**Comparative Analysis of Organic Kohl and Synthetic Eye Cosmetics**

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**Abstract:**

Kohl, sometimes known as surma, has been utilized as an eye cosmetic for an extensive period of time. The utilization of pure kohl as a therapeutic intervention for ocular ailments proved advantageous for individuals. With the progression of our societal well-being, we are encountering several issues pertaining to the purity of kohl and other eye cosmetics. This review aims to examine the distinctions between synthetic and organic kohl, as well as other eye cosmetics, by posing critical inquiries. Is lead poisoning caused by eye cosmetics other than kohl? Historical records provide evidence of the variant in question. Currently, several brands available in the market are producing kohl by combining different ingredients, hence influencing its composition. Limited information is available regarding pure/organic kohl; however, we have included information on several varieties of kohl and eye cosmetics that have supplanted its use. This research aims to examine the formulation of synthetic eye cosmetics and the potential negative consequences associated with their use, encompassing both moderate and severe manifestations of adverse effects. The reported occurrence of toxicity and lead poisoning resulting from the usage of some cosmetics has been observed. This review provides researchers with an opportunity to assess the quality of eye cosmetics commonly used on a regular basis.

**Keywords:** Organic kohl, surma, synthetic eye cosmetics, comparative analysis

**Introduction:**

The eyes possess a heightened level of sensitivity and are regarded as a vital component of the human anatomy. The importance of eye care has been a subject of concern. Kohl was one of the various kinds of eye preparations used in ancient times to prevent and treat eye problems (Mahmood et al. 2009). A review of the literature indicated that numerous ancient civilizations, including the Egyptian, Greek, Roman, Chinese, Japanese, Phoenician, Indian, and Muslim populations, embraced it (Glanville, 1947; Engelbach, 1961; Richard and Clara., 1962; Harris, 1962; Levey and AlKhaledy, 1967; Bosworth et al., 1986). Kohl is defined as an ultra-fine powder containing one or more ingredients (such as galena, herbs, pearls, gemstones, etc.) to be applied in the eyes for prophylaxis and treatment of various eye diseases in the Greek-Arabic and Eastern systems of medicine (Nadkarni, 1954, Kaushal, 2008). Muslims' usage of Kohl is referred to as "Sunnah" in two sources: Tirmidhi, Tib. 9, and Abu Dawud, Tib. 14. These results demonstrate how literature, whether secular and religious, ancient and modern, approaches the subject of Kohl from several angles, including physical, chemical, archaeological, medicinal, and cosmetics.

The compositions of kohl exhibit regional variations. Kohl is commonly employed as a cosmetic agent for eye paint. Kohl eye cosmetics have undergone significant advancements, resulting in the development of many products such as mascara, eye pencil, and liquid eyeliners, each characterized by distinct compositions, sizes, and shapes. Since ancient times, Kohl has been a well-known and widely used eyeliner throughout the Middle East and Far East. Both women and some men have applied it as a cosmetic, even to the umbilicus of infants and the eyes of toddlers. Ocular disorders have also been treated and prevented with the use of Kohl (Al-Kaff et al. 1993) .

This article provides a comprehensive overview for comprehending Kohl. The topic of Kohl has been a subject of discourse for an extended period of time. Kohl, specifically the Al Ethemd kind, possesses therapeutic properties. We have endeavored to bring attention to the beneficial properties of Al Ethemd kohl for the human body. Researchers have conducted research to establish the presence of both beneficial and detrimental effects associated with the use of kohl. Both elements can be considered accurate, as there exists a distinction between natural ancient kohl and manufactured kohl. Over time, both the composition containers and the manufacturing process have undergone modifications. Consequently, Kohl's effects can also be distinguished.

Eye cosmetic evolution is currently a topic of debate, as numerous products, some of which have not even adhered to protocols, are introduced to markets under both branded and non-branded names. They are currently in use and being sold. The chemical composition of kohl, mascaras, and other eye cosmetics has been emphasized in this article. The observed effects are significantly more hazardous than those of kohl. Some customers report moderate discomfort after applying cosmetics, even though these items are put through thorough testing to ensure human safety. The ocular changes linked to the use of eye cosmetics are less extensively documented than the cutaneous changes, such as allergic dermatitis (Ng et al. 2016). A range of problems are seen among individuals who use eye cosmetics, including but not limited to dry eye diseases, inflammation, pruritus, lead poisoning, contact dermatitis, and allergic reactions.

There is a necessity to do comprehensive research on eye cosmetics, with a focus beyond the sole consideration of Kohl. It is imperative for every nation that employs produced kohl and eye cosmetics to carefully evaluate the potential consequences associated with their usage. We must accept the current state of affairs; we cannot halt the production of eye cosmetics, but we can at least produce those with substances that are safer for children and women.

