Removal of Aldrin, Heptachlor Epoxide, and Endrin from Potatoes during Processing

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Irish and sweet potatoes were spiked with 100 ppm of endrin. One-half of the samples were irradiated and all were processed with one of four methods (heat processing, with and without water and frozen, blanched, and unblanched). Samples were stored 0, 6, and 12 weeks. Analysis detected three pesticidal residues: aldrin, heptachlor epoxide, and endrin. In the control, heptachlor epoxide was significantly greater in Irish potatoes; aldrin was significantly greater in sweet potatoes. There was no difference in the endrin content. There was a significant decrease of aldrin and heptachlor epoxide with irradiation of the control; endrin was not affected. Aldrin residues were the only ones of the three to be significantly decreased with storage. Irradiation of processed potatoes did not significantly decrease the quantities of any of the pesticidal residues in the samples. Processing significantly decreased all of the pesticidal residues. Endrin residues were significantly decreased with heat processing. Endrin was also decreased with a combination of blanching and freezing. Aldrin was altered primarily with blanching and freezing and to a lesser extent by heat processing without water. Heptachlor epoxide was equally affected by each of the processing methods.

Saha *et al.* (1970) spiked rapeseed flakes with lindane and DDT-^{14}C and studied the effects of processing on the residue content. Farrow *et al.* (1966) investigated the conversion of *p,p'*-DDT to *p,p'*-TDE during the processing of canned spinach. Lamb *et al.* (1968) continued working with spinach and investigated the removal of DDT, parathion, and carbaryl from the vegetable by commercial and home preparative methods. Similar studies were performed on tomatoes by Farrow *et al.* (1968) and on green beans by Elkins *et al.* (1968).

Hemphill *et al.* (1967) studied the effects of home preparative techniques on pesticide residues in green beans. The disappearance of malathion residue in broccoli during cooking and freezing has been investigated by Kilgore and Windham (1970).

Recent work shows that there is considerable interest in the effects of processing on pesticide residues. The effect on processing potatoes containing aldrin, heptachlor epoxide, and endrin has not been studied.

EXPERIMENTAL

Samples. Irish potatoes grown in Idaho and Louisiana yams were used in the investigation. The samples were obtained from a local supermarket making it impossible to ascertain any history of growth or pesticide application. The potatoes were, however, the same quality as found on the consumer market.

Sample Preparation. The potatoes were soaked in tap water to remove the dirt on the surfaces. They were then peeled with a hand peeler and allowed to soak in fresh water. The soaking kept browning from occurring before the potatoes could be placed into containers. Prior to canning, the samples were coarsely ground in a food chopper. The ground potatoes were thoroughly mixed to obtain homogeneous samples. An endrin solution in petroleum ether was introduced into the center of the potatoes in each can.

The processing scheme is diagrammed in Figure 1. Irradiated samples were treated for 1 hr in a ^{60}Co irradiator with a total dose level of 0.87 Mrad. The samples that were heat processed with water had 25 ml of tap water introduced into a 10.5-oz picnic can. The entire heat processed group was hermetically sealed and heated in a retort at 235° F under 10 psig for 30 min. Blanching was performed by placing the open containers of potatoes into a covered vessel of boiling water for 15 min. The containers in the frozen group were sealed, placed into a cold room, and stored at −4° C. Analyses were performed following 0, 6, and 12 weeks storage.

Analytical Methods. The extraction and cleanup procedure was that of Mills (1959). Extracts were analyzed in a Varian Aerograph Series 1200 gas–liquid chromatograph equipped with an electron capture detector. The column was a 183-cm × 4-mm (i.d.) borosilicate glass packed with 10% DC 200 silicone grease on Anakrom ABS (90–100 mesh). Operating temperatures were 210° C, 200° C, and 210° C for the flash heater, column, and detector, respectively. Carrier gas was prepurified nitrogen traveling at a flow rate of 120 ml/min. Injection sizes ranged from 3 to 8 μl.

