

CONTACT POINT

Is a high concentration of hexavalent chromium in Indian cement causing an increase in the frequency of cement dermatitis in India?

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Occupational skin diseases can constitute an important burden among workers in the construction industry. Exposure to water-soluble hexavalent chromium compounds in cement frequently caused allergic contact dermatitis in many European countries. However, methods to reduce the amounts of these compounds in cement were developed, and European legislation was adopted in 2005 to limit the amount of hexavalent chromium to 2 mg/kg of the dry cement, equivalent to 2 µg/g or 2 ppm, in products. These reduction measures drastically reduced the numbers of new chromate contact allergies resulting from exposure to cement. The construction industry is now rapidly growing in many countries that have no corresponding legislation. Therefore, the frequencies of chromate contact allergy can be expected to increase in these countries. We thus conducted a study to determine the levels of water-soluble hexavalent chromium in 7 different cement samples from New Delhi, India.

METHODS

Seven different brands of cement samples, A to G, which are commercially available on the open market and were purchased in New Delhi, India, were collected and analysed for the presence of chromium, cobalt, and nickel. Samples of 10.0 g of cement were placed in a test tube, and 10.0 mL of water was added. The extraction time was 1 hour. The solution was filtered, and reagents were added to the filtered solutions. Reagent I was a 1.0% wt/vol solution of *sym*-diphenylcarbazide in ethanol. Reagent II was 1.0 M sulfuric acid. Two drops of reagents I and II, respectively, were added. The intensity of the violet colour of the sample solution was visually compared with the colours of chromate (CrO₄²⁻) reference solutions treated with the same reagents as

the sample solutions. The following concentrations of chromate were used in the standard solutions: 1, 2, 5 and 10 µg/mL. These were prepared from a chromate standard solution of 1000 mg/l CrO₄²⁻ (Merck, Darmstadt, Germany) by dilution in 0.2 M nitric acid. The standard solutions of chromate then corresponded to 0.5, 1, 2.5 and 5 µg/mL hexavalent chromium. The amount of hexavalent chromium in the cement was calculated from the concentration of hexavalent chromium in the sample solution. By visual evaluation, which has been used for several decades in the Malmö department and found to be reliable, it is easy to determine whether the sample corresponds to the classes <0.5, 0.5, 1, 2.5, 5 or >5 µg/mL hexavalent chromium. In case of doubtful results, more advanced methods must be used.

For the atomic absorption analyses, the different types of cement were extracted with 0.2 M nitric acid. To 1.0 g of cement, 2.0 mL of nitric acid was added. The extraction time was 24 hours. The samples were filtered, and analysed with an AS-800 atomic absorption spectrophotometer, equipped with a transversely heated graphite atomizer furnace (Perkin Elmer, Billerica, Massachusetts). Samples were analysed for chromium, nickel, and cobalt. The following standard solutions were used: chromium standard solution 1000 mg/L, nickel standard solution 1000 mg/L, and cobalt standard solution 1000 mg/L (Merck). From these stock solutions, dilutions were made in 0.2 M nitric acid. Samples with a concentration above the calibrated range were further diluted with 0.2 M nitric acid.

RESULTS

The results of the analyses are shown in Table 1. Samples A, B, D and E were judged to contain 5 µg of hexavalent chromium/g (ppm),

TABLE 1 Analyses of 7 cement samples from India

Product (cement)	Cr		Co AA Acid extract 24 h (µg/g)	Ni AA Acid extract 24 h (µg/g)
	Spot test	AA, Total Cr		
	Water extract 1 h (µg Cr[VI]/g)	Acid extract 24 h (µg Cr/g)		
A	5	73.8	4.8	26.8
B	5	103	5.7	32.8
C	2	43.5	4.6	17.2
D	5	64.4	2.8	32.2
E	5	73.8	11.3	43.5
F	2	41.9	4.2	28.8
G	1	28.4	4.3	29.0

AA, atomic absorption; Co, cobalt; Cr, chromium; Ni, nickel.

whereas samples C, F and G contained 2, 2 and 1 µg of hexavalent chromium/g, respectively. Samples A, B, D and E showed higher concentrations of total chromium and of water-soluble hexavalent chromium than samples C, F and G. The concentrations of cobalt and nickel did not show any obvious correlations with the concentrations of water-soluble hexavalent chromium or total chromium.

DISCUSSION

Occupational exposure to cement can cause skin changes such as irritant and allergic contact dermatitis, cement burns, toxic paronychia, subungual necrosis, folliculitis, and petechiae.¹ Water-soluble hexavalent chromium present in cement is a potent contact sensitizer causing allergic contact dermatitis.

However, addition of ferrous sulfate causes reduction of hexavalent chromium (Cr[VI]) to its trivalent form (Cr[III]), which is water-insoluble and penetrates skin to a lesser degree. Hence, the allergic potential is reduced by lowering the hexavalent chromium content of cement to ≤2 ppm (1 µg/g = 1 ppm). This has been a regulatory requirement by law in most European countries since 2005 (European Parliament and the Council of the European Union 2003)², and has resulted in a significant decrease in the frequency of allergic contact dermatitis caused by cement. The contact sensitization to chromate decreased from 43.1 to 29.0% following the reduction of hexavalent chromium in Germany.³

However, even though the level of hexavalent chromium in cement is ≤2 ppm in Europe, sensitization may still occur.⁴ In some recent studies, processing with manganese sulfate, stannous chloride and zinc salt has also been shown to reduce the levels of water-soluble hexavalent chromium.⁵ However, it appears that not all companies producing cement in India are following this practice.

It has been claimed that the amount of water-soluble sensitizing hexavalent chromium is independent of the total amount of chromium.⁶ However, as seen in Table 1, there appears to be a relationship between a high total amount of chromium and a high amount of hexavalent chromium.

The total nickel and cobalt contents in the investigated cement samples were higher and lower, respectively, than those in 11 Asian cement samples investigated in 1986.⁷

To conclude, the study has shown high concentrations of hexavalent chromium in many cement samples in India. Therefore, we suggest that Indian manufacturers should also be subjected to regulatory control forcing them to process the cement to reduce its hexavalent chromium level, which could decrease the occurrence of occupational allergic contact dermatitis caused by cement in exposed workers in India.

Conflict of interest

The authors declare no potential conflict of interests.

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