**Historical Background:**

Traditional eyeliner i.e. kohl (derived from the Arabic words kuhl, kohhel, kohol, and cohol) is also known as "surma" in Punjabi and Urdu, "al-kahal," and "kajal" in Hindi. It has been utilized extensively throughout the Middle East, Far East, and Northern Africa as an eye cosmetic. Ancient civilizations such as the Sumerians (35001950 BC in Iraq), Egyptians (305030 BC), Greeks (1550100BC), Romans (753 BCAD 476), Chinese (2100 BC 1911 AD), Japanese (18001500 BC), Phoenicians (1200146 BC in Lebanon), Persians (569330 BC), Indians (1500 BC), and Muslims (641 AD) all acknowledged and embraced it. In fact, kohl is among the oldest ophthalmological preparations that have been documented by humankind (Fischer, 1892; Tapsoba et al., 2010; Ng et al., 2016). Kohl had a significant social role in the life of the Egyptian nobility, acting as a sign of social standing and accomplishment in addition to being a medical therapy and beauty enhancement. Kohl was so important to the Egyptians that it was applied prior to mummification and that lovely jars containing it were included for the journey to the afterlife, where it would remain forever preserved (Pauline, 2007). Galena, or lead sulphide, was also employed to treat eye conditions, according to the findings of studies on the medical applications of natural substances in "Mediaeval" and "Ottoman Al-Sham" (Lev, 2002). Additional evidence for Kohl's composition can be found in Mediaeval Islamic Civilization - An Encyclopedia (Meri, 2006) and The Encyclopedia of Islam (Bosworth et al., 1986).

Following the delivery of newborns, a substance is administered in the vicinity of the umbilical cord stump in order to darken their eyebrows and eyes. Certain moms adhere to traditional practices in order to safeguard their children from the malevolent influence of the evil eye (El-Shafey and Al-Kitani, 2017). Table 1 displays the provenance of the sixteen specimens of purported Kohl Al Ethmed (Badeeb et al., 2008).

Table 1: Origin of Samples (Badeeb et al., 2008)

|  |  |
| --- | --- |
| **No. of samples** | **Origin** |
| 3 | Saudi Arabia (Makkah) |
| 3 | Saudi Arabia (Madina) |
| 1 | Saudi Arabia (Jeddah) |
| 1 | India |
| 7 | Pakistan |
| 1 | Al-Yemen |

The gathered samples were subjected to testing using the extensively documented description of Kohl Al-Ethmed found in literature. Klod Al-Ethmed is purported to have a reddish-black hue. There is just one sample that roughly aligns with the provided description, specifically identified as sample no. 16 (Table 2).

Table 2: Color of samples (Badeeb et al., 2008)

|  |  |
| --- | --- |
| **Sample no.** | **Color** |
| 1 | Dark grey |
| 2 | Dark grey |
| 3 | Dark grey |
| 4 | Black |
| 5 | Dark grey |
| 6 | Dark grey |
| 7 | Dark grey |
| 8 | Black |
| 9 | Black brown |
| 10 | Dark brown |
| 11 | Dark grey |
| 12 | Dark grey |
| 13 | Black |
| 14 | Dark grey |
| 15 | Brown |
| 16 | Reddish-brownish-black |

**Containers:**

During ancient times, kohl was stored in various containers of varying shapes, such as small bottles, jars, or specialized kohl tubes. A variety of names have been ascribed to the receptacles used to store kohl, including "kohl pot," "kohl box," "kohl container," "Schminkdose," "stone rouge pot," and "stone pectorale." Prior to the Eleventh Dynasty, when the earliest kohl sticks were discovered, kohl was likely applied with the finger. The application of kohl, which is stored in a container, requires the use of a kohl stick. It is recommended that the sticks possess a smooth and straight surface in order to prevent any potential harm to the eyes. Typically, sticks are derived from the branches of juniper (Juniperus communis) or common boxwood (Buxus sempervirens) and are subjected to planing processes till achieving a smooth texture. Kohl stick handles are embellished as a finishing touch before being rendered functional (Sahin, 2020; Hardy et al., 2004). Based on a chemical analysis of the contents of one of the bottles and the presence of small applicators (kohl sticks) with several of the glass flasks examined, sixteen elegant glass flasks used for kohl were found in the cemeteries of two towns in northern Jordan. These findings confirm the use of these glass flasks as kohl tubes (Sultan and Khasawneh, 2015).