Thin-layer chromatography was used for confirmation of the pesticides detected with gas–liquid chromatography. The extracts were spotted on plates that had been previously spread with a 0.2% HNO_3 solution in double distilled water mixed with aluminum oxide-G. The layer was spread to a thickness of 0.25 mm. The plates were resolved with *n*-heptane and developed by exposure to ultraviolet light. Confirmation of suspected pesticidal residues was made by comparison with standards.

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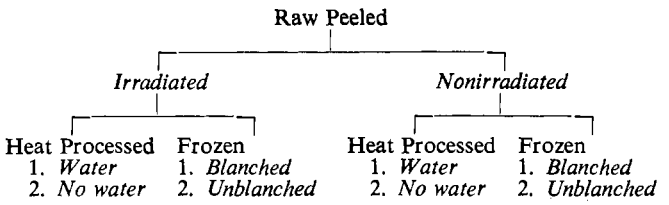

Figure 1. Sampling points within the processing of sweet and Irish potatoes

RESULTS AND DISCUSSION

Findings in the study showed that the three pesticidal residues consistently present in the two potato types were aldrin, heptachlor epoxide, and endrin. Analysis of variance was performed on the data to determine if irradiation, storage, potato type, and processing had any effect on the final residue content.

Table I compares the quantity of residues in unprocessed irradiated and nonirradiated potatoes (first sampling point of Figure 1). The results showed that irradiation produced significant decreases in the aldrin and heptachlor epoxide residues, but did not significantly affect the quantity of the endrin residue.

The effect of storage on the three pesticidal residues is shown on Table II. Storage of the potatoes for 6 weeks did not bring about significant decreases in the residue contents of any of the three residues. However, 12 weeks storage did produce significant decreases in the aldrin and endrin contents. The heptachlor epoxide residue content was not significantly affected.

Differences in residue content of the Irish and sweet potatoes brought about by processing were investigated (Table III). In each instance the residues were decreased significantly; however, the amount of decrease was dependent on the potato type. The greatest decrease of all the residues occurred in the quantity of aldrin in the sweet potatoes. More than 80% of the residue was decreased in the sweet potatoes, whereas only 63.64% was lost in the Irish potatoes. Changes in the residue content of heptachlor epoxide and endrin did not follow the same trend as aldrin. These two residues were decreased a greater extent in the Irish potatoes than in the sweet potatoes by processing.

This evidence indicated that the amount of pesticidal residue decrease depended upon the type of food in which the residue was present and the residue itself. Aldrin was more affected in sweet potatoes; heptachlor epoxide and endrin were decreased to a greater extent in Irish potatoes.

The effects of irradiation on the quantity of pesticidal residues in processed sweet and Irish potatoes were evaluated (Table IV). The quantity of aldrin was not reduced as a result of irradiation. A greater reduction in aldrin content was accomplished by processing alone. The residues of heptachlor epoxide were reduced in significant amounts with irradiation. The endrin content was not altered by irradiation.

A comparison between heat processing and freezing of the samples showed significant changes in the quantities of all three of the residues (Table V). Heat processing effectively reduced the heptachlor epoxide and endrin residue contents 34.4 and 27.0%, respectively. In both cases the reduction was highly significant. Freezing was more effective than heat processing in reducing the aldrin content of the potatoes. A reduction of 35.2% was found to be highly significant.

Table VI illustrates the results of the effects of heat processing, with and without water on the residue levels. The aldrin residue content was significantly decreased by heat

Table I. Average Quantity[a] of Pesticidal Residues in Nonirradiated and Irradiated, Unprocessed Irish and Sweet Potatoes

	Nonirradiated	Irradiated	% Difference
Aldrin	1.42	0.99	−30.1[b]
Heptachlor epoxide	1.54	0.89	−42.5[b]
Endrin	99.27	95.10	−4.21

[a] ppm. [b] Highly significant difference ($P < 0.01$).

