Lead Content of Printed Polyethylene Food Bags

by LESTER HANKIN, G. H. HEICHEL, and RICHARD A. BOTSFORD
Departments of Biochemistry, Ecology, and Analytical Chemistry
The Connecticut Agricultural Experiment Station, P.O. Box 1106
New Haven, Conn. 06504

Introduction

Plastic sheet and film are often printed by flexography (Skeels, 1972), a variation of the letterpress process widely used in printing magazines. We previously showed that some letterpress inks used in magazines contained about 29,000 ppm lead and that the colored pages from magazines may have been the major source of lead in the diet of a child brought to the attention of a health officer (Hankin, Heichel, and Botsford, 1973). The knowledge that letterpress inks are used in printing plastics led us to examine the lead content of printed polyethylene bags used for packaging foods, and we now report these results.

Methods

Food packages were purchased at local markets or procured from a bakery. The samples in Table 1 were representative pieces cut from multicolored, printed polyethylene bags for food, and those in Table 2 were sections of a single color cut from several polyethylene bread wrappers. All the samples were ashed, digested in dilute nitric acid, and filtered (Perkin Elmer, 1971). The filtrates were analyzed for lead with a Perkin Elmer Model 303 Atomic Absorption Spectrophotometer. The limit of detection for the method of assay was 1 part of lead per million parts of the original sample, e.g. the bag or dried ink.

Results

The lead content of printed pieces of polyethylene bags enclosing bread, rolls, candy, snacks, and cereal ranged from 425 to more than 23,000 ppm (Table 1). More lead was found on bags with orange or yellow as the predominant color than on those with nearly a clear background and sparcely overprinted with periodic colored designs and legend. A substantial range in lead content was found on bags containing different products from a single distributor. Samples 4 and 13 from distributor D varied nearly 3-fold from 3500 to 10,000 ppm, and samples 5 and 17 from distributor E ranged about 7-fold from about 3700 to nearly 24,000 ppm lead.

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TABLE 1.

Lead content of samples of polyethylene food bags.

Sample	Distributor	Food Description	Colors[a]	Lead(ppm)
1.	A	White bread	clear/red/ white/yellow	425
2.	B	Cereal	clear/red/orange	475
3.	C	Candy	clear/orange/ white/brown	2180
4.	D	White bread	white/red/ yellow/blue	3500
5.	E	White bread	clear/red/ white/blue	3712
6.	F	Sesame rolls	clear/orange/ purple	4375
7.	G	White bread	white/red/ yellow/blue	5750
8.	F	Wheat bread	clear/brown/yellow	6125
9.	H	Rye bread	white/green/red/ black	6500
10.	I	Cheese-flavored snacks	yellow/red/blue	6750
11.	J	White bread	white/orange/ yellow/green	8515
12.	K	White bread	yellow/red/ white/blue	8750
13.	D	Diet bread	orange/yellow/blue	10,000
14.	F	Oatmeal bread	clear/yellow/ brown	10,125
15.	F	White bread	clear/yellow/ pink/brown	11,375
16.	G	Buttermilk bread	yellow/red/blue	12,500
17.	E	Diet bread	orange/green/ brown/white	23,750

[a] Colors listed in order of predominance

The lead content of the film varied with the color of ink on the surface of the polyethylene film, and ranged from 12 ppm for white sections to over 18,000 ppm lead on orange sections (samples 1 through 6; Table 2).

TABLE 2.

Lead Content of ink washed from a bag, and of sections of a single color cut from polyethylene bread wrappers.

Sample	Description	Lead(ppm)[b]
1.	solid orange	18,100
2.	solid green	10,600
3.	solid red	6,900
4.	solid yellow	5,400
5.	solid blue	240
6.	solid white	12
7.	clear, unprinted	0
8.	inks[a]	48,100

a. All the ink was removed from one polyethylene bag with chloroform. This bag was printed, in decreasing order, with white, red, yellow, and blue colors.

b. For samples 1 through 7, ppm of lead are based on weight of ink and polyethylene; for sample 8, ppm of lead are based on weight of dried ink.

To establish that the lead was in the inks rather than in clear, unprinted polyethylene film, all the ink from one bread bag was removed with chloroform (sample 8; Table 2). The composite sample of ink from a bag printed largely with white, red, yellow, and blue inks contained 48,100 ppm. Lead could not be detected on the clear, unprinted polyethylene (sample 7; Table 2). Thus, the lead on the bags that we sampled was attributable to the ink on the exterior of the film.

We confirmed the ease of removal of the inks on the bags by rubbing them lightly on filter paper. Visible ink was deposited on the filter paper. Further, sample 17 (Table 1) was examined by a standard test used to determine the leachability of lead from earthenware (Fein, 1969). In this test, 35 ml of 5% acetic acid were placed for 24 hours in a depression formed by 164 cm^2 of the exterior portion of the bag printed in solid orange. The acetic acid extract yielded 18µg lead/ml of acid. The rejection level for earthenware similarly treated is 7µg lead/ml acid (U.S. Dept. HEW, Admin. Guidelines, 1973).

The inner surfaces of two unused bags obtained from a bakery were washed with chloroform to remove any ink that may have been

deposited during the rerolling of the film after printing, or during subsequent manufacture and handling of the bags. Each bag had a surface area of 2461 cm^2, and 300 ml of chloroform were used in the washing. The chloroform was then evaporated. The lead content of the dried residue was less than the limit of detectibility.

The movement of lead from the exterior printed to the interior unprinted side of a bread wrapper was examined by the standard acetic acid test for earthenware (Fein, 1969) as described above. The exterior surface of a bag printed with a periodic yellow design yielded 6.7µg lead/ml acid but the unprinted inner surface yielded no detectable lead.

Discussion

Interestingly, the lead content of materials used to package toys is regulated by the U. S. Food and Drug Administration, and lead cannot exceed 0.06% (600 ppm) of the total weight of the dried paint film on the package (Code of Federal Regulations, 1973). The Hazardous Substances Act (Code of Federal Regulations, 1973) bans any paint or surface coating material intended for use in or around the house that contains more than 0.5% (5000 ppm) lead in the coating. In contrast, the concentration of lead on the 17 printed polyethylene food bags that we tested averaged 0.73% of the total weight of the bag. The ink removed from one bread bag contained 4.81% (48,100 ppm) lead. Five per cent acetic acid dissolved more lead from the printed surface of another bag than the permissible amount for earthenware.

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