**Different Types of Kohl:**

Prophet Muhammad (PBUH) utilized the black kohl for therapeutic purposes and said: “Treat your eyes with kohl, for it nourishes eyes and eyelashes” (Abu Dawud, Tirmidhi). The Prophet, Peace Be Upon Him (PBUH), also mentioned in another hadith, “The best of your kohl is ithmid (antimony), for it makes the vision clear and makes the hair grow” (Nisâ’î, AbûDâwûd). The substance known as "Ithmid" has been characterized as a lustrous stone with a dark, reddish-black hue, and it has conventionally been identified as the mineral stibnite. Potentially, the mineral galena gradually replaced the ore in question due to its greater availability, similar appearance and texture, and lower cost of acquisition(Al-Hazzaa and Krahn, 1995). Certain early Muslim medical authors established a distinct categorization of eye powders and pastes, differentiating between "siyaf" powders and pastes primarily used for cosmetic purposes, typically composed of soot (amorphous carbon), and "kuhl" (kohl) powders and pastes employed for the treatment of various eye conditions and diseases (Hardy et al., 2006). Typically, kohl can be classified into two distinct categories. One type of substance utilized in this context consists of either a powdered form of malachite green or a crystalline compound known as antimony trisulphide. The composition of the alternative type exhibits significant variation across different countries, maybe incorporating a combination of scorched copper, plumbago, sandalwood, and ambergris (Hannan et al., 1987). Galena (PbS) and stibnite (Sb2S3) were employed as constituents in the production of black cosmetics, specifically for their mineral properties. These minerals exhibit disinfectant capabilities against germs transmitted by flies or contaminated water, and offer alleviation from ocular diseases.

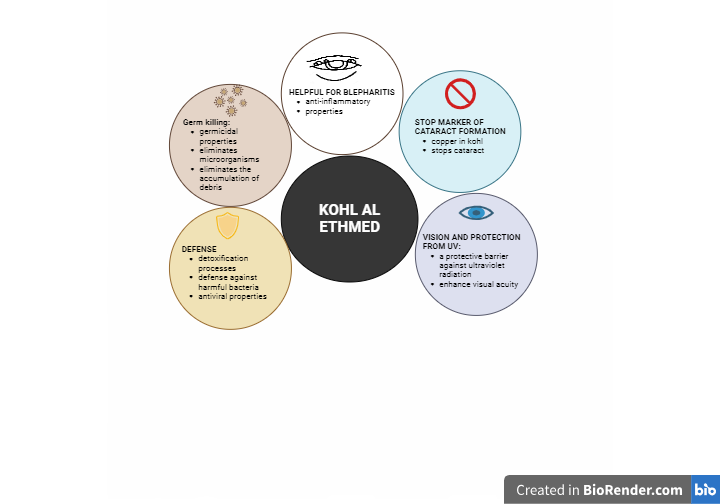
Persian Kohl is utilized for the purpose of providing long-lasting moisture to the eyes, occasionally inducing lachrymation (known as Dameè) and causing blurred vision in cases of Trachoma (referred to as Sabal). Additionally, it is said to enhance vision and strengthen the eyes, as well as alleviate itchiness in the eyes. The management of ocular injuries resulting in the whitening of the pupil or leukocoria, also known as Bayaz, is of utmost importance.

**Benefits of Kohl:**

Kohl is the most widely used eye product known to have been used in almost all human civilizations. It is used to keep the eyes cool and clean as well as to treat and prevent conditions like blepharitis, trachoma, chalazion, pterygium, cataract, conjunctivitis, and ectropion. It is also used to prevent trichiasis from recurring (Sweha, 1982). Additionally, studies have shown that Kohl enhances eyesight and maintains the health of the eyes (Levey and Al-Khaledy, 1967; Zaheer et al., 1991; Monographs of Unani Medicine, 2003). In the Arabian Peninsula, one of Kohl's most notable characteristics has been noted. According to reports, the black, glossy particles of galena, or lead sulphide, a primary ingredient in Kohl, shield the eyes from sun glare and reflection, shielding them from the damaging effects of UV rays emitted by the sun and desert dust (Heather, 1981). Several writers have also reported on further references to sun absorption, photoresistance, humidity and temperature sensor, and solar characteristics of galena (lead sulphide) (Nair et al., 1991; Pop et al., 1997).

Researchers have made an effort to locate any scientific evidence supporting the assertion that lead sulphide, or galena, has the ability to absorb solar radiation when applied topically as Kohl. There are certain plausible explanations for the conclusion that Kohl, which has lead sulphide (galena) as a primary constituent, does, when applied to the eyes, naturally shield against solar glare.

Recent research indicates that the use of kohl in Egyptian eye remedies increased the body's synthesis of nitric oxide, a molecule having antibacterial qualities. According to reports, nitric oxide plays a significant role in regulating ocular blood flow, which affects the basal blood flow in the retina, optic nerve, and choroid (Mahmood et al., 2019).



**Figure 1: Benefits of Kohl Al Ethmed**

**Precaution:**

The precautionary measures for using kohl involve restricting its usage to healthy eyes and avoiding application on infectious or wounded eyes, as these conditions may result in adverse effects. Proper handling of the eye liner stick during its application to the eyes is essential in order to prevent any potential contamination. However, the utilization of a specialized container with a narrow neck bottle provides a safeguard for the sample by preventing its exposure to the external environment. ( Andalib et al., 2018).

