Arsenic Content of House Dusts in Hawaii

by H. W. KLEMMER, E. LEITIS, and K. PFENNINGER
Pacific Biomedical Research Center
University of Hawaii, Honolulu, Hawaii

Measurements for arsenic in house dust were made as part of a broader survey, not yet complete, of levels of pesticide residues and heavy metals in dusts collected from homes in the City and County of Honolulu. Arsenic is ubiquitous in nature and may become concentrated as the result of the activities of man. We were interested in house dust as a potential source of arsenic pollution because of the presence of this element in some arsenical herbicides used in lawn and garden applications, and in several formulations used primarily in the treatment of lumber or other wood products to protect against or control termite infestations.

House dust has been implicated as a significant source of human pesticide burden. Exposure to house dust was reported to be the main source of p,p'-DDT pollution in humans (DAVIES 1972). There appeared to be no information in the literature on the level of arsenic residues in house dust. This study was designed to obtain this information and also to indicate the most likely sources of arsenic residues.

MATERIALS AND METHODS

Dust samples were collected from vacuum cleaner sweepings screened through a 0.246 mm sieve, as specified in THOMPSON (1972).

A total of 61 samples were analyzed for arsenic content by the A.O.A.C. procedure (HOROWITZ 1970). Briefly, 0.5 g samples of dust were mixed with 1.5 ml of concentrated sulfuric acid and 2-5 ml of concentrated nitric acid in 125 ml flat bottom flasks fitted with Vigreaux distillation columns, and then digested over hot plates. The oxidized samples, including water used in rinsing the digestion flasks, were transferred to graduated centrifuge tubes and diluted as necessary with water to a total volume of 15 ml per tube. The suspensions were centrifuged at low speed for 5 minutes after which 10 ml aliquots or less were removed for colorimetric determinations of arsenic by the silver dithiocarbamate method (HOROWITZ 1970), utilizing a Beckman B-G Grating Spectrophotometer. The limit of detection was ≈0.6 µg As_2O_3/10 ml aliquot. This is equivalent to 0.9 µg As/g dust (≈0.9 ppm). Samples of house dust to which known quantities of As_2O_3, $PbHAsO_4$, or copper acetoarsenite, were added, gave recovery rates ranging from 76 to 100 per cent.

Bulletin of Environmental Contamination & Toxicology,
Vol. 14, No. 4 © 1975 by Springer-Verlag New York Inc.

At the time the house dusts were collected, home owners were questioned as to what pesticides they had used in the home environment, whether pest control firms had applied chemicals in the control of pests including termite infestations, and whether any wood in the home had been pre-treated to protect it against termite infestations. This information was later used in identifying some pesticide usage and in categorizing the homes into "treated" and "untreated." Thus, homes were classified as "treated" if they contained pre-treated wood or if they had been treated by pest control firms to control termite infestations. Information also was obtained as to the occupation of the home owners which, in a number of instances, involved usage of pesticides including arsenicals.

RESULTS AND DISCUSSION

The arsenic levels found in the 61 samples of house dusts are given in Table 1. Levels ranged from 1.1 to 1080.0 µg As/g of sieved dust. Generally higher levels were found in dusts obtained from homes where chemicals had been reportedly used in the control of termites. Some instances of extremely high values in excess of 100 µg As/g dust were found in both "treated" and "untreated" homes, as shown in Table 1. In every instance, these high values came from homes where the home owner was either an employee of a pest control firm or of a firm specializing in the treatment of construction lumber with wood preservative chemicals. It was concluded that arsenic may have been brought home on clothing to contribute to the high levels in dust or, that the reporting of home usage of arsenic by the home owners involved was erroneous.

Differences in dust arsenic levels between "treated" and "untreated" homes were tested for statistical significance by a one-tailed t-test, after excluding dust values from all homes where the home owners were occupationally exposed to pesticides. The results, on a total of 46 of the dust samples, indicated that "treated" homes tended to have significantly higher levels of arsenic in dust ($P < 0.01$) than levels in "untreated" homes (mean values of 20.3 versus 10.4 µg As/g dust, respectively).

