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Chlorobenzilate Residues in Citrus-Worker Urine

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A Rebuttable Presumption Against Registration (RPAR) was issued for chlorobenzilate (CB) in May, 1976 (BOYD 1978). In June, 1978 a Notice of Determination was published by the U.S. Environmental Protection Agency because the presumptive cancer risk associated with exposure to the acaricide had not been adequately negated by assessment and research. By February, 1979 a Notice of Intent to cancel all non-citrus uses of CB was issued. Use of chlorobenzilate was thereby limited to citrus crops grown in Texas, California and Florida. The conditions for registration of CB were also made more stringent: (1) it was reclassified as a restricted use pesticide, (2) a new label indicating stricter use conditions was required and (3) utilization of more effective protective clothing and equipment were recommended.

An opportunity to obtain carefully collected urine samples from citrus-fruit field-workers arose while visiting a grove in central Florida, and an analytical method was already available (BRADY et al. 1980) by which urinary levels of chlorobenzilate, analyzed as p,p'-dichlorobenzophenone (DBP), could be determined. Moreover, rat-dosing studies (BRADY et al. 1981) also suggested the feasibility of this approach, and published reports on the metabolism of CB (WHO/FAO 1969, MIYAZAKI et al. 1970, KNOWLES et al. 1971, VETTORAZZI 1975) were all consistent with this methodology. Specifically, according to BRADY et al. (1980), the parent compound and two metabolic intermediates, p,p'-dichlorobenzilic acid (DBA) and p,p'-dichlorobenzhydrol, are all oxidized to p,p'-dichlorobenzophenone which is stable under the experimental conditions of analysis.

SAMPLE COLLECTION

Thirty-five urinary collections were obtained from five male citrus-grove field-workers: GB, JH, JJ, CP and PW, over a period of 23 days. During the days of spray application, the workers used an aqueous mixture of five components (amounts in kg active ingredient/hectare): 4.7 lead arsenate, 3.8 chlorobenzilate, 8.3 copper, 1.75 manganese and 2.12 zinc for ten hours a day on grapefruit trees growing in Polk County. While spraying, the men rode in tractors which were covered by a canopy, i.e., they were not in enclosed cabs. Their clothing was over-the-counter shirts,

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some short-sleeve; full-length coarse trousers, working or cowboy boots and hats. No protective gear such as respirators or face masks was employed. Urinary voids were collected and pooled for each worker from noon until quitting time, around 5:30 p.m. The samples were kept cool and frozen for shipment to Miami as soon as possible.

EXPERIMENTAL

Each sample volume was recorded and the urinary creatinine levels determined according to the Pierce Rapid-Stat^{R} procedure. The pH, osmolarity and specific gravity of each collection was also measured.

Filtered 5-mL aliquots of urine were oxidized in all-glass separatory funnels containing 5% $K_2Cr_2O_7$/20% H_2SO_4 (wt/vol; BRADY et al. 1980). The funnels were placed in an oven maintained at 90°C for 1 h, then removed and allowed to cool to room temperature. The oxidized mixtures were diluted with distilled water, extracted with hexane and analyzed by ^{63}Ni EC-GC. Samples of human urine which had been fortified with 0.05 ppm DBA were run through the complete procedure and served as controls.

Analyses were performed using a Tracor Model 220 gas chromatograph equipped with a 1.8 m x 4 mm ID glass U-tube packed with 1.5% OV-17 + 1.95% OV-210 on 80/100 mesh Gas Chrom Q. Respective injector, column, transfer line and detector temperatures were 250, 210, 260 and 300°C.

RESULTS AND DISCUSSION

This method can readily be used as a monitoring tool to assess human exposure to chlorobenzilate. The limit of detectability of p,p'-dichlorobenzophenone is 2 ppb (based on using 5-mL aliquots of urine). Non-exposed humans averaged less than 0.01 ppm urinary DBP. Recovery data obtained by analyzing eight urines (from non-exposed humans) spiked with 0.05 ppm DBA averaged 97% with a range of 84-108% and a standard deviation of 9%. Urinary values obtained for the workers ranged from 0.07 to 6.2 ppm with an overall average value of 1.3 ppm.

Several physiological factors may affect what levels are actually detected by this method. Among these are the pH of the individual's blood and urine and the concentration of the various urinary components. Inasmuch as the experimentally determined urinary creatinine levels, pH, specific gravity and osmolarity fell within normal limits, the data were plotted in two ways, in ppm CB determined as DBP in urine and µg DBP/mg creatinine. The most extensive data were collected on workers GB, JH and JJ. Table 1 indicates the days on which sample collections were made, the amount of pesticide residue in the total sample and the urinary concentration of chlorobenzilate determined as p,p'-dichlorobenzophenone. Figure 1 contains excretion values for all five citrus workers.