**Lead poisoning after ocular application of Kohl:**

Lead poisoning is a widespread issue that is regarded as the most significant environmental illness that affects children. Lead exposure, even at low concentrations, can be harmful. Long-term contact between lead-containing eye makeup and the skin or mucosa can cause symptoms, including blood in the eyes (Malakotian et al., 2010). Some governments have implemented import bans and educational efforts to warn users of the risks associated with using kohl that contains lead (Pb). Numerous studies have recommended for more government regulations of the kohl trade and quality control as well as greater public education regarding its hazards. Nonetheless, some authorities downplay the possible risks associated with using kohl, and consumers continue to be ignorant of these risks (Tiffany-Castiglioni et al., 2012). According to Parry and Eaton (1991), a study was conducted using Kohl samples that were gathered from several places, including London, Nouakchott (Mouritania), Rabat (Morocco), Detroit, Pittsburgh, and New York City. According to the authors, Kohl was a lead-hazardous eye cosmetics product imported from the third world into the first.The authors also stated that doctors and other healthcare professionals in the third world typically aren't aware of the risk of lead poisoning from regularly used, unanticipated objects. These authors also stated that galena, a cheap and easily accessible element, progressively replaced antimony, which was once employed by the Pharaonic Egyptians to manufacture Kohls. Antimony is rare and expensive. Gradually, galena, an inexpensive and easily accessible substance, has taken its place. Likewise, usage of Kohl, which contains lead sulphide or galena, has also been documented in Saudi Arabia, Morocco, and other Middle Eastern nations (Lekouch et al., 2001; Alkhawajah, 1992; Al-Kaff et al., 1993; Al-Hazzaa, 1995; Jallad and Hedderich, 2005; Nir et al., 1992).

Despite some of such studies, Saudi kohl is prized as a priceless gift among Muslims during the pilgrimage season. Not only is its usage socially acceptable, but people also support it and associate it with prognostic proverbs (Al-Ashban et al., 2004). Therefore, it is recommended to use natural kohl in order to avoid any harm. In conclusion, it may be inferred that, contrary to reports from other sources, Kohl (surma) poisoning or elevated blood lead concentration upon application to the eyes are probably more theoretical than actual health risks.

**Chemical composition of kohl of different countries:**

The composition of kohl varies throughout different countries. This review paper aims to examine the composition of kohl in various areas, including Yemen, Saudi Arabia, Qatar, Pakistan, and other countries. The precise chemical composition of kohl has been a subject of significant interest and contention among scholars in the scientific community. Prominent contributions to the authentication of the precise chemical composition of kohl have been made by scientists from Germany and France, employing methodologies like as chemical analysis, electron microscopy, and X-ray diffraction (Habib Ullah et al., 2010).

The chemical composition analysis demonstrated that the samples from Pakistan and Saudi Arabia consist of various elements. The primary elements identified in the Pakistan sample were carbon (C), oxygen (O), and calcium (Ca), while the minor elements detected in smaller quantities were sodium (Na), copper (Cu), zinc (Zn), lead (Pb), magnesium (Mg), silicon (Si), bismuth (Bi), sulfur (S), and aluminum (Al).

In contrast, the composition of the Saudi Arabian sample primarily consists of main elements such as carbon (C), oxygen (O), sulfur (S), lead (Pb), and iron (Fe). However, modest quantities of zinc (Zn), copper (Cu), aluminum (Al), and silicon (Si) were also discovered.

Several elements, like as iron (Fe), zinc (Zn), and copper (Cu), are known to play crucial roles in the ocular system (Andalib et al., 2018; Badeeb et al., 2008; Karbassi et al., 2022; Buksh et al., 2020; Aziz & Junejo, 2022). A comprehensive collection of 20 distinct samples of Kohl (Surma) was procured from several local marketplaces throughout the city of Karachi. Of all the samples analyzed, 75% of the Kohl samples exhibited significant antibacterial activity against P. mirabilis and S. epidermidis. Furthermore, it was shown that 30% of the samples had antagonistic properties against fungal infections. The Candida and Mucor species had the highest level of activity. It is well acknowledged, however, that the majority of historical kohl brands are composed of antimony-based powders that have been commonly utilized. For years, it has been widely recognized that the majority of kohl brands consist of antimony (III) sulfide (Sb2S3) (ethmid).The aforementioned type of kohl was produced through the process of pulverizing ethmid stone. Antimony (Sb) ores occur naturally as stibnite or antimonite, which consist of antimony(II) and antimony(III) oxide (SbO and Sb2O3) together with small amounts of copper(II), silver, and lead sulfide. Regrettably, as a result of the high cost and limited availability of Sb2S3, PbS, which possesses comparable characteristics and aesthetic appeal, was employed as a substitute in the production of kohl. The research findings suggest that this particular kind of kohl does not exhibit mutagenic activity. It is conceivable that there may be non-antimony-based eyeliners available on the market, which may contain a range of unidentified components, some of which could potentially possess mutagenic properties (Buksh et al., 2020).

