

Review Study on the Analysis of Lead from Sindoor Samples

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ABSTRACT: Lead Tetroxide (Pb_3O_4 , red lead) has been found as an adulterant in sindoor, known as vermilion, is a yellow, maroon, or crimson tiny particles used by Hindus for cultural as well as for religious reasons. Sindoor powder is frequently tinted with red lead to create a rich red color. While many individuals believe that cosmetics are pure, multiple studies have revealed that the majority of cosmetics include heavy metals and other toxins. The harmful health consequences of lead poisoning have been widely documented. A fast inspection or "search" method for provisional detection of powders was tested utilizing an X-ray Fluorescence (XRF) lead paint commercially supplied testing kit for use by state health agencies. Field sampling methods, besides prediction values targeted at samples containing $3 \times 10^5 \mu\text{g/g}$ lead have all been extensively altered. The above-mentioned measures were 100 percent in the samples containing $3 \times 10^5 \mu\text{g/g}$ lead, although the Confidence Intervals (CIs) showed a wide variation. Also concentration of 5,110 $\mu\text{g/g}$ was unable to be definitely identified using any field inspection method. Colorimetric and semi-quantitative XRF studies effectively identified lead in samples with higher Pb levels ($>3 \times 10^5 \mu\text{g/g}$ lead), but not in those with lower Pb levels. According to the results, health department inspectors cannot utilize screening kit as a fast field test for sindoor. In a word, these results emphasize the significance of sindoor threat monitoring.

KEYWORDS: Cosmetics, Health, Lead Levels, Lead Poisoning, Paint, Powders, Sindoor, XRF.

1. INTRODUCTION

According to the primary effects that it produces when it comes into contact with the body, lead poison is classified as an irritating metallic poison. Lead has been found to be one of the most thoroughly studied neurotoxicants in recent decades. Lead is a prevalent toxin that builds up over time. Its negative repercussions or side effects are well recognized, and the decrease in Blood Lead Levels (BLLs) during the last several decades is generally considered as one of the greatest public health achievements of the twentieth century [1]. Lead is a steel-grey alloy with a high melting point. In reality, metallic lead and all of its salts are toxic:

- Lead acetate (lead sugar): white crystals are the main ions that induce poisoning
- Safeda (lead carbonate): a white crystalline powder
- Lead chromate is a light yellow powder that may be utilized in a number of applications
- Litharge (lead monoxide): light brick-red or pale orange masses
- Scarlet crystalline powder of lead tetroxide (red lead, vermilion, sindoor) (red lead, vermilion, sindoor)
- In nature, lead sulphide is the least poisonous.

Storage batteries, solders, paints, hair colors, electric wire insulations, pottery and ceramics, and gas are all produced of lead. Lead is the most frequent heavy metal utilized in chronic poisoning, but acute lead poisoning is rare. Lead is a naturally occurring element of the earth's crust and maybe utilized in trace amounts of soil, water, and plants. Lead is practically immobile, but when mined and utilized by people, it becomes highly toxic. Pollution in the air, fish, and water may all be sources of lead in the environment. The main sources of lead poisoning and pollution in the atmosphere is thought to be lead-containing gasoline and paints. Lead-based paint was banned in 1978, and by the mid-1990s, lead was phased out of fuel in the United States (US), in order to eliminate lead from these ubiquitous products such as gasoline and paints [2]. Analysis demonstrating a link between reduced BLLs in the US population and the phase out of lead from gasoline has demonstrated the benefit of banning lead from gasoline in the US for public health (see Figure 1) [3].



Figure 1: Scarlet Crystalline Powder of Lead Tetroxide (Red Lead, Vermilion, Sindoor). The Majority of Cultural Goods Possessed More Than One Gram of Lead per Gram, And Some Sindoor Contained Very High Amounts of Bio-accessible Lead [Wikipedia].

Occupational exposure and exposure from dust and chips of old lead-based paint are the most frequent causes of high BLLs in adults and children today [4]. Staff in areas such as smelting, battery manufacturing, and mining have greater BLLs than employees in any other industry. Workers from these professions are classified as "take-home exposures", meaning they will carry lead dust home with them on their clothes, boots, and other items. At home, which may then be collected on carpets, chairs, beds, and other surfaces. They are not only a source of exposure for these professions at home, but they may also be a source of exposure for their family members. The majority of today's lead poisoning in children comes from decaying old lead-based paint and the lead dust that may collect on window sills, windows, and other surfaces as the paint deteriorates [2]. In addition to lead-based paint or industrial pollution, immigrant populations may be exposed to lead through cultural artifacts brought from their native countries.

