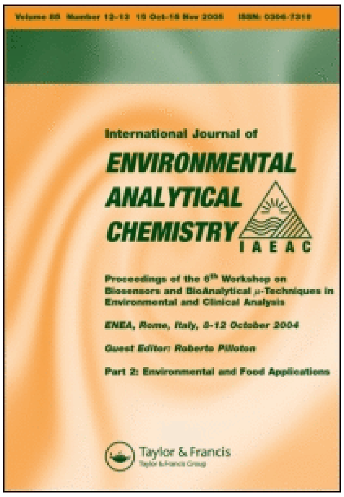

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Colored Gift Wrapping Papers as a Potential Source of Toxic Metals

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Sanitary land fills are the alternate to waste incineration in New Jersey. While industrial waste disposal is controlled, few restrictions apply to the disposal of domestic solid waste. Among the materials of concern from domestic sources are colored gift wrapping papers. Cadmium, chromium, copper, iron, manganese, molybdenum, nickel, lead and zinc were determined in some dozen and a half samples of gift wrapping paper by atomic absorption spectrometry after wet ashing and after simulated leaching. High levels of lead and chromium were found in many of the papers. The leachates showed correspondingly high levels of lead.

KEY WORDS: Waste paper, trace metals, toxic wastes, lead, chromium.

INTRODUCTION

Much activity has been directed to the identification of potential sources of toxic elements in the industrial and occupational environments. The domestic environment has received less scrutiny, but some work in this area has been reported. Katz and Samitz,[1] for example, have reported that significant amounts of nickel can be leached from a variety of consumer items under simulated domestic conditions. On the basis of their thallium and lead determinations, Toots and Parker[2] have urged caution in the use of salt substitutes found in the domestic environment. Eaton *et. al.*[3] have reported that lead and chromium are extracted from children's magazines under simulated stomach conditions.

The use of inorganic pigments in the printing of colored paper is wide spread. Although many printers have voluntarily changed to lead-free inks for the printing of children's magazines, the use of toxic metal compounds

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as pigments is neither prohibited nor regulated. Hence, the individual consumer bears the risk of the initial exposure, and society at large may suffer long term consequences from the disposal of such papers.

Our work is concerned with the levels of some toxic elements in colored gift wrapping papers and with the leachability of these elements under conditions simulating the disposal of these papers in sanitary land fills.

Seventeen different specimens of gift wrapping paper were collected from a variety of sources. Aside from storage in plastic bags, no special handling procedures were employed. Samples were cut from each specimen of paper with stainless steel scissors. For the determination of total metal contents, 100 mg samples were used; 250 mg samples were taken from each specimen for the leaching aspect of our work. Samples of Whatman No. 1 filter paper were employed to determine reagent blanks.

The total metal contents of the paper specimens were determined by atomic absorption spectrometry after wet ashing of 100 mg samples in acid digestion bombs (Parr #4745). Redistilled nitric acid was used to digest the samples in accord with the manufacturers directions. The digests were quantitatively transferred from the Teflon cups of the bombs to 10 mL volumetric flasks with deionized distilled water. Dilution of the contents of the flasks was with deionized distilled water.

To stimulate the leaching of metals from the papers by ground water, 250 mg samples of each paper specimen contained in plastic beakers were treated with 25 mL of 1.0×10^{-2} M ammonium nitrate solution at pH 5.2 and sealed with plastic coated covers. The beakers with their contents remained undisturbed for 30 days prior to the determination of leachable metals in the ammonium nitrate solution.

The metal levels in the paper digests and leachates were determined by atomic absorption spectrometry. A Perkin Elmer model 360 atomic absorption spectrometer was used in accord with the manufacturer's instructions for the determination of cadmium, chromium, copper, iron, lead manganese, molybdenum, nickel and zinc. The results of these measurements on the paper digests are presented in Table I as total metal contents. Table II lists the amounts of metal leached from the paper specimens by the ammonium nitrate solution.

Among the inorganic compounds used as yellow pigments are cadmium sulfide, zinc chromate and lead chromate. Lead chromate is frequently mixed with lead sulfate or barium sulfate.

Papers 6, 10 and 11 show total lead to total chromium ratios of 4.42 to 1, 4.17 to 1 and 4.24 to 1 respectively. The lead to chromium ratio of lead chromate is 3.98 to 1. Hence, papers 6, 10 and 11 may contain lead chromate. Papers 1, 2, 5, 7, 8, 9, 12, 13, 14 and 16 show lead to chromium ratios above 5 to 1 indicating that lead sulfate may be present with the lead chromate. The low cadmium levels would indicate that cadmium sulfide was not used as a yellow pigment in the papers studied.

Prussian Blue, Turnbull's Blue, Williamson's Blue and other iron compounds of hexacyanoferrates are used as blue pigments. Copper phthalocyanine is also a frequently encountered blue pigment. Paper specimen 12 would appear to contain copper phthalocyanine while specimens 8 and 16 show copper and iron levels indicating the presence of both pigments.