The galena ore utilized in the production of kohl has regional variations. Specifically, galena sourced from Sinai, Saudi Arabia, and Iran is devoid of antimony, but a majority of the galena obtained from Macedonia, Turkey, and Armenia contains minute amounts of this particular element (Mahmood et al. 2015). Consequently, the chemical study conducted on the kohl indicates that its composition aligns with conventional components, but with indications of potential sourcing from remote origins. A comprehensive study into the chemical characteristics of kohl is now underway, with plans for its forthcoming publication.

In the rural areas of Oman, a significant proportion (73%) of the local public utilized kohl products. Among these, the majority were composed of galena (PbS), with one variant consisting of hematite. Additionally, the other Omani-produced kohl products predominantly comprised amorphous carbons. There are two primary classifications for Omani-made kohl: mineral-based and carbon-based kohls. The precursor material utilized in the creation of kohl, formerly associated with Kohls, and primarily consists of minerals sourced from Oman or imported from various other nations. These minerals undergo processing to facilitate their transformation into kohl. The composition of the precursor material used in the production of traditional carbon-based kohl in Oman exhibits regional variations, influenced by the diverse resource availability across different areas (El-Shafey and Al-Kitani, 2017).

Among the four kohls acquired by the city of Dubai, one was derived from galena, two were derived from amorphous carbon, and one was derived from sassolite. Out of the 18 kohls acquired by the city of Abu Dhabi, nine were derived from galena, one from amorphous carbon, five from zincite, one from calcite/aragonite, and two from sassolite. The kohl procured from Yemen was discovered to be composed primarily of galena. In summary, the research conducted on a sample of 23 kohls revealed that 48% of them were discovered to contain lead. However, when focusing solely on the kohl samples purchased in Abu Dhabi city, a slightly higher proportion of 50% was seen ( Hardy et al., 2002).

Khojati Surma Sada, Khojati Surma Sada Aswad, Khol Noori, Kohl Original Stoneb (With Zam Zem Water), Hashmi Surma Asmar, Hashmi Kohl Aswad, Hashmi Surma ,Special Surma Al-Sherifain Harmain’S Surma, Hind Ka Noor (Eye Liner), Delux Surma (Khojati) Khojati Surma ,Hashmi Kajal Khojati Surma ,Black (Export Quality) ,Lateef Surma ,Shamsy Surma (with Zam Zem water), Rahat-e-Noor ,White kohl, Hind-ka-Noor, Noory by Samah are among the brands of kohl originating from the United Arab Emirates, Dubai, and Pakistan.

The composition of Egyptian kohl comprises various substances, including Galena (PbS), Carbonate of lead (PbCO3), Brown Ochre (Fe203.nH20), and Limonite (a combination of iron oxide and hydroxide). It is important to note that while the mentioned formula represents one variation of this mineral, alternative formulas also exist.The compounds mentioned include iron(II,III) oxide (Fe3O4), manganese dioxide (MnO2), copper(II) oxide (CuO), antimony(III) sulfide (Sb2S3), malachite (Cu2(OH)2CO3), and chrysocolla (CuSiO3·2H2O).

Several examples of medicinal Persian kohl found in Qarābādins include Kohlo-l-dameȇ, Kohlo-l-basalighoon, Kohlo-l-ramādi, Kohlo-l-jawaher, Kohl-e-tarsa, Kohl-e-za’faran, and Kohl-e-anzaroot, among others. The composition of the aforementioned substance includes saffron, fennel extract, ammonium chloride, camphor, black pepper, long pepper, burned zinc, silver oxide, gold oxide, and tutiya burnt gold ( Soleymani and Zargaran, 2018).

The Kohl goods originating from Zamfara State necessitate particular consideration or are preferably avoided as cosmetics because to their potential to induce radiation-related harm. The potential for increased α particle injury to tissues can be significantly heightened by the ingestion of kohl through activities such as licking the lips, feeding, and direct ingestion by younger individuals. It has been recognized that the utilization of both imported and local items has an equivalent risk of radiation-induced disorders (Zakari et al., 2014).

In this study, a comprehensive analysis was conducted on a set of 18 kohl samples utilizing two analytical techniques: X-ray powder diffraction (XRPD) and scanning electron microscopy (SEM). All of the samples were acquired in Cairo, with eleven of them having their origins traced back to Egypt. Galena (PbS) was identified as the predominant constituent in six samples, with four of these samples originating from Egypt and the other two from India. In an additional set of ten samples, the predominant constituent was identified as one of the following substances: amorphous carbon, calcite (CaCO3), cuprite (Cu2O), goethite (FeO(OH)), elemental silicon, or talc (Mg3Si4O10(OH)2). The primary constituent of the remaining two samples was an unidentified amorphous organic substance. The sample set consisted of six specimens derived from galena, five specimens derived from amorphous carbon, two specimens derived from silicon/silicon-based compound (talc), one specimen derived from calcite, one specimen derived from cuprite, one specimen derived from goethite, and two specimens derived from unknown (yet presumed to be carbon-based) amorphous compounds (Hardy et al., 2004).