Culture-specific tools, cuisines like Mexican tamarind candies, cosmetics like kohl, kajal, tiro, and henna (used in Middle Eastern and South Asian cultures), and therapies like Ayurveda medicines (employed by South Asians) and Mexican digestive remedies are examples of these alternative outlets. Heavy metals end up in these materials whether they are either purposefully or inadvertently introduced to enhance cleanliness, to increase prices for goods sold by weight, or due of contamination during the production process. Lead from the wrapping of Mexican sweets may seep into the candies [5]. Glazed pots or ceramics, which may leach into meals (these pots/ceramics may employ lead glaze to give the pottery a smooth finish and brilliant colours); plastics and vinyl mini-blinds; and manufactured candles with leaded wicks are examples of non-culture related items that may be sources of lead [6].

Elemental lead is a glossy, dense, silvery metal with a cubic crystal structure that tarnishes to a blue hue when exposed to air. It is typically very fragile and flexible. Several of its salts (listed above) are accessible as a range of coloured powders or liquids and are widely employed in business and at home, resulting in cumulative toxicity after clinical exposure. Lead's low melting point and malleability made it one of the earliest metals smelted and utilized for lead, including pipes, cooking utensils, and ceramic glazes, a grape syrup cooked down in lead pots, was a favorite activity used as a sweetener and preservative. Lead use increased rapidly since the industrial revolution, and it is currently the most frequently used non-ferrous metal, with worldwide demand on the order of 9 million tons a year [7].

Lead output in the US is 1.1 million tons a year, with approximately 0.5 million tons coming from new mines and 0.6 million tons coming from scrap metal recycling. Lead is widely utilized in industry because of its water

resistance, as well as its electrical and radiation shielding qualities. Electric storage batteries utilize both metallic lead (as grids) and lead oxide (as paste), accounting for nearly two-thirds of yearly US consumption. Since batteries last only 27 months on average and 80 percent of battery lead is re-melted as waste, the secondary smelting and processing industry's main supply of raw lead is this single commodity. Lead alloys are used to safeguard power and telecommunications cables, as well as to produce type in the printing industry and solders. Solders are utilized in a number of sectors, including tin can production, plumbing and repair, and the automobile industry, particularly radiator manufacturing and maintenance. Chemical reaction tanks are coated with sheet lead, which is frequently used in medical and industrial radiation shields. Metallic lead is also utilized in the manufacturing of guns, bronze and brass, as well as annealing, galvanizing, and plating [8].

Inorganic lead compounds have long been considered to be among the finest paints available. In the production of polyvinylchloride plastics, glazes for ceramic ware, and glass designed for crystal optical and electrical applications, such as colour television picture tubes, lead compounds are employed as stabilizers. Lead azide and styphnate are used in explosives. In the early nineteenth century, lead salts, notably lead acetate (lead sugar), were used medicinally to manage bleeding and diarrhoea; recent analyses of hair samples from Andrew Jackson revealed elevated lead levels, which are consistent with his lifelong affliction of bilious colic, a condition characterized by constipation and intense, cramping abdominal pain.

Recently, the production of lead in India has been curtailed for the year. In contrast to the 18.4 percent rise in Financial Year (FY18), output rose by 14.6 percent in FY19. The anticipated quantity of mined metal output has been decreased by the full closure of opencast operations. During FY19, recycled lead accounted for approximately 63 percent of all processed lead. Primary lead production rose by 17.6 percent in FY19, compared to a 21.0 percent rise in FY18, while secondary lead, or recycled lead, production increased by 12.9 percent, compared to a 16.9 percent increase in FY18. During FY19, demand for lead increased by 11.6 percent. In India, lead consumption is primarily driven by its use in the production of lead acid batteries (74 percent) (Which may be further split into Starting-Lighting-Ignition (SLI) batteries (50 percent) and Industrial batteries (24 percent)). Automobile production increased by 6.4 percent in FY19 (passenger cars, recreational vehicles, and two and three wheelers).

Lead is also utilized in remote access power devices, load levelling systems, and glass and plastics composites, as well as for radiation shielding. South Korea, Australia, Malaysia, the United Arab Emirates, and Myanmar import refined lead, which is subsequently transported to the US, South Korea, Taiwan, Vietnam, and Thailand. India has been a net exporter of processed lead in the past two years (FY18 and FY19). During FY19, exports increased by 10.3 percent, while imports dropped by 1.5 percent. Lead will continue to experience high demand, driven mainly by the automotive and industrial battery sectors. Lead consumption is projected to increase by 9.4 percent by the end of FY20.

