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Cadmium, Chromium, Lead, and Mercury Residues in Finger-Paints and Make-Up Paints

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Cadmium (Cd), Chromium (Cr), Lead (Pb) and Mercury (Hg) have been shown to be toxic to human health as well as to the environment (Langard and Norseth, 1979; US EPA, 1981; Bertram et al., 1985; IPCS, 1988; IPCS, 1989a; IPCS, 1989b). Furthermore, children have been shown to be very susceptible to chronic Pb exposure during their development (Smith et al., 1989). Chronic toxicity to Pb, as a result of absorption of Pb through the skin, has also been demonstrated (Rastogi and Clausen, 1976).

Finger-paints are commonly used by picture painters as well as by children. Theater artists and children are also exposed to make-up paints. To protect above mentioned groups from toxic effects of metals, the contents of several metals in finger-paints as well as in make-up paints have been regulated by national and international authorities. Levels of Cd, Cr, Hg and Pb in finger-paints and make-up paints have been elucidated in the present study.

MATERIALS AND METHODS

Fifty-seven samples of finger-paints (28 samples) and make-up paints (29 samples) available in Danish Market, from hobby shops and toy shops, were investigated in the present study. All in all 28 products of finger-paints (14 products) and make-up paints (14 products) with different colors were from 16 different European manufactrures. Both water-based paints and grease-paints were analysed for the contents of Cd, Cr, Hg and Pb. Red, pink, yellow, orange, golden, blue and green paints were chosen for the study, because they may contain metallic pigments. The study also included 8 white paint samples which may not contain metallic pigments. Thus, the possible impurities of Cd, Cr, Hg and Pb in the colored samples of finger-paints and make-up paints could be elucidated.

Approximately 1 g sample, water-based paint or dry powder, was mixed with 25 ml of 4N nitric acid in a

kjeldahl flask, and the mixture was refluxed at 180°C for 30 min. Thereafter, 10 ml of 30% hydrogen peroxide was added and the mixture was further refluxed for another 20 min. After cooling, the contents of the flask were filtered through a 0.45 μm non-metallic prewashed filter paper, and the filterate was made up to 50 ml with 0.2% nitric acid. The filterate was used for the analyses of metals.

In case of grease paints, approximately 1 g sample was suspended in 50 ml n-hexane, with the help of a magnetic stirrer. After standing overnight, the clear hexane phase was transferred into a separating funnel and that was extracted with 5 ml distilled water. The water phase was added to the residue (undissolved material) together with 5 ml of 8N nitric acid. The residue was made up to 25 ml with 4N nitric acid and refluxed as described above. Further treatment of the sample was the same as in the case of water-based paints.

For recovery analyses, two samples from each group were spiked to 200 ppb Cd, 500 ppb Hg, 1 ppm Cr and 1 ppm Pb, and they were treated as described above.

Cd, Cr and Pb were analysed by graphite-furnace atomic absorption spectrophotometry (AAS) at wavelengths 228.8 nm, 357.9 nm and 283.3 nm respectively. The analysis of Hg was peformed by mercury hydride system - AAS at 253.7 nm. Sodium borohydride was used as reductant for the analysis of Hg. Calibration curves of Cd, Cr, Hg and Pb were prepared by the analysis of 1 ppb-100 ppm of standard solutions of these metals, under the same conditions as the samples.

RESULTS AND DISCUSSION

The analysis of the spiked finger-paint samples revealed that the recoveries of all the 4 investigated metals were >96%; and the recoveries of these metals from spiked make-up paints were 89%-92%. Therefore,an external standard method was used for the analysis of metal contents in both the finger-paints and the make-up paints. The relative standard deviation of the method was found to be <3% for all the 4 metals analysed. The detection limits of Cd, Cr, Hg and Pb in the paint samples were 0.5 ppb, 10 ppb, 15 ppb and 2 ppb repectively.

The metal contents in the investigated samples is described in Table 1. The results are not corrected for the recovery. All the investigated samples were found to contain <1 ppm Cd and Hg. However, only 81% and 72% of the investigated samples containted <1ppm of Cr and Pb respectively. Nine of the samples (16%) contai-

ned 1-10 ppm Cr, and 13 samples (23%) contained 1-10 ppm Pb. Two make-up paints, a green and an orange, were found to contain 66.3 ppm and 72.3 ppm Cr respectively. Three different samples (colours: orange, yellow and green) of a water-based finger-paint contained 43-55 ppm Pb. The accumulative content of the 4 metals in the investigated samples is shown in Table 2.

Table 1. Metal content in finger-paints and make-up paints.

Metal	Number of samples containing		
	<1 ppm	1-10 ppm	>10 ppm
Cd	57		
Cr	46	9	2 (66.3 ppm and 72.3 ppm)
Hg	57		
Pb	41	13	3 (43.5 ppm, 44.0 ppm and 54.5 ppm)

Table 2. Accumulative content of Cd, Cr, Hg and Pb in finger-paint and make-up paint.