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Kohl Country** | **Kohl Composition** | **Reference** |
| 1. | Pakistan | Carbon (C), oxygen (O), and calcium (Ca), while the minor elements detected in smaller quantities were sodium (Na), copper (Cu), zinc (Zn), lead (Pb), magnesium (Mg), silicon (Si), bismuth (Bi), sulfur (S), and aluminum (Al) | Andalib et al., 2018; Badeeb et al., 2008; Karbassi et al., 2022; Buksh et al., 2020; Aziz & Junejo, 2022 |
| 2. | Saudi Arabia | Carbon (C), oxygen (O), sulfur (S), lead (Pb), and iron (Fe).  Modest quantities of zinc (Zn), copper (Cu), aluminum (Al), and silicon (Si) | Andalib et al., 2018; Badeeb et al., 2008; Karbassi et al., 2022; Buksh et al., 2020; Aziz & Junejo, 2022 |
| 3. | Dubai | Galena, two were derived from amorphous carbon, and one was derived from sassolite | Hardy et al., 2002 |
| 4. | Egypt | Galena (PbS), amorphous carbon, calcite (CaCO3), cuprite (Cu2O), goethite (FeO(OH)), elemental silicon, or talc (Mg3Si4O10(OH)2 | Hardy et al., 2006 |
| 5. | Oman | Galena (PbS), with one variant consisting of hematite | El-Shafey et al., 2017 |

**Eye cosmetics:**

Cosmetic products consist of intricate formulations of multiple chemicals, which are designed without the intention of exerting pharmacological effects within the human body. Nevertheless, a considerable number of these constituents, including water, oils, fats, plant extracts, protein hydrolysates, and color additives, possess the potential to facilitate the proliferation of microbes. A wide range of eye cosmetics are readily accessible in the market, with the purpose of enhancing facial aesthetics or improving facial appearance. The use of cosmetics on the eyes to improve appearance and beauty may result in visual abnormalities, allergic responses, and discomfort (Jones et al., 2015). Hospital referrals for allergic contact dermatitis most frequently result from adverse reactions to cosmetics, toiletries, and topical treatments. Most of the time, these are only moderate or momentary, and most reactions are irritating rather than allergic. Acute toxicity, percutaneous absorption, skin irritation, eye irritation, skin sensitization and photosensitization, subchronic toxicity, mutagenicity/genotoxicity, and phototoxicity/photoirritation are only a few of the possible negative effects. The way a cosmetic product is used affects how safe it is since it affects how much of the ingredient can be swallowed, breathed, or absorbed through the skin or mucous membranes (Nigam, 2009).

Cosmetic products designed for the eyes can be categorized into two groups: colored and non-colored variants. Colored eye cosmetics encompass a range of products such as mascaras, eyeliners, eye shadows, and eyebrow pencils, which are formulated to provide pigmented hues. On the other hand, non-colored eye cosmetics consist of serums, eye gels, and eye creams, which do not possess pigmentation but are intended for specific eye care purposes. Elements such as As, Sb, Cr, and various others have been measured and quantified in various categories of cosmetic products ( Periz et al., 2018). The presence of cobalt (Co), chromium (Cr), cadmium (Cd), lead (Pb), and nickel (Ni) in eye shadows is a matter of concern (Ababneh and Al-Momani, 2018).

**Considerations in Eye Area Cosmetic Formulation**

1. Frequently encountered allergens and irritants ought to be devoid from the formulation or, failing that, their concentration should be decreased.
2. Pure, high-quality materials devoid of impurities ought to be chosen.
3. Preventing hypersensitivity reactions with appropriate antioxidants is crucial in order to avert the formation of autoxidation products.
4. Substances that generate cutaneous stimulation and volatile vehicles should to be eradicated.
5. Skin-penetrating solvents, such as ethanol and propylene glycol, ought to be circumvented.
6. Surfactants, whether employed for emulsification or purifying functions, ought to be meticulously chosen.
7. The selection of preservatives should be based on their low sensitizing potential (parabens) as opposed to their high sensitizing potential (formaldehyde and formaldehyde releasers).

The utilization of coal tar colors on eyelashes is restricted under the US Food, Drug, and Cosmetic Act. Consequently, when choosing colorants for mascara, options are limited to vegetable colors or inorganic pigments and lakes (Draelos, 2001; Periz et al., 2018).

**Eye Shadow:**

Eye shadows are offered in many formulations, including powder, cream, stick, and pencil. The object exhibits a diverse range of hues and surface qualities. The selection of colors is permitted. This feature offers a greater level of complexity and intricacy.