- Demand for lead acid batteries in the form of replacement demand in cars will continue to promote their usage. The market will be sluggish to respond.
- Telecom business network expansion, smart grid initiative introduction, car-charging technology deployment, onus put on hybrid and electric vehicle manufacturing, and increasing installation of renewable energy systems will all assist lead acid battery growth.

Primary lead production hit new highs in FY19, but aluminum production stalled and zinc and copper output fell significantly. Lead costs between \$1,900 and \$1,950 a ton in United States Dollar (USD) (USD). Lead poisoning affects individuals of all ages, although it seems to cluster into a few distinct at-risk categories. The problem's scope and clinical significance are highest in young children, ages 1-6, whose primary source of exposure is deteriorating lead paint in their houses. Childhood lead poisoning has been considered the most severe public health problem for young children in underdeveloped nations. Adults that engage in lead smelting or reclamation, construction or demolition, or the production or maintenance of lead-containing goods are the second major group of individuals who have been exposed at work.

2. LITERATURE REVIEW

H. Frumkin articulated that the harmful consequences of various environmental exposures, such as toxic chemicals, radiation, and biological and physical agents, have been the focus of environmental health study and teaching. Certain kinds of environmental exposures, on the other hand, may have positive health effects. Humans

are inherently attracted to other living creatures, according to the biophilia hypothesis. Later philosophers expanded on this notion, arguing that people have an intrinsic relationship to nature in general. This implies that such kinds of real world contact may be good to one's health. This hypothesis is backed by data from four distinct aspects of the natural world: animals, plants, ecosystems, and wildness. Finally, the implications of this hypothesis for a broader public health agenda, including both harmful and positive impacts, are explored. This agenda asks for studies on a range of potentially hazardous environmental exposures, collaboration among practitioners from different disciplines ranging from public health to landscape design to community planning, and research-based methods [3].

B. P. Lanphear *et al.* stated that the mechanisms and routes for lead intake among urban children, as well as the relative contributions of various lead sources to lead-contaminated home dust, were examined using a linear structural equation modelling method. Dust lead levels were found to be significantly related to blood lead levels in newborns, both indirectly and directly via hand lead. Lead levels in home dust were affected by both soil and paint lead, although paint contributed significantly more lead to house dust than soil ($P < 0.001$). Blood lead levels in children is strongly affected by their ethnicity and economic position. Finally, time spent outdoors was related to youngsters putting dust or gravel in their teeth, which was linked to blood lead levels in children. These results indicate that mouthing behaviors are a significant cause of lead poisoning in urban children with low blood lead levels, and that lead-based paint is a larger source of lead in home dust than lead-contaminated soil [4].

3. BUREAU OF INDIAN STANDARDS

The Drugs and Cosmetics Act 1940 and Rules 1945 regulate cosmetics goods in India. The Bureau of Indian Standards (BIS) sets cosmetics standards for goods listed in Schedule "S" of the Drugs and Cosmetics Law of 1945. Rules 148(7) of the Drugs and Cosmetics Rules 1945 require that ingredients present in concentrations of more than 1 percent be listed in descending order of weight or volume at the time of addition, followed by those present in concentrations of less than or equal to 1 percent in any order, and preceded by the word "ingredients", provided that this statement is not needed for p. Cosmetics comprising Dyes, colours, and pigments other than those specified by the Bureau of Indian Standards (IS: 4707 Part 1 as modified) and Schedule Q are banned under Rule 134 of the Drugs and Cosmetics Rules.

- 2 ppm (parts per million) of Arsenic (calculated as Arsenic Trioxide) in the authorized Synthetic Organic Colors and Natural Organic Colors used in the Cosmetic.
- 20 parts per million (ppm) of lead (measured as lead)
- 100 parts per million (ppm) of heavy metals other than lead, measured as the total of the metals.

