Malathion Used Properly Produces No Off-Flavors

PESTICIDES AND FLAVOR

Effect of Malathion on Flavor of Certain Fruits and Vegetables

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Because some insecticides have been reported to impart off-flavors to processed fruits and vegetables, it has become necessary to test the flavor of new insecticides prior to their commercial release. The purpose of this work was to ascertain the effect of a new organic insecticide, malathion, on the flavor of selected fruits and vegetables grown in the state of Washington and in an adjacent area of Oregon. For the average nonprofessional taster, the usual dosages of malathion have no effect on the flavor of the products tested in this study. Malathion, from the standpoint of flavor, can be used in Washington for the following crops: potatoes, beans, peas, sweet cherries, apples, peaches, pears, and strawberries.

THE NECESSITY FOR TESTING the flavor of new organic insecticides prior to their commercial release has been emphasized by many recent reports (*1, 3, 4, 6–13, 15, 16*). Some insecticides impart off-flavors to fresh and processed products; others do not. The present study was part of a large testing program involving a new organic insecticide known as malathion (oxy, oxydimethyldithiophosphate of diethylmercaptosuccinate, American Cyanamid Co., New York 20, N. Y.). This program included field tests and flavor studies in several areas of the country. Specifically, the purpose of the work reported herein was to ascertain the effect of malathion on the flavor of selected fruits and vegetables grown in the state of Washington and an adjacent area of Oregon.

The study included fruits from two growing seasons and vegetables from one. Both fruits and vegetables were obtained from experimental field plots in which several malathion treatments were tested and from check plots in which no malathion was used. The tree fruits were grown at the Tree Fruit Experiment Station at Wenatchee, the peas in northwest Washington, the potatoes in Yakima County, and the strawberries and beans in northwest Oregon. The dosages of malathion are given in Tables I and II, along with the dates of application and the harvest dates. All products were processed by simulated commercial procedures. Particular care was taken in growing, harvesting, and processing to ensure comparable products from the treated and check plots.

Procedure

Handling Of Products Fruit products tested for flavor included fresh sweet cherries (Bings), fresh apples (Jonathan), sweetened and unsweetened canned applesauce, canned peaches (Elberta), canned pears (Bartlett), and frozen strawberries (Marshall); vegetables included cooked fresh potatoes (White Rose), canned wax beans (Puregold), canned snap beans (Blue Lake), and canned peas (Perfection and Thomas Laxton). Tests were made shortly after processing (approximately 2 weeks) and after 3 and 6 months' storage at ambient room temperature.

The fresh sweet cherries were served as unpitted fruit picked at random from each of the treated and check groups. The fresh apples were presented to the judges whole and unpeeled. Six to eight replicate cans of canned fruit were combined into one large sample, the sirup was drained, and the fruit was cut into small pieces and thoroughly mixed. Subsamples were placed in coded paper cups for the panel judging. On occasion, it was necessary to add a small amount of a tasteless red dye to the canned applesauce for homogeneity of color between subsamples. Six to eight replicate cans of canned vegetables were combined and heated at boiling for 5 minutes. The vegetables were served hot without canning liquid. The potatoes were quartered and cooked with

skins for 30 minutes and served hot. No salt or other seasoning was added.

Taste Tests The triangular pattern (*14*) was used in setting up the samples for the judging panel. In this sequence of three samples, two were identical and one was different. The judges were asked to pick the different samples in each sequence. For each panel session, the judges were presented with two sequences known as a "block." An uncoded sample of the product being judged (usually the check sample) was given also, so the judges had the taste of the product before tasting the unknowns. Distilled water was supplied for rinsing the mouth between sequences. A separate session was held for each malathion treatment for any one product.

A panel of 15 untrained tasters, with alternates, was selected from the staffs of the Departments of Horticulture and Home Economics. Each sex was represented by approximately equal numbers; ages of judges ranged from the twenties to the fifties. Each judge was randomly assigned one of 15 blocks (two sequences) for tasting. He was instructed to taste the samples from left to right, tasting each sample in a sequence once, and identifying the sample which seemed to be different. Five minutes elapsed before tasting the second sequence. The quality of the difference was estimated from written remarks of the judges in regard to degree of "sweetness," "sourness," "bitterness," "saltiness," off-flavor, and aroma.

