structurally related to methyleugenol were examined for their attractiveness against oriental fruit fly. A part of these synthetic compounds, 27 out of 60, were also tested against melon fly.

MATERIALS AND METHODS

Among 60 compounds tested, 42 compounds were synthesized in the laboratory. The methods of synthesis together with their structures, melting points or boiling points and yields of these compounds were reported in the previous work.⁵⁾ Eighteen compounds were procured from the commercial products and purified either by redistillation or by recrystallization.

The screening tests against oriental fruit fly for their attractiveness were performed in the Fruit Fly Research Unit, Taiwan Citrus Protection Research Laboratory, Hsinchu, Taiwan. In the laboratory screening test, a specially designed olfactometer was introduced with 2,000-2,500 laboratory reared oriental fruit flies. The olfactometer (Fig. 1) is an octagonal cage, 3 feet high and 2.5 feet wide, equipped with 8 glass flask (without bottom) traps. In each flask trap was placed an one-inch length of cotton roll on which a 50% of candidate lure in alcohol solution was saturately absorbed. Three candidate lures with one alcohol control were tested simultaneously and a pair of the

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Fig. 1 Olfactometer for screening test.
A. Dorsal view, B. Side view.

same compound was put at an opposite angle. Experiments were done in 3 replicates with each compound. During the course of test, the olfactometer was rotated at every 30 min for one angle to eliminate any positional advantage. After 4 hr, the numbers of fruit flies caught were counted and the relative attractiveness was subsequently calculated according to the following formula:

$$\text{Relative attractiveness} = \frac{\text{Total number of fruit flies caught in test lure trap}}{\text{Total number of fruit flies caught in alcohol trap}} \times 100$$

The tests of attractiveness against melon fly were carried out in a same manner with that of the method performed for oriental fruit fly.

RESULTS AND DISCUSSION

As a fundamental structure, all of these compounds have at least one methoxyl group in the benzene nucleus. The results were compared to that of the above mentioned literature compiled by Beroza and Green⁴⁾ and tabulated as shown in Table 1. Four compounds, namely methylisoeugenol, veratric acid, methyleugenol and eugenol were found to be the most effective attractant to this insect. The strong attractiveness of veratric acid to oriental fruit fly seemed to be a new finding in this study. None of the chemicals

Table 1 Attractancy of compounds related to methyleugenol for oriental fruit fly and melon fly.

Compd. No.	Original Compd. No. ⁵⁾	USDA Item No. ⁴⁾	Chemical	Relative attractiveness					
				Oriental fruit fly			Melon fly		
				(%)	USDA Class*	USDA Class***)	(%)	USDA Class*	USDA Class***)
1	51	2610	Methylisoeugenol	1396	4	3	19	1	—
2	16	—	Veratric acid	465	4	—	96	2	—
3	50	2608	Methyleugenol	441	4	3	48	1	—
4	44	2501	Eugenol	407	4	3	88	2	—
5	2	2606	Veratrol	324	4	2	26	1	1
6	34	499	<i>o</i> -Anisic acid butyl ester	319	4	2	—	—	—
7	15	84	<i>p</i> -Anisic acid	314	4	1	211	4	—
8	35	2511	Guaiacol	227	4	3	55	2	2
9	32	—	<i>p</i> -Methoxycinnamic acid	226	4	—	67	2	—
10	47	1233	Eugenol acetate	222	4	3	93	2	2
11	37	—	Guaiacol valerate	186	3	—	108	3	—
12	66	—	4,4-Dimethoxybenzophenone	178	3	—	106	3	—
13	38	1301	Guaiacol <i>n</i> -caproate	176	3	2	50	2	1
14	9	346	Veratraldehyde	176	3	3	—	—	2
15	57	—	Acetylvanillic acid	172	3	—	—	—	—
16	53	344	Vanillin	151	3	2	—	—	—
17	26	—	<i>p</i> -Acetanisidide	143	3	—	362	4	—
18	27	2624	<i>p</i> -Methoxyacetophenone	130	3	1	149	3	1
19	25	2985	<i>o</i> -Acetanisidide	129	3	1	184	3	1