Red lead and vermilion are used as red pigments. The absence of data for mercury precludes commenting on the presence of the latter pigment. The high levels of lead in paper specimens 4, 7, 8 and 12 may be due to red lead.

The most frequently encountered green pigment is chrome green, a mixture of yellow lead chromate and Prussian Blue. Sometimes, green pigments are prepared by mixing zinc chromate and ultramarine. The presence of zinc in paper, however, is more likely due to extenders. The presence of chrome green pigments in the specimens we studied is not immediately obvious from our data.

TABLE I

Total metal contents of colored gift wrapping papers, mg/kg

Paper specimen	Cd	Cr	Cu	Fe	Pb	Mn	Mo	Ni	Zn
1	*	463	*	218	2670	*	*	*	52
2	*	37	*	440	251	*	*	*	27
3	–	–	–	–	–	–	–	–	–
4	*	95	86	340	1140	*	*	*	123
5	*	1430	*	340	7290	*	*	*	*
6	*	2190	*	274	9700	*	*	*	25
7	*	240	*	602	3710	*	*	*	117
8	*	300	2680	1020	2830	*	*	*	1140
9	*	2020	*	215	11300	*	*	*	289
10	*	2470	*	150	10300	*	*	*	96
11	*	3370	105	352	14300	1440	*	*	241
12	*	133	3180	167	2080	*	*	*	3370
13	*	393	*	326	3630	*	*	*	51
14	*	1260	*	392	11900	*	*	*	157
15	–	–	–	–	–	–	–	–	–
16	*	92	2690	684	826	*	*	*	2040
17	–	–	–	–	–	–	–	–	–
Blanks	*	*	*	*	*	*	*	*	*

* = None detected: less than 20 mg/kg for Cd, Cu and Zn
less than 50 mg/kg for Cr, Fe, Pb, Mn and Ni.
less than 100 mg/kg for Mo.

– = Not analyzed

TABLE II

Leachable metal contents of colored gift wrapping papers, mg/kg

Paper specimen	Cd	Cr	Cu	Fe	Pb	Mn	Mo	Ni	Zn
1	*	*	*	*	125	–	–	–	20
2	*	*	*	*	*	–	–	–	*
3	*	*	*	*	346	–	–	–	44
4	*	*	*	*	*	–	–	–	*
5	*	*	*	*	115	–	–	–	*
6	*	*	*	*	*	–	–	–	*
7	*	*	*	*	*	–	–	–	*
8	*	*	1110	*	*	–	–	–	589
9	*	*	*	*	372	–	–	–	52
10	*	*	*	*	140	–	–	–	35
11	*	*	*	*	*	–	–	–	*
12	*	*	240	*	*	–	–	–	700
13	*	*	*	*	*	–	–	–	*
14	*	*	*	*	*	–	–	–	*
15	*	*	*	*	183	–	–	–	*
16	*	*	78	*	*	–	–	–	351
17	*	*	*	*	58	–	–	–	20
Blanks	*	*	*	*	*	*	*	*	*

* = None detected: less than 20 mg/kg for Cd, Cu and Zn
less than 50 mg/kg for Cr, Fe, Pb, Mn and Ni
less than 100 mg/kg for Mo.

– = Not analyzed.

Molybdate orange ($PbCrO_4 \cdot MoCrO_4$) and umber ($Fe_2O_3 + MnO_2$) appear not to have been used in the printing of the papers we examined. Aside from paper specimen 11, manganese was not detected. Molybdenum was not detected in any of the specimens.

Although nickel compounds are not commonly used as pigments in printing inks, we analyzed for nickel because of its dermatological hazards.[4] Nickel, however, was not detected in any of the specimens we examined.

The data in Table I show that the paper specimens examined contain high levels of lead and, in some cases, chromium. Eaton and her coworkers[3] have thoroughly discussed the risk to children who might chew and swallow such papers. Campbell[5] and Law[6] have identified the environmental consequences of incinerating such papers as municipal solid waste.

That significant amounts of lead, as well as some of the other metals present, can be leached from the papers is shown by the data in Table II.

While the use of 1.0×10^{-2} M ammonium nitrate has not been established as a leaching medium, it does reflect the slightly acid ground waters found in southern New Jersey. The 1 to 100 ratio of paper sample to leaching medium may not correspond to actual sanitary land fill conditions. None the less, the data in Table II clearly show that metals are leached from colored gift wrapping papers under relatively mild conditions. The concentrations of lead in the leachates from more than half of the samples were well above the limits for potable water established by the Safe Drinking Water Act.[7]

From the data in Tables I and II, we conclude that the use of lead and chromium compounds in the manufacture of colored gift wrapping papers represents a hazard to the consumer in his domestic environment. The possibility of ingestion by children is real, and the incineration of gift wrappings in the Yule-tide fire may result in the inhalation of these toxic elements.

Disposal of these colored gift wrapping papers presents the possibility of environmental contamination. Incineration immediately leads to air pollution problems, and land fill disposal can certainly lead to the pollution of ground water.

An obvious solution to this situation would be to avoid the use of compounds of toxic elements in the manufacture of colored gift wrapping papers.

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