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Lead chromate pigments dominate lead paints sold in Mexico

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Abstract

Testing the lead content of new paints is important to inform governments of the potential hazard in countries that have yet to ban or regulate the lead content of these products. This study included a sample of paints for automotive, metal primer, architectural enamel, and road-marking applications in Mexico. Samples from 213 paint products manufactured by 54 domestic and 5 foreign paint companies were purchased from retail outlets and tested at an accredited laboratory in the United States for lead content. Samples were selected to be representative of the available brands of red and yellow coatings sold in small containers in retail outlets. A total of 118 (55%) of the 213 paint products sampled contained lead in excess of 90 ppm (all ppm concentrations in this paper designate wt/wt values) and these samples were then analyzed for chromium content. A majority (91%) of the lead paints tested had a mass ratio of Pb:Cr consistent with pure lead chromate that has a ratio of 4:1 suggesting the presence of lead chromate pigments. Labels indicating that no lead was present were observed on 12 products that our testing demonstrated contained lead in concentrations ranging from 1,100 ppm to 120,000 ppm. The testing showed that Sherwin Williams, the largest global United States-based paint company, continues to sell lead paints in Mexico. These results have significant implications for workers in diverse industries in Mexico due to the lead hazards and the carcinogenicity of hexavalent chromium. National regulations and third-party conformity assessment procedures are desperately needed to control the widespread use of lead chromate pigments in Mexican paints.

Keywords lead, lead paint, lead chromate, lead poisoning, lead pigments, Mexican paints

What's important about this paper

The testing of new paints sold in retail outlets in Mexico revealed that the country's failure to regulate the lead content of these products has resulted in the common use of lead chromate pigments. More than 90% of the lead paints purchased in 2025 had a lead to chromium mass ratio (Pb:Cr) suggesting the presence of lead chromate pigments. The readily available supply of lead chromate pigments and the failure of paint companies to voluntarily reformulate their products are apparent in our finding that most consumer paints in Mexico contain

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high concentrations of lead. This is the first study documenting the widespread use of lead chromate pigments for multiple paint applications in any country. Given the carcinogenicity of these pigments and the other adverse health effects of lead, workers and the general public are at greater risk due to the presence of lead and hexavalent chromium.

Introduction

Mexico has no regulatory limit on the allowable lead content in paints and other coatings. Past efforts to assess the presence of lead in new paints sold at the retail level in Mexico have been conducted with limited numbers of samples and have not been published in the scientific literature. In 2018, Casa Cem conducted a survey of 118 solvent-based paints and found that 45% contained lead at concentrations greater than 90 parts per million (ppm)—the standard used in the United States and other countries. That testing revealed that the highest concentrations were generally found in red and yellow paints with concentrations up to 200,000 ppm (Casa Cem and IPEN 2018).

A survey of lead paint on playground structures was conducted with X-ray fluorescence in 2019 in public spaces in Guadalajara, Mexico. The testing found that 81% of the readings were greater than 90 ppm (Casa Cem 2019). In 2022, a sample of 43 paints used by 5 Mexican municipalities for roadways and other infrastructure were tested for lead content at an accredited laboratory. The testing indicated that 70% of the samples had lead concentrations greater than 90 ppm with levels ranging up to 110,000 ppm (Casa Cem 2022).

Others have investigated the lead content of new auto and architectural paints in other countries in recent years. For example, a study from Nigeria found lead concentrations in auto paints ranging from 4,790 to 79,300 ppm and from 2,220 to 91,500 ppm for architectural enamel paints (Akindele and Osibanjo 2024). A study from Sri Lanka found that 22% of enamel paints purchased in the country had levels exceeding 90 ppm, despite the country having a law regulating lead content of paints since 2013. (Lakmini and Mahanama 2021).

Whereas many studies have tested new paints in countries around the world for the presence of lead, few have also tested for chromium. Other studies have tested for lead and chromium in legacy paints from roadways and playground equipment. Lead chromate is of particular concern as it contains both lead and hexavalent chromium which is a human carcinogen classified by the International Agency for Research on Cancer as Group 1 carcinogenic to humans (IARC 2012).