20	59	238	Vanillin ethyl ether	126	3	3	—	—	1
21	36	1266	Guaiacol acetate	117	3	3	279	4	2
22	31	—	<i>p</i> -Anisalcinnamalacetone	117	3	—	—	—	—
23	29	2241	<i>o</i> -Anisalacetone	112	3	2	—	—	1
24	23	3029	2,5-Dimethoxyaniline	101	3	2	—	—	1
25	64	—	1,1-Bis(<i>p</i> -methoxyphenyl) 2,2,2-trichloroethane	101	3	—	—	—	—
26	67	—	1,1-Bis(<i>p</i> -methoxyphenyl) ethane	101	3	—	—	—	—
27	14	81	<i>m</i> -Anisic acid	100	3	1	—	—	1
28	49	—	Eugenol cinnamate	96	2	—	—	—	—
29	40	—	Guaiacol cinnamate	87	2	—	—	—	—
30	52	2106	Anethole	86	2	1	20	1	—
31	58	176	Vanillic acid	86	2	2	—	—	1
32	46	—	<i>o</i> -Eugenol	80	2	—	—	—	—
33	24	—	<i>o</i> -Dianisidine	76	2	—	—	—	—
34	21	3039	<i>o</i> -Anisidine	73	2	1	56	2	—
35	17	93	3,4,5-Trimethoxybenzoic acid	71	2	1	—	—	1
36	42	2564	<i>p</i> -Methoxyphenol	65	2	2	—	—	2
37	41	2157	Guaiacol allyl ether	59	2	1	—	—	1
38	63	—	Acetylferulic acid	57	2	—	—	—	—
39	54	345	<i>o</i> -Vanillin	56	2	2	—	—	1
40	45	2519	Isoeugenol	52	2	3	106	3	—
41	60	2240	Vanillalacetone	49	1	2	—	—	1
42	4	2174	<i>p</i> -Dimethoxybenzene	48	1	1	—	—	1
43	33	—	<i>o</i> -Methoxycinnamic acid	47	1	—	—	—	—
44	10	—	<i>o</i> -Methoxybenzyl alcohol	47	1	—	—	—	—
45	61	—	Vanillalacetone acetate	45	1	—	—	—	—
46	28	—	<i>p</i> -Methoxybenzophenone	44	1	—	—	—	—
47	3	2173	<i>m</i> -Dimethoxybenzene	41	1	2	48	1	1
48	18	2124	<i>o</i> -Methylanisole	40	1	1	52	2	1
49	11	2132	Anisyl alcohol	39	1	2	47	1	—
50	48	—	Eugenol benzoate	33	1	—	—	—	—
51	62	—	Ferulic acid	29	1	—	—	—	—
52	8	249	<i>p</i> -Anisaldehyde	19	1	1	23	1	—
53	12	—	4-Methyl-2-methoxy- benzyl alcohol	18	1	—	—	—	—
54	7	246	<i>o</i> -Anisaldehyde	18	1	1	5	1	1
55	22	3042	<i>p</i> -Anisidine	17	1	1	—	—	—
56	1	2109	Anisole	16	1	1	7	1	—
57	20	2125	<i>p</i> -Methylanisole	15	1	1	12	1	—
58	13	82	<i>o</i> -Anisic acid	15	1	1	—	—	1
59	65	—	1,1-Bis(<i>p</i> -methoxyphenyl) 2,2-dichloroethylene	15	1	—	—	—	—
60	19	2123	<i>m</i> -Methylanisole	11	1	1	37	1	1

* Attractancy index for

Class 1: Relative attractiveness less than 50%. Class 3: Relative attractiveness from 100 to 199%.
Class 2: Relative attractiveness from 50 to 99%. Class 4: Relative attractiveness greater than 200%.

** Attractancy index for

Class 1: Less than 11 for males, less than 6 for females.

Class 2: From 11 to 50 for males, from 6 to 50 for females.

Class 3: Greater than 50 for males, greater than 50 for females.

tested was found to be significantly effective against melon fly.

Although there is no definite correlation

between the structure and activity was found, conversion of allyl group to propenyl group by isomerization from methyleugenol (Compd.

3) to methylisoeugenol (Compd. 1) increased the activity significantly. But from eugenol (Compd. 4) to isoeugenol (Compd. 40), this phenomenon was not observed in spite of the close similarity. Additional methoxyl group at ortho position in the benzene nucleus seemed to be useful in requirement of attractancy as shown in methylisoeugenol (Compd. 1), veratric acid (Compd. 2), methyleugenol (Compd. 3) and veratrole (Compd. 5). But one more addition of methoxyl group in veratric acid (3,4-dimethoxybenzoic acid) (Compd. 2) to give 3,4,5-trimethoxybenzoic acid (Compd. 35) greatly decreased the activity.

In general, the results of the attractiveness were well agreed to that of the data reported in the literature,⁴⁾ even though 22 compounds were not included in the report.

Methyleugenol still seemed to be an effective attractant available at present time. This compound has been officially recommended for the control of male oriental fruit fly in the citrus orchard in Taiwan for many years. Especially it is important for the evaluation of the population of this harmful insect in the field.

The leaves and stems of sweet basil, *Ocimum basilicum* L. (*Labiatae*) were found to be attractive to male oriental fruit fly and occasionally used as an attractant by the local people in the field in Taiwan. The active constituents of this plant were isolated and identified as methylchavicol and methyleugenol by the authors.⁶⁾ Kawano *et al.* also reported that the existence of methyleugenol in the blossom of golden shower, *Cassia fistula* L. (*Leguminosae*) was considered to be the cause of its attractiveness to oriental fruit fly.⁷⁾ No connection could be derived regarding the attractiveness between oriental fruit fly and melon fly with these chemicals.

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要 約

メチルオイゲノールは、現今でも雄のミカンコミバエ (*Dacus dorsalis* Hendel) に対して最も有力な誘引剤であるとされている。化学構造とこの害虫に対する誘引作用との関係を明らかにし、より有効なミカンコミバエ誘引剤を見つける目的でメチルオイゲノールと関連のある芳香族化合物 60 種を試験材料とし、この試験のためにとくに設計したミバエ誘引試験装置を用いて効力を試験した。結局、化学構造と誘引作用との間に明確な関係を見つげ出すことはできなかったが、若干の傾向の存在を認めることができた。供試薬剤の中で最も効力の強かったものは methylisoeugenol, veratric acid, methyleugenol および eugenol であった。veratric acid がミカンコミバエに対して強力な誘引作用を持っていることは従来知られていなかったようである。一部の化合物については、ウリミバエ (*Dacus cucurbitae* Coquillett) に対する誘引作用を試験したがとくに強力なものは得られなかった。

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