Table II. Average Quantity[a] of Pesticidal Residues in Irish and Sweet Potatoes after Three Storage Periods

	0 Weeks	6 Weeks	% Difference[b]	12 Weeks	% Difference[b]
Aldrin	0.35	0.40	+11.82	0.23	−34.5[c]
Heptachlor epoxide	0.36	0.42	+15.75	0.46	+22.5
Endrin	42.40	47.95	+11.58[c]	33.64	−20.7[c]

[a] ppm. [b] Compared to 0 weeks storage. [c] Highly significant difference ($P < 0.01$).

Table III. Comparison of the Effects of Processing[a] on the Quantity[b] of Pesticidal Residues in Irish and Sweet Potatoes

	Irish			Sweet		
	Before	After	% Decrease	Before	After	% Decrease
Aldrin	1.10	0.40	−63.64[c]	1.31	0.25	−80.92[c]
Heptachlor epoxide	1.26	0.36	−71.42[c]	1.16	0.46	−60.34[c]
Endrin	97.68	34.07	−65.12[c]	96.69	48.58	−49.75[c]

[a] Processing includes the effects of the four processing applications used in the study. [b] ppm. [c] Highly significant difference ($P < 0.01$).

Table IV. Average Quantity[a] of Pesticidal Residues Resulting from Irradiation of Processed Irish and Sweet Potatoes

	Non-irradiated	Irradiated	% Difference
Aldrin	0.18	0.47	+61.0[b]
Heptachlor epoxide	0.36	0.46	+22.6[c]
Endrin	42.69	41.20	−3.5

[a] ppm. [b] Highly significant difference ($P < 0.01$). [c] Significant difference ($P < 0.05$).

Table V. Average Quantity[a] of Pesticidal Residues in Irish and Sweet Potatoes as a Result of Two Different Processing Applications

	Un-processed	Heat processed	Frozen	% Difference[b]
Aldrin	1.42	0.39	0.26	−35.2[c]
Heptachlor epoxide	1.54	0.33	0.50	+34.4[c]
Endrin	99.27	34.88	47.79	+27.0[c]

[a] ppm. [b] Calculated as differences between heat processed and frozen group. [c] Highly significant difference ($P < 0.01$).

Table VI. Average Quantity[a] of Pesticidal Residues in Sweet and Irish Potatoes, With and Without Water

	Un-processed	Heat processed		
		Water	No water	% Difference[b]
Aldrin	1.42	0.47	0.32	−31.8[c]
Heptachlor epoxide	1.54	0.35	0.31	−11.8
Endrin	99.27	32.41	37.31	+13.1[c]

[a] ppm. [b] Calculated as difference between water and no water group. [c] Highly significant difference ($P < 0.01$).

Table VII. Average Quantity[a] of Pesticidal Residues in Frozen, Unblanched, and Blanched Sweet and Irish Potatoes

	Unprocessed	Frozen		
		Unblanched	Blanched	% Difference[b]
Aldrin	1.42	0.29	0.22	−25.8
Heptachlor epoxide	1.54	0.53	0.47	−12.1
Endrin	99.27	50.72	44.70	−11.9[c]

[a] ppm. [b] Calculated as difference between unblanched and blanched group. [c] Highly significant difference ($P < 0.01$).

processing with the addition of water. Heptachlor epoxide was equally affected by both methods. Quantities of endrin were affected to a greater extent by heat processing with water than heat processing alone.

The results of blanching compared to nonblanching of the frozen potatoes are listed in Table VII. Blanching significantly reduced the endrin residue levels in the potatoes. Aldrin and heptachlor epoxide were not affected to an extent that the difference was significant.

Results of thin-layer chromatography, used for confirmation of residues detected with gas–liquid chromatography, compared favorably in R_{DDD} values to the standards.

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