Metal content	No. of samples	% of total samples
<1 ppm	35	61
1-10 ppm	16	28
>10 ppm	6	11

The contents of Cd, Cr, Hg and Pb in the samples with respect to their colors is shown in Table 3. The white paints contained <1 ppm Cd and Hg. However, <1 ppm Cr and Pb were found in only 7 and 5 white samples respectively. The remaining white samples contained 1-10 ppm of Cr/Pb. Considering that no metallic pigments were used in the formulation of white paints, upto 1ppm Cd and Hg as well as upto 10 ppm Cr and Pb may be re-

Table 3. Metal content in finger-paint and make-up paint with respect to their colors.

Color	No. of samples analysed	Metal content	No of samples containing			
			Cd	Cr	Hg	Pb
White	8	< 1ppm	8	7	8	5
		1-10 ppm	-	1	-	3
Red	21*	<1 ppm	21	19	21	19
		1-10 ppm	-	2	-	2
Yellow	17**	<1 ppm	17	13	17	9
		1-10 ppm	-	3	-	6
		>10 ppm	-	1	-	2
Blue	4	<1 ppm	4	2	4	4
		1-10 ppm	-	2	-	-
Green	7	<1 ppm	7	5	7	4
		1-10 ppm	-	1	-	2
		>10 ppm	-	1	-	1

* one pink sample. ** one golden and 3 orange samples.

garded as impurities of these metals in the finger-paints and make-up paints. Residues of metals in these products may be introduced through the ingradients. Thus, higher concentrations of Cd, Cr, Hg and Pb in the finger-paints and make-up paints may be expected when pigments containing these metals are used in the formulation of above mentioned products. In the present study 5 samples (9%) were found to contain >10ppm Cr/Pb. These products may, therefore, contain Cr-/Pb-pigments. The results of the present study may thus indicate that the individuals using finger-paints and make-up paints may be chronically exposed to toxic metals like Cr and Pb. Because finger-paints and make-up paints come in direct contact with the skin, it may be important to keep the residues of toxic metals in these products at minimum. Finally, the results of the study may indicate that the use of metallic pigments in the formulation of finger-paints and make-up paints may not be necessary, as only 9% of the samples were shown to contain such pigments.

Finger-paints and make-up paints in Denmark, and other EEC countries, are regulated by the EEC directive on cosmetic products, 76/768/EEC. According to the directive, Cd-, Cr-, Hg- and Pb-pigments are not allowed in

cosmetic products. However, no lower limit of Cd, Cr, Hg and Pb content in cosmetic products is set by the directive. At present no data is available in the literature, concerning the safe levels of toxic metals in finger-paints and make-up paints. In an earlier study, however, a high blood Pb content (>40 ppm) of automecanichs were related to high Pb content (>500 ppm) of motor oils to which they were exposed during service and repair of automobiles (Clausen and Rastogi, 1977). In the present investigation, none of the samples were found to contain >500 ppm Pb. The metal toxicity of finger-paints and make-up paints may not only be determined by the concentration of the toxic metal in it, but also by other factors, for example, the amount of the paint applied on the skin, the area and health status of the skin, the frequency of application of the paint, the time of contact between the paint and skin, and ingradients of the paint which may facilitate absorption of metallic compounds through the skin. A systematic study in which above mentioned parameters may be related to biochemical and physiological changes in persons using finger-paints and make-up paints is necessary to determine safe levels of toxic metals in these products.

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REFERENCES

Bertram HP, Kemper FH, Zenzen C(1985) Man - A target of ecotoxicological influences. In Pollutants and their ecotoxicological significance (Nurenberg HW ed) pp. 415-439. John Wiley & Sons, New York.

Clausen J, Rastogi SC (1977) Heavy metal pollution among autoworkers. I. Lead. Brit J Ind Med 34: 208-215.

IPCS International Programme on Chemical Safety(1988) Environmental health criteria 61. Chromium. WHO, Geneva.

IPCS International Programme on Chemical Safety(1989a) Environmental health criteria 85. Lead. WHO, Geneva.

IPCS International Programme on Chemical Safety(1989b) Environmental health criteria 86. Mercury. WHO, Geneva.

Langard S, Norseth T(1979) Chromium. In Handbook of toxicology of metals (Friberg L, Nordberg GF, Vouk VB eds) pp 383-397, Elsevier Science Publishers, Amsterdam.

Rastogi SC, Clausen J(1976) Absorption of lead through the skin. Toxicology 6: 371-376.

Smith MA, Grant LD, Sors AI(1989) Lead exposure and child development - An international Assessment. Kluwer Publisher, London.

US EPA(1981) Health assessment document for cadmium. United States Environment Protection Agency 600/8-81/023, Research Triangle Park, NC.

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