This coloring agents are generally regarded to be healthful. Some indicate the maximum concentration of final products. The use of lead and arsenic compounds in cosmetics for the purpose of coloring is forbidden under Rule 145 of the Drugs and Cosmetics Rules. Rule 135 prohibits the importation of cosmetics that have been tinted with a lead or arsenic component. Cosmetics containing mercury compounds are banned by Rules 145 D and 135 A, respectively. The Bureau of Indian Standards adopted the Indian standard after the Petroleum, Coal, and Related Products Division Council approved the Cosmetics Sectional Committee's final drafting. Sindoor is a fine homogenous material made composed of pigments and hues floating in a liquid with baryte powder as the main component. Baryte powder is produced from barium sulphate stone that is usually 99 percent pure. In Sindoor, lead oxide is not allowed since it is applied to the hair parting. It comes in a range of crimson tones. There are no restrictions in this standard for a particular Sindoor composition. The concentration of raw ingredients employed in the formulation of final goods, on the other hand, must be devoid of any harmful consequences. The IS 4011: 1997 standard may be used to evaluate the protection of a novel formulation. Check techniques for evaluating the safety of cosmetics (second revision) (second revision). Before releasing Sindoor for sale, the producers must convince themselves that their formulation is dermatologically and microbiologically protected pursuant to IS 4011: 1997 and Indian Standard on Microbiological Protection of Cosmetics (under development), respectively.

4. DISCUSSION

Under today's sophisticated societies, broad chemical exposures from contaminated air, water, and food are uncommon, but they may potentially damage an entire community in exceptional situations. Exotic sources, such as contaminated traditional remedies, cosmetics, ingested lead foreign bodies, stored bullets, artists or other sharp

items, shooting ranges, uncontrolled distilled alcoholic beverages, and drugs of violence, are occasionally detected. Since ancient times, it has been utilized in cosmetics, internal and topical medicinal formulations, paint pigments, and glazes. Lead Tetroxide is the most popular “sindoor” used by married Hindu women on the parting of their scalp hair, while Muslim women use Lead Sulphide as an eyeliner.

Hindus use sindoor as a cosmetic item during prayer and other occasions. As a customary symbol of auspiciousness, married ladies put it to the parting of their hair. To produce fast and vivid red colors, most sindoor on the market is products, lime, alongside lead and mercury salts. Long-term use of the sindoor may result in health concerns. Over the past half-century, there has been a lot of discussion at the worldwide level about the usage of healthy colourants the production of consumer products similar coloured fabrics, veggies, and cosmetics. Because of the harmful effects of synthetic dyes on people and the environment, Germany was the first to ban the production and use of a variety of transparent azo-dyes. Similar restrictions have been imposed in the Netherlands, India, and a few other countries. The majority of nations have adopted relevant laws and regulations related to public health and safety, industrial process management, pesticide use, wastewater disposal, and environmental protection. Protection and environmental laws will continue to control the trade in the existing work community, and the processor will need to examine the changes that must be done to satisfy these needs. The crimson sindoor were typically with alum as well as turmeric. When mixed, the turmeric powder becomes crimson. It may also be produced plant, or from sandalwood mixed with musk (safflower).

Raw rice produced that was then pulverized was another frequent component used in creating sindoor. Sindoor was also reported to be produced in the past using a particular type of red marble stone that was covered with turmeric and a little oil and left undisturbed for a few days before converting into red powder. However, with the introduction of the offered a variety of fast a low rate, these traditional preparations were largely forgotten. Sindoor is produced today using artificial colors, synthetic textiles, and lead salts. It was produced by powdering crude red lead for some of the manufacturers (Pb_3O_4). Sindoor on in terms of size and circumstances, and its consistency is usually inappropriate for skin usage. There is a high possibility that additional hazardous and banned red dyes are being utilized because there are no rigorous monitoring. Goals are to produce a fast a cheap cost using some brilliant respect for the product's risks and negative effects. To create powerful brilliant red powders, different techniques such as mixing components utilized.

It's hardly surprising that the red hue originates from Rhodamine B dye, which has been related to genetic problems. Mercury sulphite, which may cause skin cancer, may also be responsible for the red hue. Hair loss, oedema, allergic contact may all be caused by these toxic substances. Long-term use of the sindoor usually leads in skin irritation and toxicity. Blisters, itching, rashes, pigmentation, and, in rare instances, serious dermatological disorders may occur. Continuous use of sindoor leads in skin de-coloration at the application site, as well as greying hairs. Based on the degree and duration of exposure, lead exposure may produce a range of biological consequences. Ingesting, breathing, or absorbing traces of lead salts may harm nearly any, including the brain, kidneys. It's worth mentioning that kohl (kajal/surma), a widely used conventional cosmetic that's recognized. In certain areas, it may be a frequent cause of lead poisoning. PbS , as well as Pb_3O_4 , amorphous fuel, Fe_3O_4 , ZnO , $CaCO_3$, and H_3BO_3 , are the main components of kohl. Consumers are generally ignorant of the danger of lead poisoning from this widely used item. In the United Kingdom and the US, the use of lead in cosmetics is explicitly prohibited. In India, depending on the hue and tint, a variety of different or their mixes may be used to create Herbal Sindoors.

