Flavor Changes of Some Fruits and Vegetables Treated with Pesticides

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Fresh and processed fruits and vegetables were treated with pesticides, and effects on flavor were analyzed by the triangular method of comparison.

Table I. Pesticide Application and Flavor Judgment by Commodity

Commodity	Pesticide	Dosage[a]	Time between Final Application and Harvest	No. of Judgments Total	No. of Judgments Correct
Apples, Winesap					
Raw		(1) 2 lb. methoxychlor/100 gal. (2) 1 lb. methoxychlor, 1/2 pt. Chlorobenzilate/100 gal. (3) 2 lb. methoxychlor, 1/2 pt. Chlorobenzilate/100 gal.	2 1/2 mo.	30	17[b]
Applesauce, canned				30	14
Apples, Delicious					
Raw	Guthion	3 lb. 15% W.P.[c] sprayed 3 times	2 mo.	32	21[d]
Sauce, fresh				32	6
Apples, Winesap					
Raw	Guthion	3 lb. 15% W.P. sprayed 3 times	2 1/2 mo.	32	14
Sauce, fresh				32	12
Apples, raw	Demeton	(1) 1 pt. (42%)/100 gal.	..	30	14
Juice, canned		(2) 2 pt. (21%)/100 gal.		60	32[d]
Apples, raw	Demeton	(1) 1/2 pt. (42%)/100 gal.	..	30	9
Juice, canned		(2) 1 pt. (21%)/100 gal.		60	28[e]
Peaches, Elberta					
Raw	Chlorobenzilate	1 lb./100 gal.	1 mo.	30	15
Canned				30	17[b]
Raw	Chlorobenzilate	2 lb./100 gal.	2 weeks	30	10
Canned				30	12
Peaches, J. H. Hale	Demeton	(1) 1/2 pt. (42%)/100 gal.	1 mo.	30	9
Canned		(2) 1/2 pt. (42%)/100 gal.			
Cherries, Bing					
Raw	Demeton	1 pt. (42%)/100 gal.	..	30	10
Canned				30	13
Pears, Bartlett Canned	Demeton	(1) 1/4 pt. (42%)/100 gal.	3 mo.	30	8
		(2) 1/4 pt. (42%)/100 gal.			
	Demeton	(1) 1 pt. (42%)/100 gal.	3 mo.	30	10
		(2) 1 pt. (42%)/100 gal.			
Loganberries, frozen	Demeton	1/2 pt. 90% E.C.[c]	1 mo.	60	20
	Thimet	8 oz. actual	1 mo.	60	23
	12008[f]	8 oz. actual	1 mo.	60	23
	Chlorobenzilate	2 pt. 25% E.C.	1 mo.	60	23
	Sulphenone	4 pt. 50% E.C.	1 mo.	60	23
	Diazinon	4 lb. 25% W.P.	1 mo.	60	26
	Aramite	2 pt. 15% E.C.	1 mo.	60	16
Beans, Yellow Wax, canned	Carco X[g]	14.5 lb. actual/acre	105 days	90	36
	Demeton	16.0 lb. actual/acre	105 days	30	13
	Schradan	4.0 lb. actual/acre	105 days	30	11
Potatoes, cooked	Demeton	6 oz. active ingredient/acre	1 mo.	60	17
		12 oz. active ingredient/acre		30	10
	Schradan	2 lb./acre	..	60	20

[a] Numbers in parentheses indicate sequence of application. [b] Significant at 1%. [c] E.C. emulsifiable concentrate; W.P. wettable powder. [d] Significant at 0.1%. [e] Significant at 5%. [f] American Cyanamid Co. (*O,O*-diethyl *S*-isopropylmercaptomethyl dithiophosphate). [g] Proprietary mixture containing coal tar neutral oil (60%), coal tar acid (8%), and gamma-BHC (hexachlorocyclohexane 0.5% and related isomers 0.9%).

FOR SEVERAL YEARS the flavors of fruits and vegetables treated with new organic pesticides have been evaluated as part of the over-all pesticide-testing program in Washington state. That some insecticides produce "off-flavors" in fresh and processed products is well recognized (*1*, *3–5*, *7*, *8*, *10*). The effect of malathion on the flavor of selected fruits and vegetables has been reported from this laboratory (*6*). Flavor evaluations of a variety of products treated with several different pesticides are reported herein.

Experimental Procedure

Products and Pesticides. The products tested for flavor include: raw apples, canned applesauce, fresh applesauce, canned apple juice, fresh and canned peaches, fresh and canned cherries, canned pears, frozen loganberries, frozen strawberries, frozen raspberries, canned wax beans, and fresh potatoes. The pesticides varied with the crop. Tables I and II summarize by commodity the pesticides, the dosage, and the time between final application and harvest. Standard methods of application were employed. The tree fruits and loganberries were sprayed by hand gun. The beans and potatoes were sprayed with ground equipment. Heptachlor, aldrin, and chlordan were applied evenly over the ground and rotary cultivated into the soil prior to planting the raspberries and strawberries. Kelthane, endrin, and Diazinon were applied with a power sprayer using a berry gun.