Several studies have investigated the presence of lead chromate in legacy road marking paints. A 2018 study conducted in Mexico found that the mean concentration of lead in the 80 road marking paints tested was 42,870 ppm with the highest concentrations exceeding 88,000 ppm (Meza-Figueroa et al. 2018). They also reported the mean Cr concentration for these samples was 5,839 ppm with a range of 1,294 to 11,758 ppm. A study conducted of 24 paint samples in one city in the United States also found that lead chromate was common on roadways although the municipality stopped using new lead chromate coatings (White et al. 2014). A larger study found that lead was detected in 148 of 236 (63%) road paint samples collected in 11 European countries at concentrations up to 172,000 ppm, while Cr was detected in 81 samples (Turner and Filella 2023). The mass ratio of Pb:Cr in many of the yellow paints were consistent with the presence of lead chromate.

The present study was conducted to better assess the Mexican paint market to help inform ongoing efforts to regulate the lead content of these products. Although previous testing indicated that lead was commonly found in architectural and road marking paints in Mexico, little was known about the content of lead in automotive paints and metal primers. We also intended to evaluate which lead additives are commonly being used by Mexican paint manufacturers by testing total chromium in cases where lead is present to assess the extent of lead chromate pigment usage.

Methods

A total of 213 paint products from 54 domestic, 1 Spanish, and 4 US paint companies were purchased from retail stores in 2025 from major cities—Guadalajara, Ciudad Juárez, and Puebla—in 3 geographically distinct regions of Mexico and from 2 online consumer platforms. Based on results of previous testing we focused on yellow and red metal primers (23), architectural enamels (108), automotive (63), and road-marking traffic applications (19). Sampling was limited to retail outlets and the largest container sampled was 3.785 liter. In addition, we selected a convenience sample of paints to include the available brands for each application category in each of the 3 cities.

Paints were applied to a glass surface and allowed to dry for 8 to 12 d. Disposable gloves were then used to

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Table 1 Summary of all paint sample results by application, mean and range.

Paint application type	Number of samples	Percent ≥ 90 PPM lead	Arithmetic mean lead PPM	Range lead PPM
Automotive	63	48	40,280	<4.4–180,000
Architectural Enamel	108	57	34,314	<4.2–290,000
Metal primer	23	39	10,744	<4.7–140,000
Traffic/Road	19	90	56,238	<4.8–130,000
Total	**213**	**55**	**35,660**	**<4.2–290,000**

avoid possible sample contamination when preparing the samples. The dry paint films were scraped off the glass and placed in sealed plastic bags that were sent to EHS Laboratories in the United States (Richmond, Virginia). EHS is an accredited laboratory under the US EPA National Lead Laboratory Accreditation Program.

Samples were coded based on the manufacturers' suggested surface application including road marking, metal primer, architectural, and automotive paints. General architectural enamel paints and metal primers are used on a wide range of surfaces in homes and commercial facilities. Enamel coatings have a smooth and glossy finish which are often applied to components subject to friction and impact such as doors, windows, and cabinetry.

Samples were digested and analyzed by EPA methods SW846 3050B/6010D, using inductively coupled plasma (ICP) spectrometry to determine lead content. Samples with lead concentrations greater than 90 ppm were also tested for total chromium content. Test results were reported in mg/kg or parts per million (ppm).

Quality Control procedures were followed by EHS Laboratories. The laboratory successfully participates in the Environmental Lead Proficiency Analytical Testing Program which requires them to blindly test proficiency samples of paints with known lead content representative of the compounds and interferences typically encountered. The results must fit within the acceptable upper and lower performance criteria based on the consensus values from the participating reference laboratories. In addition, at a frequency of every 10 samples analyzed a calibration verification sample is run along with a calibration blank. Recovery rates for verification samples must be within 10% for the analyte of interest and the calibration blank value must not exceed 50% of the reporting limit.

Results

Table 1 summarizes the lead content testing for each of the 4 paint application categories. A total of 118 (55%) of the 213 paint products sampled contained lead in excess of 90 ppm and 74 (35%) contained less than 20 ppm lead. The mean lead concentration was 35,660 ppm with a range up to 290,000 ppm (29%) for these samples. Ten of the enamel paints tested had pigments added at the retail outlets. None of these tinted paints contained lead in concentrations greater than 90 ppm.