Information provided by the home owners of the "treated" homes was not sufficiently specific to provide definitive sources for the higher levels of arsenic. However, it is known that copper acetoarsenite (Paris Green) is used by both home owners and pest control firms to treat against termite infestations occurring in homes. This compound, applied as a dust, is a probable major source of additional arsenic in treated homes. A further source may be derived from the copper-chrome-arsenic formulations or fluor-chrome-arsenic-phenol formulations that have been used extensively in Hawaii as wood preservative chemicals. However, these formulations are considered to be a minor source of arsenic in dust because the arsenic tends to be fixed or mordanted

within the wood fibers (HARTGORD 1973). Arsenic levels in dust from 3 homes that had been reported as containing pre-treated lumber (excluding samples taken from homes of employees of pest control or wood treatment firms and samples from all homes treated by pest control firms) averaged 14.6 µg As/g dust, a value not appreciably higher than the mean value of 10.4 µg As/g for dusts from untreated homes

TABLE 1

ARSENIC CONTENT OF DUST COLLECTED FROM 61 HOMES CATEGORIZED AS TREATED AND UNTREATED WITH RESPECT TO REPORTED USE OF CHEMICALS FOR TERMITE CONTROL

Treated Homes[a]		Untreated Homes	
Sample No.	As in µg/g dust	Sample No.	As in µg/g dust
23	23.1	3[b]	5.2
26	23.0	15	9.1
30	3.0	21	8.2
31	16.2	28[b]	4.8
34	28.0	29[b]	32.0
40	7.7	39	6.4
50	8.2	42	6.4
57[b]	28.0	44	6.4
81[b]	15.4	45	7.6
103	36.0	54	13.0
106	20.0	59[b]	31.0
107	11.0	60[b]	3.6
110	13.0	62	25.0
111	5.9	66	7.6
113	11.0	87	7.2
133	50.0	90	9.0
139[b]	22.0	117	10.6
142[b]	17.0	119	3.6
148	8.3	122[b]	13.0
162	64.0	125[b]	5.9
168	21.0	136	6.7
171	12.0	152[b]	7.3
181	16.0	165[b]	1080.0
182[b]	16.0	170	5.3
183[b]	8.3	175	11.0
193[b]	162.0	199[b]	1.1
195[b]	10.6	209[b]	210.0
210[b]	16.0	217[b]	7.1
211[b]	11.0	220	6.4
212[b]	380.0		
224	24.0		
232	26.4		

[a] Homes containing pre-treated wood or homes treated by pest control firms to control termite infestations.

[b] Samples taken from homes of employees of pest control or wood treatment firms.

Arsenic has been reported to occur in soil from various areas of the world at an average concentration of 5 µg As/g soil (VINOGRADOV 1959). While levels of arsenic in Hawaiian soils seem not to have been reported, it is logical to assume that a portion of the arsenic found in Hawaii house dusts is derived from soil brought into the home.

Some portion of the arsenic found in house dust may also be derived from arsenical herbicides used on lawns or gardens and subsequently transferred via air or clothing to the interior of homes. However, reported usage of herbicides by nine home owners involved in this study failed to identify any arsenicals and levels of arsenic found in dusts from these homes were not elevated above the mean value for all the treated homes.

ACKNOWLEDGMENT

This study was supported by the Epidemiologic Studies Program, Technical Services Division, Office of Pesticide Programs, Environmental Protection Agency, under contract number EPA 68-02-0560. The views expressed herein are those of the investigators and do not necessarily reflect the official viewpoint of the supporting agency.

REFERENCES

DAVIES, J.E.: West Indian Med. J. 21, 172 (1972).

HOROWITZ, W. (ed.): Official Methods of Analysis of the A.O.A.C. 11th Ed. A.O.A.C., Washington, D.C. (1970).

THOMPSON, J.F. (ed.): Analysis of Pesticide Residues in Human and Environmental Samples. (Revised, Nov. 1972) Perrine Primate Res. Labs., Environ. Protect. Agency, Perrine, Fla. (1972).

HARTGORD, W.H. In Preservatives and preservative systems. Vol. II (edit. by D.D. Nicholas), Syracuse University Press, Syracuse, N.Y. (1973).

VINOGRADOV, A.P.: The Geochemistry of Rare and Dispersed Chemical Elements in Soils, 2nd Ed. Consultants Bureau, Inc., New York, N.Y. (1959).