



Detection of Adulteration of Heavy Metals in Sindoor: A Review

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ABSTRACT

It is a well-known fact that Sindoor is considered a significant sign of a married woman and recent studies showed the presence of heavy metals in the Sindoor, can be easily adulterated and due to this adulteration, Sindoor may have ill effects on the human health.

After examining and studying Sindoor through various chemical tests such as Instrumentation techniques and various Chemical Tests the different metals and different adulterating agents can be easily detected which helps us to examine the following things in Sindoor. These include:

1. To study and examination of Sindoor and its composition.
2. To study various properties of different heavy metals, present in the Sindoor.
3. To study various adulterating agents, present in the Sindoor.
4. To examine and observe the effects of various metals and adulterating agents on the human body because of their application.
5. To study the toxic effects of Sindoor.

Sindoor is considered a symbolic sign for many married women. Due to its excessive demand, it is adulterated with many harmful chemicals. Recent studies have shown the presence of heavy metals in their composition. Using adulterated sindoor can cause several health issues in women. Quantitative and Qualitative studies revealed that a major part of sindoor. Manufacturing in India is not up to standard values. Consequently, it may be harmful to end consumers. It is a well-known fact that the presence of heavy metals can be tested through the following procedures to examine the Sindoor, the various tests we can perform over it are Chromatographic Analysis through Paper, TLC, GC, HPTLC, and HPLC along with metallic ion examination through Chemical Tests and at last we can go for its analysis through Spectroscopic Analysis.

Keywords – Adulteration, Heavy Metals, Sindoor.

Background

The origin of excess use of various substances in beauty, skin, body, hair, and nail care products can be found in ancient times. To achieve better variety and to enhance their quality, some supplements like various compounds, stabilizers, material pigments, stains, and shine were induced in these products. Some of these substances can have allergic, irritation, and hazardous effects on human health. This study aims to optimize potentiometric stripping analysis (PSA) to reduce the content of heavy metals (lead, cadmium, zinc), and some commercial cosmetic products are lipsticks, eye shadows, and henna hair dye, etc. [6]. Kumkum is an integral part of the religious beliefs of the Hindu community. Sindoor is also popularly referred to as Kumkum in the southern part of India. [11]. Sindoor is a frequently used product in the Indian market. Some women place a dot on the forehead, called a bindi. In the olden days, sindoor was made at home using turmeric powder, alum, calcium salt, camphor, saffron, sandalwood, and beet extracts. However, presenting this product must be carefully used vermilion is of various colors, orange, red and maroon.[10]. The composition of sindoor includes turmeric, a calcium compound, alum, iodine, camphor, and Chandan. The synthetic dye industry grows low-priced red dyes termed sindoor which are available everywhere and mainly contain the following: -

- Vermillion, (a reddish-orange element that is a powdered form of cinnabar)
- Chemical dye, lead, and other synthetic materials
- Powdered crude red lead, Pb304
- Rhodamine B dye.

•Mercury sulfite.

But on the other hand, there are many unbranded blood-red powders available at cheap rates within the market because the manufacturers aim at producing any local dye which is quickly available with toxic substances. These elements can render rich color that is attractive and most women ignore ingredients when buying sindoor. Traditional sindoor was naturally produced with turmeric and alum or lime, or from other herbal ingredients. Modern material being sold as sindoor mainly uses vermilion, an orange-red pigment, the purified and powdered sort of cinnabar, which is the chief form during which mercury sulfide naturally occurs while on the other hand, Sindoor is a poisonous chemical, made up of burnt mercury and lead both are harmful to health. [14]