Flavor Evaluation. All panel members were experienced in judging the flavor of pesticide-treated products. The triangular method of comparison (*11*) was used for all products except frozen strawberries and raspberries. Fifteen people, approximately equal numbers of men and women, made up the panels in the triangular method. Thirty to 90 judgments were made of each treated and untreated comparison.

For strawberries and raspberries, a modified multiple comparison method (*9*) with a balanced block design was

employed. Six women judges composed this type of panel. Four coded samples and a "hidden control" were judged at each sitting of the panel. Ten sittings were necessary to complete the balanced block presentation of 6 treated samples. By this design, each treated sample was replicated 5 times and judged a total of 30 times. Each coded sample was compared to a known reference or control. The judges were asked to indicate the degree of flavor difference between the coded sample and the control. The amount of flavor difference was marked on a descriptive scale ranging from "no difference" to "extreme difference." The descriptive scale was later quantified from 1 to 10—e.g., no difference was given a value of 1, extreme difference a value of 10. With 30 total judgments per sample, the lowest possible total score, indicating no difference from the reference or control, was 30. The highest possible score was 300, indicating an extreme difference in flavor from the control. Analysis of variance was used to determine significant differences between treated samples and the control and between treatments.

With both panel methods, the judges were asked to give qualitative reasons for their judgments—e.g., sour, bitter, sweet, musty, off-flavor.

Environmental conditions were controlled through the use of taste panel booths. Colored lights masked any differences in color of the samples.

The products were presented to the panel as nearly as possible in the form in which they would ordinarily be consumed. The vegetables were served hot in small pieces. The fruits were served at room temperature in small pieces and with sirup in the case of canned samples.

Results and Discussion

Significant flavor differences (Table I) were detected in raw apples treated with methoxychlor and Chlorobenzilate and with Guthion. The principal basis of differentiation was "sweetness." Four of the 30 judgments mentioned "off-flavor" in the methoxychlor-Chlorobenzilate-treated apples. The differences were no longer apparent in the canned applesauce.

Canned apple juice treated with demeton (Systox) was judged significantly different from the control sample (Table I). Again sweetness or sourness was given as the reason. Two panel members mentioned off-flavor.

Of the pesticides studied with peaches, only Chlorobenzilate-treated canned peaches showed a significant difference in flavor from the control (Table I). Two judges gave off-flavor and one bitterness as basis of judgment; the other 12 judges gave sweetness as the reason.

In strawberries and raspberries significant flavor differences were found between the treatments and the untreated control, but not between treatments (Table II). None of the treatments was described as unacceptable. Sweetness again was given as the main reason for the difference in flavor.

The other pesticides studied did not cause significant flavor changes in the commodity evaluated.

Maturity may account for some of the sweetness judgments. The Delicious apples were definitely overripe. Every effort was made to handle the treated and check samples alike through harvest, processing, and serving to the panel. However, some physiological change may occur which results in a difference in sugar metabolism in the pesticide-treated plants. Limited work with blackberries indicates a higher sugar content in the insecticide treated than in the untreated berries (*2*). Sugar analyses might well be included in further flavor investigations of pesticide-treated fruits.

Gilpin and Geissenhainer (*4*) also report no significant flavor change in aldrin, endrin, chlordan, and heptachlor treated products. Birdsall, Weckel, and Chapman (*1*), however, have found undesirable flavor effects in the soil treatment with aldrin on canned sauerkraut and cooked rutabagas; endrin on canned beets, sauerkraut, squash, pumpkin, and cooked rutabagas; chlordan on canned potatoes and pumpkin; and heptachlor on canned sauerkraut and pumpkin. Different products seemingly react differently to a given insecticide.

Table II. Pesticide Application and Flavor Scores by Commodity

(Multiple comparison method)

Commodity	Pesticide	Dosage, per Acre	Time between Final Application and Harvest, Months	Flavor Score[a]
Strawberries, Northwest, frozen	Kelthane	1 qt. (18.5%)	1	155
	Kelthane	2 qt. (18.5%)	1	124
	Endrin	1 qt. (19.5%)	1	136
	Endrin	2 qt. (19.5%)	1	119
	Diazinon	2 qt. (25%)	1	108
	Diazinon	4 qt. (25%)	1	91
Strawberries, Siletz, frozen	Heptachlor	7 1/2 lb. (actual)	1	132
	Chlordan	15 lb. (actual)	1	115
	Aldrin	7 1/2 lb. (actual)	1	107
Raspberries, Washington, frozen	Heptachlor	7 1/2 lb. (actual)	3 1/2	113
	Chlordan	15 lb. (actual)	3 1/2	91
	Aldrin	7 1/2 lb. (actual)	3 1/2	105

[a] Lower values indicate treatment resembles control. Total of 30 judgments. Lowest possible score, 30; highest possible score, 300.

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