If A represents the control sample and B the treated sample in any one panel session, there are six possible sequences of A and B in a triangular pattern (*14*) containing duplicate samples of either A or B. Fifteen judges testing two sequences will total 30 sequences. In other words, the six possible sequence arrangements are replicated five times within a panel session. The random assortment of sequence pairs within replicates as given by Cochran and Cox (*2*) was employed.

Results were analyzed for statistical significance of difference between treated and check samples according to Roessler *et al.* (*14*). As there were 30 tests in each panel session, significant differences at the 5% level are indicated by 16 correctly identified sequences; at the 1% level by 17; and at the 0.1% level by 19 correctly identified sequences out of the 30 judged.

Results and Discussion

A review of individual judges' records for this study indicated a normal pattern for nonprofessional tasters as described by Girardot, Peryam, and Shapiro (*5*). The range for individual records was from 16 to 67% correct judgments, with the majority falling between 40 and 50%. This would place most of the judges in Girardot's "average" group, representative of the population as a whole. He chose professional tasters from judges significantly above average.

Flavor Tests The results of the flavor tests with malathion-treated fruits and vegetables are given in Tables I and II.

For most fruit products tested, malathion treatment had no significant effect on flavor. With one sample of unsweetened canned applesauce (2 pounds of water-wettable powder) and two samples of sweetened canned applesauce (1.5 pints of E-20-X), significant differences were found. However, judges were not able to define the difference

Table I. Flavor Tests with Malathion-Treated Fruits

Product	Malathion Treatment per 100 Gal. Spray	Application Dates	Harvest Date	Storage Period, Months	No. of Correctly Identified Sequences Out of 30[a]
Apples, fresh	1 1/4 lb. water-wettable powder[b]	7/24/51 8/31/51	9/10/51		11
Applesauce[c], canned, unsweetened	1 pt. E-20-X[d]	7/23/51 9/1/51	9/10/51	2 weeks 3	8 11
	1 1/4 lb. water-wettable powder	7/24/51 9/1/51	9/10/51	6	15
	1 1/2 pt. E-21-X[e]	5/22, 6/5 7/10, 8/12/52	9/9/52	3 6	10 10
	1 1/2 pt. E-20-X	5/22, 6/5, 7/17, 8/12/52	9/9/52	3 6	14 13
	2 lb. water-wettable powder	5/22, 6/5 7/17, 8/12/52	9/9/52	3 6	18 13
Applesauce[c], canned, sweetened	1 pt. E-20-X	7/23/51 9/1/51	9/10/51	2 weeks 3 6	13 11 13
	1 1/4 lb. water-wettable powder	7/24/51 9/1/51	9/10/51	6	10
	1 1/2 pt. E-21-X	5/22, 6/5 7/10, 8/12	9/9/52	3 6	17 8
	1 1/2 pt. E-20-X	5/22, 6/5 7/17, 8/12/52	9/9/52	3 6	28[f] 14
	2 lb. water-wettable powder	5/22, 6/5 7/17, 8/12/52	9/9/52	3 6	10 11
Peaches, canned	1 pt. E-20-X	8/9/51	9/1/51	2 weeks 3 6	14 12 13
	1 1/2 pt. E-21-X	5/2/52 8/11/52	9/15/52	4 6	14 12
	1 1/2 pt. E-20-X	5/2/52 8/11/52	9/15/52	4 6	15 6
	2 lb. water-wettable powder	5/2/52 8/11/52	9/15/52	4 6	10 9
Pears, canned	1 pt. E-20-X	7/23/51	8/21/51	2 weeks 3 6	10 6 8
	1 1/2 pt. E-20-X			3 6	15 14
	1 lb. water-wettable powder	5/27/51	8/9/51	6	20
	1 lb. water-wettable powder +1/2 pt. E-20-X	5/27/51(WP) 8/3/51 (E-20-X)	8/9/51	6	14
	2 lb. water-wettable powder	4/15, 5/24, 6/23, 7/22/52	8/20/52	3 6	14 31[f]
Strawberries, frozen	5% dust[g]	5/7/52 5/22/52	6/3/52	2 weeks	13
Cherries, fresh	1 1/2 pt. E-20-X	6/9, 6/24/53	7/5/53	...	17
	2 lb. water-wettable powder	6/9, 6/24/53	7/5/53	...	11