Adulteration in sindoor

The adulterated sindoor contained chemical dyes, artificial materials, and lead salts. In maximum cases, the poisonous low-grade business minimal oxide became observed. The Drug Technical Advisory Board (DTAB) says sindoor fabricated from business dyes and artificial chemical substances can purpose rashes, routine pigmentation, pores, and skin cancer. The sacred sindoor (vermilion), an emblem of married Hindu ladies and additionally liberally used at Hindu shrines, will want to fits protection standards. The Drug Technical making plans board (DTAB) has determined to control the sale and quality of sindoor being sold. Sindoor is introduced below the Schedule of the Drugs and Cosmetics Rules, certainly making it a "cosmetic." A Union fitness ministry professional stated the Drug Controller General of India's workplace became receiving court cases concerning the sale of poisonous and ecologically unfriendly sindoor at shrines and shops. Sindoor or roll became observed to comprise one hundred percent poisonous chemical substances. It can purpose nearby infection, pores, and skin toxicity. The nature of sindoor or kumkum can with publicity to the surroundings over time, and this may bring about blisters, itching, rashes and pigmentation, and, at times, severe dermatological disorders. [15]

Can sindoor be harmful?

Many studies showed Qualitative and Quantitative test results, which showed the impact of lead, an extremely toxic poison related to lower IQ, behavioral problems, and growth delays in children, analysis a study that examined samples of the cosmetic powder collected from India.

- Aside from rashes, itching, hair loss, other problems which will be caused include:
- Skin cancer (due to mercury sulfite.)
- Hereditary disorders (due to Rhodamine B dye)
- Itching and dandruff problem.
- Harmful for the brain, kidney, eyes, and reproductive system if inhaled, absorbed or consumed.
- Lead poisoning or lead nephropathy (Read: Seven hazardous chemicals in beauty products that can ruin the skin.) [16]

Main Text

Kapoor (2007) develop a natural dye-based sindoor In India, Prolonged use of synthetic dye-based sindoors has shown symptoms of hair loss, graying of hair, edema, erythema, and even skin cancer. Given the above scenario, process technology has been developed to produce an alternative, safe, non-toxic, eco-friendly natural dye-based sindoor. In these heavy metals are used. The process provides a chance for the preparation of various reminder sindoor like orange, red, dark red, maroon, etc., using different dyes and their blends. As per the results of Double-Blind Clinical testing, the red and maroon-colored herbal sindoor is quite safe for skin application having no adverse effect on the skin. The orange-colored herbal sindoor synthetic dye-based sindoor.

Singh (2013) observed and examined Sindoor (Vermillion) & stains on white cotton fabric using thin-layer chromatography. It was also found that the simplest visualizing method for studying TLC chromatograms of sindoor samples is the iodine fuming technique.

Samariya (2013) did Formulation and Evaluation of Herbal Sindoor using different Natural/Herbal Ingredients Sindoor the use of such products has increased and the choice of shades of color and texture has been changed and become wider. Herbal sindoor uses different natural ingredients, as these preparations are one among the key cosmetics to be preferred by married women.

Kianoush (2014) researched the recent Advances in the Clinical Management of Lead Poisoning is a common issue. Acute or chronic lead exposure may cause reversible or may be permanent damage to the citizenry. Environmental lead exposure may be a global health concern in children. Occupational plumbism remains a health issue, particularly in developing countries. During the last decades, new methods and medications are advocated for the prevention and treatment of plumbism. This review deals mainly with recent developments within the management of plumbism. Sources of lead exposure are introduced, and methods for the first prevention of plumbism are discussed. Details for the screening of adults and youngsters also are explained to function as a practical guideline for secondary prevention. Standard chelation therapy in several groups and up-to-date less toxic new medications for the treatment of plumbism are finally discussed. Our published clinical research on the therapeutic effects of garlic tablets in mild to moderate occupational plumbism also will be discussed.