The base material for powder eyeshadow is pressed powder on cake, which is hydrated magnesium silicate. Potato starch and kaolin (hydrated aluminum silicate, titanium dioxide, and calcium carbonate) are incorporated into the cake in order to facilitate the absorption and coverage of oil originating from the eyelids. Zinc stearate is employed for the purpose of achieving enhanced smoothness and improved adherence to the surface of the eyelid. Pigments commonly employed in many applications include micronized titanium dioxide, zinc oxide, and silicone derivatives. In order to prevent flaking and facilitate the dispersion of pigmenting chemicals, binders such as lanolin, mineral oils, and isopropyl stearate are used into the cake. The conventional powdery texture and appearance of eyeshadows is currently considered unfashionable. Bismuth oxychloride and mica are incorporated into the formulation to achieve a visually appealing frosted or glittering effect, while fish scale essence is utilized to impart a pearly or shiny appearance.

Cream eyeshadows are cosmetic products that possess water-resistant properties and consist of anhydrous compositions containing pigments inside a base of petrolatum, cocoa butter, or lanolin.

Pencil eyeshadow is composed of various components, including talc as a filler, mica, sericite (a type of fine-grained mica), magnesium stearate, colorants, preservatives, and magnesium stearate as a dry binder. The ingredients are subjected to high pressure, resulting in their compression. (O'Donoghue, 2000).

**Mascara:**

Eyelashes assume a significant function in an individual's persona and contribute to the development of self-assurance. Mascara serves to augment the appearance of eyelashes by increasing their length and thickness. Mascara has always served as the earliest and most prevalent choice among users. Typically, this composition comprises a blend of waxes, pigments, and either resins or petroleum distillates. The transitory nature of mascara's effects is evident.

There are two contemporary formulations of mascara that are currently available: cake and liquid. The predominant variant is a conventional oil-in-water emulsion, typically incorporating neutralized stearic acid as an emulsifier. Certain mascaras may possess a certain level of water resistance. Conversely, another form of mascara exhibits significantly higher waterproof properties due to its composition, which relies on a wax/solvent combination. The solvents which are most frequently utilized are derived from petroleum distillate and isoparaffins, exhibiting different levels of volatility (O'Donoghue, 2000; Draelos, 2001).

**Eyeliner:**

In numerous Eastern cultures, the application of traditional kohl is observed at the mucocutaneous junction. Additionally, eyeliner is frequently put on the periorbital skin, extending beyond the eyelash line. Eyeliner is more commonly preferred in Western cultures than to kohl. Eyeliner can be obtained in various forms, including cake, liquid, and pencil. Eyeliner serves as an additional cosmetic for the eyelashes, however with the distinction of being placed on the lid border instead of the lashes themselves. Its purpose is to delineate the boundaries of the eye. It is applied just outside the lash line and occasionally even within it, with the placement and color scheme being determined by current trends. It improves the appearance of the lower and upper eyelashes.

The composition of liquid eyeliner often includes colors, water, cellulose gum, thickeners such as magnesium and aluminum silicate, and water-soluble styrene-butadiene latex or a polymer ammonium acrylate. The product consists of a cylindrical container that houses a brush, specifically designed for liquid eyeliner application.

Pencil eyeliner is composed of a blend of natural and synthetic waxes, along with oils and pigments. This particular liner does not contain any fragrance or preservatives. Cake eyeliner is similar to eye shadow, with the distinction that it contains surfactants that facilitate the creation of a paste-like consistency when the powder is combined with water (O'Donoghue, 2000; Draelos,2001).

**Eyebrow Cosmetics:**

Eyebrow cosmetics encompass a range of products, such as eyebrow pencils, sealers, eyebrow dyes, and the more recent addition of artificial eyebrows. Eyebrow pencils are widely recognized as the predominant choice among users for enhancing the appearance of eyebrows. The formation of these substances occurs by the amalgamation of pigments, typically iron oxides, alongside waxes of either synthetic or natural origin or oils. The utilization of colours holds significant importance in the marketing strategies employed for cosmetic items. A wide array of compounds is employed for the purpose of colouring either the product itself or other bodily parts such as hair, skin, eyelashes, and nails. Synthetic dyes are extensively utilized within the cosmetics business, enjoying a wide-ranging prevalence.

When comparing the aforementioned eye cosmetics to Kohl, it is evident that the former include a significant amount of chemicals that have detrimental effects, surpassing those of Kohl. Several examples are mentioned in this context.

**Negative Effects of Eye Cosmetics:**

The use of synthetic eye cosmetics poses a growing health danger among female individuals, particularly teenagers. The potential consequences are very minor, as evidenced by the occurrence of dermatological reactions caused by cosmetic goods. These reactions typically manifest as a localized response characterized by redness, swelling, the formation of small vesicles or blisters, and increased sweating. Consequently, individuals may experience a variety of symptoms, including tingling sensations, burning sensations, a sensation of tightness, irritation, or discomfort. Several of these substances have the potential to function as allergies, carcinogens, endocrine disruptors, immunosuppressants, irritants, mutagens, toxins, and/or tumor promoters, and may cause harm to the eyes (Sullivan et al., 2023).