Table 2 summarizes the results for paint samples with lead concentrations greater than 90 ppm. These 118 samples were tested for chromium content to determine the ratio of Pb:Cr which can suggest the presence of lead chromate pigments. The Pb:Cr mass ratio in $PbCrO_4$, is 4:1. A large majority (91%) of the paints tested for chromium content had Pb:Cr ratios between 2 and 6 with a median of 4.4 suggesting the presence of lead chromate pigments. The mean chromium concentration for these 118 samples was 15,803 ppm with a maximum of 66,000 ppm.

Of the 59 companies included in our sample, at least 46 (78%) make lead paint products (see list in Table S1 in materials). Among the paints tested that were made by companies based in the United States, only paints made by Sherwin-Williams contained lead at greater than 90 ppm with chromium levels suggesting that lead chromate is added. The company is the largest paint company in the world and operates in 120 countries. Given the limited number of samples purchased from each company, it is not possible to make any conclusions as to which companies have completely reformulated to stop using lead compounds.

Table S2 (see materials) lists the Pb:Cr mass ratio for the 118 paint samples with lead content greater than 90 ppm. Note that 11 (9%) of the 118 paint samples with lead content greater than 90 ppm have a Pb:Cr mass ratio of less than 2 or greater than 6. In addition, 6 of the 8 samples with the highest ratios have a chromium content less than 20 ppm suggesting that another type of lead pigment or drier was added to these products. By contrast, all 3 samples with ratios less than 2 have a chromium content exceeding 6,000 ppm, which may indicate that these contain additional chrome pigments.

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Table 2 Summary of paint samples with lead concentrations ≥ 90 PPM by application, mean chromium, range of Pb:Cr ratios, and median Pb:Cr ratio.

Paint application type	Number of samples with Pb ≥ 90 PPM	Arithmetic mean Cr PPM	Range Pb:Cr ratios	Median Pb:Cr ratio
Automotive	30	20,276	2.7–375.0	4.8
Architectural enamel	62	14,875	1.8–183.3	4.4
Metal primer	9	5,639	0.26–41.9	5.0
Traffic/Road	17	16,676	2.3–4.3	4.1
Total/Median	**118**	**15,803**	**0.26–375.0**	**4.4**

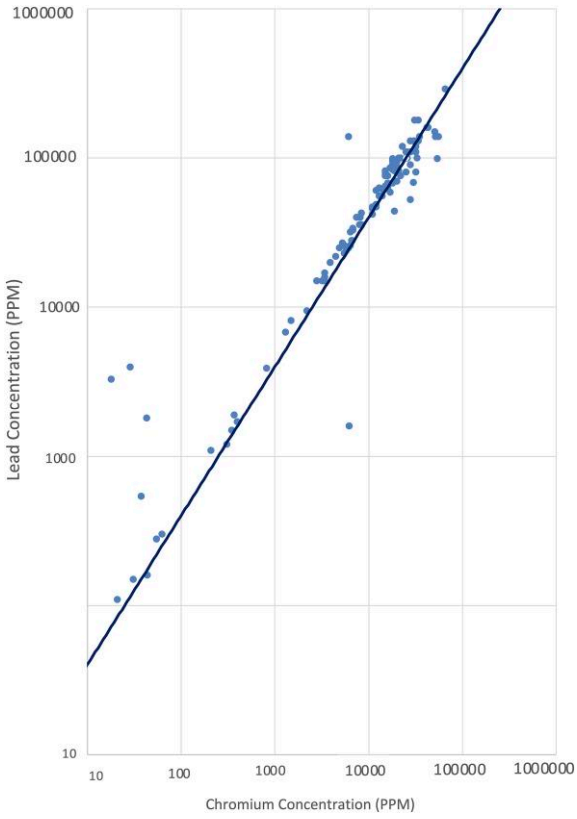


Figure 1 Plot of Pb:Cr ratio for all paints with lead content greater than 90 mg/kg (ppm).