Kalicanin (2015) A Study of the Possible Harmful Effects of Cosmetic Beauty Products on Human Health. To achieve better quality and enhance their effects, some additives like preservatives, stabilizers, mineral pigments, dye, and shine were added to those products. Some of these substances can also

have allergic, irritating, and harmful effects. This study aimed to study the optimization of the potentiometric stripping analysis (PSA) to determine the content of heavy metals (lead, cadmium, zinc heavy metals (Pb, Cd), the paper analyzed hair that contains lead, a highly toxic metal. The lead content that was analyzed during this study contained a particular amount of zinc also which is an important element, although its content above the prescribed limit may lead to side effects. A highly toxic metal, cadmium, wasn't detected within the tested samples. The presence of these metals content of toxic heavy metals.

Bogden (2017) studied and observed the lead content of Sindoor to assess the extent of lead content of sindoor which has been linked to childhood plumbism when inadvertently ingested. samples of sindoor samples with atomic absorption spectrophotometry methods for lead. The analysis determined that sindoor samples contained lead. The maximum lead content detected in sindoor samples is more than the lead continued need for lead monitoring in sindoor.

Shukla (2018) carried out a Preliminary Study on the Forensic Examination of Vermillion Stains by Using Thin-Layer Chromatography Cosmetic commodities are often turned up as traces manifest at the crime scenes like lipstick, blood, soil, glass, sindoor, paints, etc. Sindoor is trace evidence and freely swapped from one article to another. It may serve to associate the victim with the suspect or crime scene and the suspect with the victim or crime scene.

Paikrao (2020) has worked on Kumkum plays a very vital role in the religious beliefs of the Hindu community. Kumkum/Sindoor is a red color powder worn by Hindu married women in the middle of their hair and forehead to indicate marital status. Kumkum is often adulterated with red lead (Pb₃O₄) due to its characteristic red color. The use of lead in kumkum can cause various adverse effects on human health like irritability, learning disorder, deafness, reduced attention, high B.P., and amnesia. The current investigation focuses on the detection techniques of lead in minute quantities which can be used as the gold standard to avoid adulterated kumkum. Quantities that can be used as the gold standard to avoid adulterated kumkum.

Chophi (2020) has studied vermilion (sindoor) using attenuated total reflectance Fourier transforms infrared spectroscopy in combination with PCA and PCA-LDA in the Vermilion (sindoor) Analysis of such evidence can provide a link between the criminal, the victim, and therefore the crime scene and thereby be utilized as associative evidence within the court of law, ATR-FTIR spectroscopy has been implemented for the examination of vermilion samples. Chemometric methods like principal component analysis (PCA) and PCA-LDA were performed on the obtained spectra for objectives explanation. PCA showed 99.06% discrimination of specimens while PCA-LDA employed for classification purposes delivered 95.25% calibration accuracy and 88% determination authenticity. Subsequently, the validity of the chemometric methods employed was tested by blind testing of samples. A preliminary study on the effect of selected substances (cotton cloth, tissue, glass, and plastic) on sample analysis indicates that while sample stain on substrates might be linked to its parent source even after a month, associating aged samples (after 8 months) could be hindered because of evaporation of components present in vermilion. All things considered; the present technique utilized features a potential prospect in future forensic casework.

Sinha (2020) observed Forensic Identification of Sindoor Stain on Cloth as Trace Evidence Analysis: the cause of death was asphyxiation due to strangulation. an abnormally high level of mercury by Instrument Atomic Absorption Spectrometer (AAS). A detailed comparative analysis was again undertaken using Fourier Transform Infra-Red Spectrometer (FTIR) which further confirmed the same chemical composition present in sindoor Stain.

Forensic significance of Sindoor

The composition of trace elements in various types of cosmetics is known to vary between different manufacturers and series, and also between different series of the same manufacturer. Hence, discrimination between cosmetic exhibits is achieved by considering the presence or absence of trace elements in exhibits, the varying concentration level of trace elements, and also the ratio concentration of these elements. However, cosmetic exhibits trace elements and would vary from case to case exhibits. [13]

