

Effects of the Cooking Process on the Removal of Chlordane Residues from Wheat Flour and Rice

by A. BEVENUE

*Department of Agricultural Biochemistry,
University of Hawaii, Honolulu, Hawaii*

and

CHEE YEE YEO

*Department of Food Science and Technology,
University of Hawaii, Honolulu, Hawaii*

Recently completed sorption studies with technical grade chlordane vapors and wheat flour and polished rice (1) prompted a sequential study of the effect of the cooking process on the retention and/or removal of residues of this pesticide from the treated commodities. Two cooked products were prepared in the form of edible foodstuffs, i.e., cookie formulations were prepared from the contaminated flour and baked; the rice was mixed with water and boiled. The cooked products were analyzed for chlordane residues.

Procedure. The flour and rice used in this work had been exposed to chlordane vapors over a period of 90 days as previously described (1). The formula for each cookie consisted of 10 g flour, 6 g granulated cane sugar, 3 g oleomargarine, and 4 ml distilled water. Each mixed cookie batter was placed on a baking tin and baked in an air oven at 180°C for 30 minutes. Ten-gram rice samples were washed three times with 20 ml portions of distilled water, to remove the glucose-talc coating. The wash

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water was retained for subsequent chlordane analysis. Each washed rice sample was boiled with 15 ml distilled water for 15 minutes. Uniformity in cooking the rice samples was accomplished by means of a National Rice-o-Mat cooker (Matsushita Electric - Osaka, Japan).

Chlordane residues were isolated from the baked cookies by the procedures of Mills (2) and Johnson (3), and from the cooked rice by the procedure of Mills et al. (4). The chlordane residues in the rice water washings were extracted in a separatory funnel with Nanograde hexane; the hexane extracts were filtered through a plug of anhydrous sodium sulfate and made to a suitable volume for analysis. Residue analyses were determined by gas chromatography as previously described (5).

Results and Discussion. The amounts of chlordane residues found in the baked wheat flour cookies, the boiled rice, and the rice water washings are given in Tables 1 and 2. The cooking process did not remove all of the residue. The amounts removed from the wheat flour (cookies) varied from 33% to 73% with a mean value of 53%. The washing process removed about 6% of the residue from the rice; residue removed by boiling the rice with water varied from 58% to 79% with a mean value of 67%. Combined washing and cooking effects on rice removed an average amount of about 73% of the chlordane residue.

The qualitative patterns of the gas chromatograph curves of the chlordane residues obtained from the cooked products and the rice water washings were similar to the pattern of the chlordane residues

observed in the contaminated commodities prior to cooking; no formation of 1-hydroxychlordane or heptachlor epoxide from the heptachlor component of the chlordane was detectable.

The less efficient removal of chlordane from the cookies during the baking process compared to that of boiling rice is not readily explainable. It was presupposed that the large shallow surface of the cookie batter coupled with the high temperature dry heat for 30 minutes would effectively remove most, if not all, of the chlordane residue. Contrariwise, more of the chlordane residue was removed from the rice, which was cooked under enclosed steam temperature conditions. The more complex matrix of the cookie formulation (i. e. , the gluten structure of the flour dough and higher fat content) may have been instrumental in retaining almost 50% of the chlordane residue.

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TABLE I

Effect of baking on the removal of chlordane residues from wheat flour

Sample No. ^{1/}	Chlordane content of:		Chlordane removed during baking process		
	Flour ^{2/} μg	Cookie ^{2/} μg	μg	%	Average %
1	4	2	2	50	
	3	2	1	33	42
7	24	14	10	42	
	21	7	14	67	55
21	78	50	28	36	36
30	68	25	43	63	63
40	95	59	36	38	
	104	58	46	44	41
50	97	38	59	61	
	95	38	57	60	61
60	184	74	110	60	
	181	49	132	73	67
90	311	115	196	63	
	196	99	97	50	57
Mean					53

^{1/} The sample no. also refers to the number of days the wheat flour samples had been exposed to chlordane vapors; see text.

^{2/} Flour (10 grams) equivalent to amount of flour in cookie.

TABLE II

Effects of washing and cooking on the removal of chlordane residues from polished rice

Sample No.	Chlordane Content of:				Chlordane Removed by:		Percent Chlordane Removed by:		
	Raw Unwashed Rice ^{1/}	Water Washings	Raw Washed Rice	Cooked Rice	Cooking μg	Washing and Cooking μg	Washing	Cooking	Washing and Cooking
7	10	1.5	8.5	2.5	6.0	7.5	15.0	60.0	75.0
14	28	1.5	26.5	8.5	18.0	19.5	5.3	64.3	69.6
	28	1.5	26.5	4.8	21.7	23.2	5.3	77.5	82.8
21	37	2.0	35.0	13.6	21.4	23.4	5.4	57.8	63.2
30	39	1.5	37.5	14.3	23.2	24.7	3.8	59.5	63.3
40	66	3.0	63.0	20.5	42.5	45.5	4.5	64.4	68.9
50	90	3.0	87.0	16.8	70.2	73.2	3.3	78.0	81.3
	113	6.5	106.5	16.8	89.7	96.2	5.7	79.4	85.1
60	196	5.5	190.5	35.6	154.9	160.4	2.8	79.0	81.8
	102	5.5	96.5	32.8	63.7	69.2	5.4	62.4	67.8
90	243	14.5	228.5	61.2	167.3	181.8	6.0	68.8	74.8
	154	13.0	141.0	51.1	89.9	102.9	8.4	58.3	66.7
Mean							5.9	67.5	73.4

^{1/} The sample no. also refers to the number of days the rice samples had been exposed to chlordane vapors; see text.

^{2/} 10 grams of rice.