Figure 1 is a plot of lead to chromium for paint sample results with a lead content greater than 90 ppm with the solid line representing a 4:1 ratio. Note that 2 of the 118 lead paint samples were reported as having a chromium content less than the limit of detection (<4.8) and were not included in this graph. There appear to be few outliers representing the presence of other lead compounds or other chrome pigments.

Generally, product labels were insufficient to warn consumers of the presence of lead or that the lead paints contain lead chromate—a known human carcinogen. In addition, labels indicating "lead-free" were observed on 12 products that our testing demonstrated contained lead in concentrations ranging from 1,100 ppm to 120,000 ppm.

Discussion

Although no guidance or regulatory standard addresses chromium levels in paints, the purpose of this testing was to use the mass ratio of Pb:Cr to predict the presence of lead chromate pigments. Lead chromate pigments include a number of specific compounds including lead chromate, lead sulfo-chromate, lead chromate molybdate sulfate red, molybdenum orange, and lead chromate oxide. Pure lead chromate is known to have a weight-weight ratio of Pb:Cr of 4 to 1 in contrast to other lead compounds that have been used for color or drying agents. However, pigment manufacturers also combine other lead pigments with lead chromate to improve the durability of coatings. These colorants include mixed-phase pigments and encapsulated mixed-phase pigments which, despite this terminology, may have a water-soluble shell (Rathschlag et al. 2005).

Chrome yellow often contains lead oxide along with lead sulfate and will typically have a ratio greater than 4:1 (Hartogensis and Zielhuis 1962). Similarly, a ratio of less than 4:1 suggests that other chrome compounds are present (Ibid). Red and orange lead chromate generally have the addition of lead oxide and/or lead molybdate and are sold under various trade names (IARC 1990).

Lead chromate is fairly ubiquitous and even has been identified in airborne aerosols deposited across borders. It is suggested that these nanosized particles originate in lead chromate traffic paints (Lee et al. 2016). Lead chromate is commonly found in outdoor dust samples collected in Mexico and other countries. A study of 146

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road dust samples from Hermosillo, Mexico had an arithmetic mean lead concentration of 147 ppm and a chromium content of 168 ppm (Meza-Figueroa, et al. 2018). From the results of isotopic analysis of the dust samples the authors conclude that this material includes traffic paints mixed with lead from other sources including atmospheric deposition and legacy lead gasoline emissions. That same study included 80 traffic paint samples collected from streets with a mean lead concentration of 42,870 ppm and 5,840 ppm for chromium.

The high percentage of these coatings that apparently contain hexavalent chromium compounds is also troubling from a health perspective. Although industry often characterizes hexavalent chromium compounds as "insoluble" this classification may not be predictive of lead absorption or the biological properties of these compounds. There is no general agreement on the definition of solubility and it is important to note that these compounds can be broken down over time from environmental factors (IARC 1990, p. 55).

As many of these products are intended for exterior use on metal structures, automotive parts, and traffic paints, it is important to understand the potential for these surfaces to weather from exposure to precipitation and sunlight. A study found that lead and chromium are released from commercial lead chromate pigments due to sunlight and dissolve following exposure to water (Gao et al. 2019). In addition, the maintenance of metal structures and automotive body repair requires the removal of existing coatings down to the substrate with abrasive blasting, sanding and/grinding creating fine particulates. Enamel paints used on homes and other structures are also periodically removed with scraping and sanding which generally releases micrometer sized particulates (Koponen et al. 2011). Road marking paints must also be periodically removed during road maintenance. The removal of lead paint results in significant occupational lead exposures and environmental contamination.

A study analyzing new enamel paints following the regulation of lead paint content in Sri Lanka found 2 (6%) of 34 paints sampled contained lead chromate with a mass ratio of Pb:Cr ranging from 4.2 to 4.3 for a yellow and green coating (Lakmini and Mahanama 2021). The authors also noted that both samples exceeded the allowable concentration for chromium in that country of 250 ppm. A study of 5 new paint samples from 3 manufacturers in Saudi Arabia found a mean lead level of 526.7 ppm and 124.8 ppm for chromium with ICP analysis. The mass ratio of Pb:Cr ranged from 2.8 to 6.5 with a mean of 4.3 (Gondal et al. 2011). The results for new paints reported in these studies are consistent with our results showing similar ratios of lead to chromium.