Qualitative and Quantitative analysis

It is concluded that the adulteration in sindoor is of heavy metals which are detected by both preliminary and confirmatory methods. Preliminary methods include thin-layer chromatography in which 4 types of solvent systems are used 1. Methanol: Acetone 2. Acetonitrile: Acetone: Methanol 3. Acetonitrile: Methanol 4. Benzene: Methanol: Acetic acid and in confirmatory methods, various sophisticated analytical methods can be used such as HPLC, Gas chromatography, Atomic Absorption Spectrometer (AAS), Fourier Transform Infra-Red Spectrometer (FTIR), etc. in the examination of Sindoor (Vermillion) stains on white cotton fabric using thin-layer chromatography. The usefulness of thin-layer chromatographic analysis within the differentiation of samples of fifteen different brands of sindoor (vermillion) was evaluated. The power of varied solvent systems to separate the constituents of selected sindoor samples was studied.

Twenty solvent systems were examined from which a solvent system comprising butanol: propanol: water in the ratio 60:30:10 (v/v/v) was found to be the best, as it showed a high degree of separation of the constituents. It was also found that the simplest visualizing method for studying TLC chromatograms of sindoor samples is the iodine fuming technique. In the suggested course, 15 sindoor samples of the numerous brands were solicited. 10 solvent systems were worked on each sample of sindoor during which the four solvent systems [methanol: acetone (8:2), Acetonitrile: Acetone: methanol (2:4:4), Acetonitrile: methanol (2.5:7.5) and benzene: methanol: acetic acid (8:1:1)] were established for the evaluation of sindoor specimens by employing Thin Layer Chromatography sindoor tints that are encountered at the crime scene can be singled out or scrutinized by testing it with its substantive origin by thin-layer chromatography with a newly improved solvent system.

Chemical examinations done on the samples seized by Investigating Agency (Delhi Police) disclosed an abnormally high level of mercury by Instrument Atomic Absorption Spectrometer (AAS). A detailed comparative analysis was again undertaken using Fourier Transform Infra-Red Spectrometer (FTIR) which further confirmed the same chemical composition present in both the samples.

Objective of Study

The objective of the study is to review the significance of sindoor with the help of forensic science. Emphasis has been given to the literature related to the analysis of the elements of the sindoor and also to review adulteration in the sindoor. That can be helpful for forensic analysis and examining the quality of the vermilion and also in cases of sex offenses.

Conclusion

After reviewing all the research articles, it was found that a common adulterant that was used in sindoor is lead. Many studies focus on finding minute quantities of lead in sindoor as per the available literature the authors conclude that the most adulteration in sindoor is of heavy metals which are detected by both preliminary and confirmatory methods. Preliminary methods include thin-layer chromatography in which 4 types of solvent systems are used 1. Methanol: Acetone 2. Acetonitrile: Acetone: Methanol 3. Acetonitrile: Methanol 4. Benzene: Methanol: Acetic acid and in confirmatory methods, various sophisticated analytical methods can be used such as HPLC, Gas chromatography, Atomic Absorption Spectrometer (AAS), Fourier Transform Infra-Red Spectrometer (FTIR), etc. In the review article, it is found that the common adulterant in sindoor is lead. Proper Quality checks must be done on sindoor manufacturing therefore, in this review work, we concluded several authors did a forensic analysis of sindoor to provide an overview of its significance. The examination of Heavy Metal Adulteration in sindoor is conducted by simple and manual tests in the research papers.

The research article aimed to detect some common adulterants to present Heavy Metal Adulteration in sindoor that was collected from different areas. This paper tried to detect the adulteration of sindoor samples by tests such as detection of heavy metals, detection of effects on the human being, detection of harmful for our skin, hairs, etc. The purpose of this paper was to detect adulterants from the sindoor by Thin-layer chromatography. All of these tests were non-expensive and perform in a short period. This test can be done by many more techniques like HPLC, Gas chromatography, Atomic Absorption Spectrometer (AAS), and Fourier Transform Infra-Red Spectrometer (FTIR) to know which metal is present in the sindoor and which an adulterant.

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