[a] No. of correct answers necessary to establish significant differentiation at 5% level, 16; at 1% level, 17; at 0.1% level, 19.
[b] Water-wettable powder, 25%.
[c] Control plots treated with 1/2 lb. parathion + 1 1/2 lb. DDT.
[d] Emulsion containing 5 lb. of malathion; formula consisted of malathion (95%), 56%; emulsifier, 35%; solvent, 9%.
[e] Emulsion containing 5 lb. of malathion; formula consisted of malathion (95%), 60%; emulsifier, 8%; solvent, 32%.
[f] Out of 60 tastings. No. of correct answers necessary to establish significant differentiation at 5% level, 28; at 1% level, 30; at 0.1% level, 33.
[g] Applied at 30 to 40 lb. per acre.

clearly or consistently. The judges' remarks indicated that judgments were made on the basis of "sweetness" and "sourness." Determinations of pH on the sweetened and unsweetened sauce showed slightly lower pH values in the malathion than in the check samples. In spite of every effort to obtain fruit of uniform maturity, it is possible that the malathion-treated fruit was somewhat more acid than the check fruit. No "off-flavor" was reported in either the control or treated samples. Similarly, the significant difference evident with one treatment of cherries is considered due to differences in maturity between the treated and check samples. With one treatment of canned pears (2 pounds of water-wettable powder) two panel sessions were run. In the first, a significant difference was indicated by 18 correct judgments out of 30. In the second, there were 13 correct out of 30. It was decided that the more discriminating judges were picking up slight differences in sweetness. No "off-flavor" was involved.

Among the vegetables tested, only one malathion treatment of peas (1 quart of E-20-X per acre) showed a significant difference in flavor between treated and check samples. Two panel sessions were run. In the first, there were 18 correct out of 30; in the second, 14 out of 30. Remarks of the judges indicated an after effect which masked tasting ability. To test this possibility, the results from the two panel sessions were grouped into those for the sequence tasted first and those for the sequence tasted second. In the first sequence, there were 20 out of 30 correct judgments; in the sequences tasted second, there were 11 out of 30. This is strong evidence in favor of a masking effect. Some effect on flavor might be expected because of the high dosage of malathion used in this treatment and also because a short period (9 days) elapsed between application of the insecticide and the canning of the peas. The malathion-treated peas were vined and canned one day and the control samples the next. That this might be a factor involved is supported by the fact that the test with Metacide (methyl combination of parathion and the dimethyl analog of parathion) as a check, in which treated and control were handled the same day, did not show a significant difference. However, caution should be exercised with high dosages of malathion on peas.

Conclusion

For the nonprofessional panel, the usual dosages of malathion have no detrimental effect on the flavor of the fruits and vegetables tested here.

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Table II. Flavor Tests with Malathion-Treated Vegetables

Product	Malathion Treatment per Acre	Application Dates	Harvest Dates	Storage Period, Months	No. of Correctly Identified Sequences Out of 30[a]
Potatoes[b], fresh cooked	1 pt. E-20-X[c]	5/17, 5/30 6/22, 7/8/52	7/28/52	1 week	12
	5% dust	5/17, 5/30 6/22, 7/8/52	7/28/52	1 week	12
Beans[d], wax, canned	5% dust	8/2/52	8/5/52	3	7
				6	12
Beans, snap, canned	1 pt. E-20-X	8/9/52	8/12/52	3	11
				6	15
	5% dust	8/9/52	8/12/52	3	9
				6	9
Peas[e]	1 pt. E-20-X	7/21/52	8/4/52	3	14
				6	11
	1 qt. E-20-X	7/9/52 7/19/52	7/28/52	3	32[f]
				6	16
	1 qt. E-20-X[g]	7/9/52 7/19/52	7/28/52	6	11

[a] Number of correct answers necessary to establish significant differentiation at 5% level, 16; at 1% level, 17; at 0.1% level, 19.
[b] Control samples treated with dust containing 5% DDT + 0.5% parathion + 15% sulfur.
[c] Emulsion containing 5 lb. malathion; formula consisted of malathion (95%), 56%; emulsifier, 35%; solvent, 9%.
[d] Control samples treated with 2% DDT and sulfur.
[e] Control samples treated with 25% parathion emulsion.
[f] Out of 60 tastings. No. of correct answers necessary to establish significant differentiation at 5% level, 28; at 1% level, 30; at 0.1% level, 33.
[g] Control Metacide treated.

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