The road traffic paints we tested had the highest percentage exceeding 90 ppm lead with 90% of the 19 samples exceeding this limit. These samples had an overall average lead content of 56,238 ppm (Table 2). A study of 236 samples of legacy traffic paints from roadways in 11 European countries found a mean lead content of 40,200 ppm with a maximum of 172,000 ppm, and a mean chromium content of 2,470 ppm with a maximum of 19,400 ppm. The authors noted that most of the paint samples tested exceeded a Pb:Cr mass ratio of 4:1 suggesting the use of mixed phase pigments that include lead chromate. The lead and chromium concentrations were consistent to our findings for new road marking paints in Mexico (Turner and Filella 2023).

Results for lead content of the 63 automotive paint samples tested ranged up to 180,000 ppm with 30 (48%) samples exceeding 90 ppm (Table 2). A study of 32 automotive paints from Kenya, following the implementation of an East Africa regional paint standard, had a maximum concentration of 2,740 ppm but 31 (7%) of the samples exceeded 90 ppm (Mwai et al. 2023).

Fifty-seven percent of the 108 architectural enamel paints we tested exceeded 90 ppm with levels ranging up to 290,000 ppm (Table 1). Similarly, 94% of 31 enamel paints purchased from shops in India had a mean concentration lead of 26,130 ppm with a maximum of 140,000 ppm (Kumar and Gottesfeld 2008). In our sample, metal primers generally had lower concentrations of lead with only 39% of the 23 samples exceeding 90 ppm.

The European Commission banned the use of lead chromate pigments for all applications under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation and later allowed some specific uses for 2 lead chromate pigments under an "authorisation" given to one company in 2016. In 2019, an EU tribunal deemed the authorization for the limited continued use of lead chromate was illegal and the European Court of Justice confirmed this ruling in 2021 (ClientEarth 2021). More recently, Cameroon, Morocco, and Switzerland filed a petition with the Rotterdam Convention on lead chromate to establish a prior informed consent procedure. This action would require any party shipping these compounds to another country to first provide advance notice and obtain written consent from the importing country.

Conclusion

The results from this testing of paint products indicates that in Mexico lead paints hold a substantial market share among automotive, metal primers, road markings, and even enamel paints commonly used on the interior and exterior of homes and commercial buildings. These

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findings suggest that there is an immediate need to regulate the lead content of these coatings and to put in place a third-party monitoring system to ensure that manufacturers reformulate. As none of the product labels had any warning language concerning lead hazards, there is an urgent need to inform the public and implement laws requiring truth in labeling.

The presence of lead at the concentrations observed is not just putting children at risk of lead poisoning but is a serious concern for occupational health among a large group of diverse workers. People employed in trades including paint and pigment manufacturing, construction, automotive repair, building maintenance, and painting are known to be exposed to high airborne lead concentrations that result in elevated blood lead levels from routine tasks that disturb these coatings. Workers in paint manufacturing facilities in Kenya had a mean lead exposure of 76.3 μg/m^3 with levels up to 157.0 μg/m^3 with significant dust observed from handling pigments (Were et al. 2014).

The market for lead chromate is approximately evenly split between paint and plastic applications with a far smaller share going into inks and ceramicware (Dominion Colour Corporation 2014). In both cases, there are suitable substitutes that are safer and noncarcinogenic. In light of the results presented here documenting that this is the most common lead pigment used, the Mexican authorities should take immediate action to ban these pigments for all applications.

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Supplementary material

Supplementary material is available at *Annals of Work Exposures and Health* online.

Author contributions

P.G. wrote the first draft and provided technical assistance in sample testing; S.C. initiated the study design, developed the sampling plan, and edited the draft manuscript; L.M. procured the samples, prepared samples for laboratory analysis, and collated the results; A.B.V. procured the samples, prepared samples for laboratory analysis, and prepared the data tables; J.W. provided technical support and edited the draft manuscript.

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Conflict of interest

P.G. serves as an expert witness in litigation concerning lead poisoning and occupational lead exposures. The other authors declare no conflict of interest relating to the material presented in this article.

Data availability

The data underlying this article are available in the article and in its online material.

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