The solid-line values are in ppm CB determined as DBP in urine; the broken-line data are in µg DBP/mg creatine.

The low but consistent recovery values obtained for chlorobenzilate during earlier rat-dosing studies (BRADY et al. 1981) make it tempting to suggest that the values obtained during this investigation may not accurately represent the actual body burdens of these individuals. However, no radio-labeled compound was used during the rodent study, and it is not known if the remainder of the acaricide was stored in various tissues or eliminated via the feces. We have chosen to report these values without the application of any correction factor. At best this method only represents one step forward in the residue chemist's ability to quantify human urinary levels of chlorobenzilate residues. The procedure is useful as a routine monitoring tool and may be used to assess relative exposure of field workers to chlorobenzilate and related pesticides.

Table 1. Urinary Chlorobenzilate Residues in Exposed Citrus Workers

	Exposed Worker					
	GB		JH		JJ	
Day	µg[a]	ppm[b]	µg	ppm	µg	ppm
2	99	0.66	330	0.87	170	0.46
3	270	1.2	430	0.66	210	0.60
4	340	2.0	220	0.56	370	1.1
10	-	-	160	0.33	61	0.35
11	350	1.5	210	0.68	140	0.37
12	450	1.8	290	1.4	530	6.2
14	470	1.1	210	1.0	420	1.3
15	550	2.6	300	1.1	390	2.6
16	550	2.6	220	2.2	760	3.0
24	240	1.8	430	1.7	680	3.0

[a]Amount of CB, analyzed as DBP, in void.
[b]Concentration of CB, analyzed as DBP.

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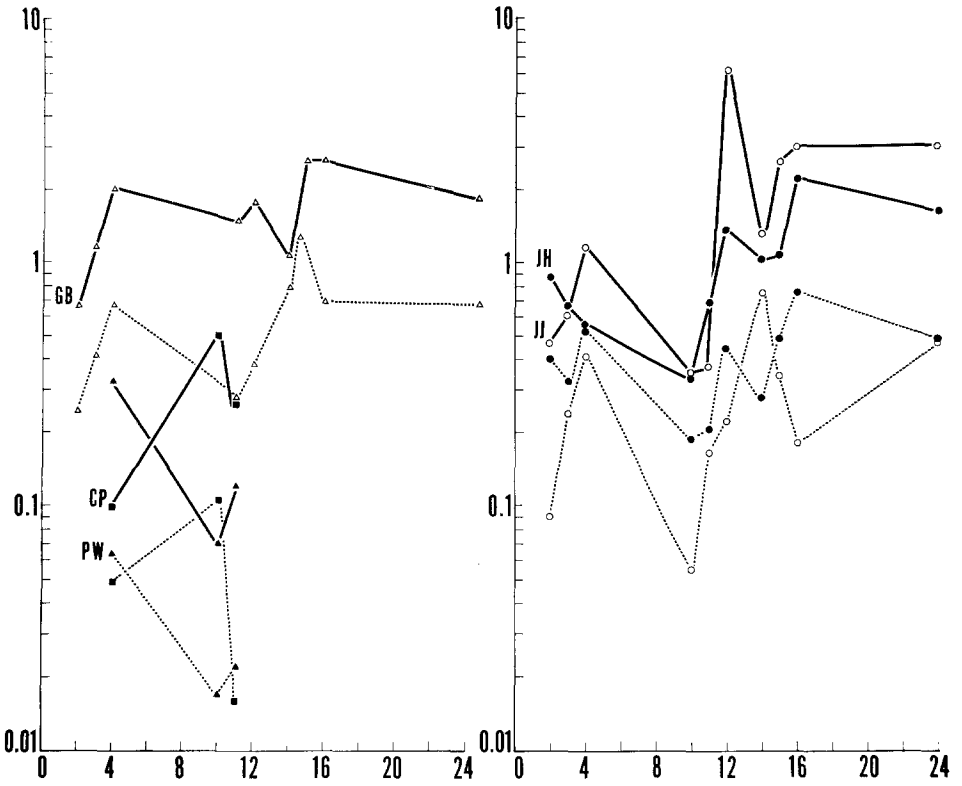

Figure 1. Semi-log plots of urinary chlorobenzilate residues vs time in days. Specific workers are cross-referenced to Table 1 by initials. Solid-line data are in ppm chlorobenzilate (as p,p'-dichlorobenzophenone; DBP) and broken-line data are in μg DBP/mg creatinine.

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