Sindoor may be worn by women aesthetic motives, or by both men and women for religious reasons. Manufacturers often utilize red lead color (lead tetroxide, Pb_3O_4) [9]. Irritability, intellectual impairments, stomach, reduced growth, behavior are all signs of lead poisoning in babies. Furthermore, no blood lead level (BLL) in children is considered healthy. Individuals and families have been reported to have been lead poisoned as a consequence of accidentally eating lead tainted sindoor. Blood testing revealed in 2004, according to physicians. A lead testing for blood revealed decilitre in the child, with BLLs of 85 and 95 $\mu g/dL$ in the father and mother, respectively. Utilizing an X-Ray Fluorescence (XRF) instrument, found increased levels of lead in a jar marked. Following additional testing for lead content, it was found that the sindoor contained 58 percent. During, it was found that this sindoor had been utilized as a food colouring additive [10].

The information about BLL was communicated to New York City Department of Health and Mental Hygiene (NYC DOHMH) in 2013. Following an inquiry, it was found that the girl had been putting sindoor in her mouth.

The family's indoor artifacts were collected and tested for lead content. Lead levels ranged from 3.2 to 330,000 parts per million, according to the research particles per million (ppm) (ppm). The official representatives of NYC DOHMH went to the stores where the family claimed to have acquired indoor goods and bought a range of items. The leftover materials exhibited lead levels ranging from non-detectable to 36 parts per million. Authorities may opt to utilize XRF analyzers specifically developed for consumer products like dolls, pottery, ceramics, jewelry, or powders like indoor to conduct fast field tests store or in a person's home. However, owing to financial limitations, state and local health authorities will not be able to acquire these client product-specific XRF analyzers due to their high cost (up to \$15K).

For real-time examination of paint quality, lead based paint inspectors utilize FP-XRF analyzers to assess risk of lead centered paint. Furthermore, commercially useable colorimetric lead detection kits, such as the FP-XRF analyzer, may be viable options for rapid field inquiry or provisional lead evaluation. The lead test kit utilized in this study (both Rapid and Leach techniques) could not be an instrument, comparable to the FP-XRF analyzer. There was no colour change in the majority of the samples, even those with lead level of $5 \times 10^3 \mu\text{g/g}$. Furthermore, while the slight yellow or brown colour changes observed in matched to vendor requirements, identification of small colour changes was arbitrary and unpredictable, making it less helpful for identifying lead adulteration. Furthermore, observed colour variations may really be the consequence of the powder's pigment "rolling off" into the applicator nozzle, rather than a genuine colour difference in the indicator solution. As a consequence, the small colour variances accidental. Any of the inconsistencies or abnormalities in colour observation between the triplicate measurements may be explained by the unknown essence of colour identification. Furthermore, removed, the association findings of confirmed laboratory research results was weak in character.

5. CONCLUSION

According to the aforementioned research and findings, the Health Department practitioners do not fully depend on FP-XRF analyzers made commercially available lead test kits for assessing non-indoor or indoor. Because these are two requirements for every screening test, conducted in the studies were extremely promising. Under today's sophisticated societies, broad chemical exposures from contaminated air, water, and food are uncommon, but they may potentially damage an entire community in exceptional situations. Exotic sources, such as contaminated traditional remedies, cosmetics, ingested lead foreign bodies, stored bullets, artists or other sharp items, shooting ranges, uncontrolled distilled alcoholic beverages, and drugs of violence, are occasionally detected. Since ancient times, it has been utilized in cosmetics, internal and topical medicinal formulations, paint pigments, and glazes. Lead Tetroxide is the most popular indoor used by married Hindu women on the parting of their scalp hair, while Muslim women use Lead Sulphide as an eyeliner. Measures was essential that screening devices were precise and reliable in detecting the drug in problem. Because are based on prevalence, it has been regarded as significant. The feasibility of using an FP-XRF analyzer equipped for lead in paint to evaluate the presence of lead was also highlighted as needing good sensitivity and negative predictive values. Researchers should concentrate on assessing alternative methods that may be used in the future, that are designed for usage with lead-centered paint and detect lead and other particles. The effectiveness of ex-situ FP-XERF analysis and the quantitative measurement using has been prompted by these results.

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