The determination of toxic and potentially toxic elements in cosmetics used for make-up is a challenging task, and the development of a universal method is difficult because of the complexity and the variable amount of organic and inorganic compounds in these products (Mesko et al., 2020).

**Microbial And Chemical Contamination:**

The decline in purity can be attributed to the contamination and mixing of many substances. Previous studies have documented the harmful effects of kohl resulting from the presence of microbial and chemical contaminants. In recent research, bacteria and fungi were identified and separated from several samples of Kohl. The most prevalent pollutants identified in Kohl samples were species belonging to the Bacillus and Aspergillus genera. The use of synthetic kohl has the potential to contribute to lead poisoning. The prolonged exposure of adults to excessive amounts of lead has been found to have several long-term impacts. These effects include the development of lead palsy, anemia, suppression of heme production, increased fragility and toxicity of red blood cells, and subsequently, an elevated rate of cell disintegration (Andalib et al., 2018; Grandjean, 1978; Ng et al., 2016;Sullivan et al., 2023). There is a notable correlation between color cosmetics and a heightened probability of detecting microbial proliferation compared to non-color cosmetics.

**Mascara Effects:**

The application of mascara has the potential to cause conjunctival pigmentation when it is inadvertently introduced into the conjunctival sac through the flow of lacrimal fluid. There have been reports of allergic contact dermatitis associated with the presence of rosin (colophony) and dihydroabietyl alcohol (Abitol) in certain mascara products. The application of mascara has the potential to result in the loss of eyelashes. A 19% incidence of eyelash loss was recorded. The patients who had a higher mean years of use of mascara (5.17 ± 3.8 vs. 3.19 ± 2.6, P = 0.027, t test) experienced a greater impact on the fall of their eyelashes. The occurrence of eye itching before the loss of eyelashes was noticed in all participants (P = 0.0002, Fisher's exact test). Subjects that utilized water for the removal of waterproof mascara exhibited a greater proportion of eyelash loss, with a recorded percentage of 27%. The act of applying mascara for an extended period of time leads to its occurrence. The correlation between the act of hair removal and hair loss Raise the parameter 60% water-resistant mascara (N=68) 60% simple mascara (N=60) Media utilized in its elimination 80/60 Water Tissue/Oil 8.0 Subjects whose hair was removed with water experienced hair loss (Kadri et al., 2013). The microorganisms Pseudomonas aeruginosa, Citrobacter freundii, and Klebsiella pneumoniae were recovered from the mascara sample.

**Eyeliner Effects:**

Eyeliners are susceptible to bacterial and fungal contamination, similar to mascara, particularly when opting for the liquid formulation. However, a significant adverse effect that may occur is the potential for conjunctival pigmentation, which is also observed with the use of mascara. Evidence suggests that when cosmetic products are applied to the skin surrounding the eyes, they have the potential to migrate into the tear film, leading to contamination of the tear film. The use of cosmetics, such as eyeliner, might involve a closer approach to the ocular surface when applied along the lid margin and over the meibomian glands. The application of liquid eyeliners has been associated with the development of dermatitis.

**Preservative Effects:**

In order to mitigate the risk of infection, the majority of eye cosmetics have preservatives; nonetheless, it is worth noting that these preservatives have the potential to induce disease. The inclusion of preservatives, surfactants, and emulsifiers in cosmetic products has the potential to induce irritation on the ocular surface, much as their potential to irritate the surrounding periocular skin. (Ng et al., 2012). Contact dermatitis may manifest as a result of exposure to certain preservatives found in eye cosmetics, as well as the presence of rosin (colophony) or dihydroabietyl alcohol (Abitol) in certain mascaras that are designed to provide extended use. Eye cosmetics, like waterproof eye shadows and mascaras, may necessitate the use of certain cleansers for their removal. These cleansers may contain surfactants, which have the potential to elicit an unfavourable response. Additionally, the act of removing the cosmetic product may cause irritation due to the increased mechanical activity involved. These products have the potential to directly and indirectly disturb the maintenance of homeostasis in the ocular surface and tear film. The utilization of water for the purpose of removal has been found to potentially correlate with an increased prevalence of eyelash loss in those who have applied a waterproof eye makeup. The presence of preservatives in cosmetic products has the potential to disturb the tear film. Eyelash cosmetics have been shown to induce a localized dermatitis along the lash line, while eyelid cosmetics have been found to impact the entire surface of the eyelid. Benzalkonium chloride (BAC) is widely employed as a preservative in eye cosmetics. Benzalkonium chloride (BAC), thimerosol, chlorhexidine, and colophony are employed as preservatives in eye cosmetics, and each possesses the potential to induce contact allergy. Thimerosol finds its primary application in the formulation of mascaras. Occasionally, eye shadow and mascara products use colophony or rosin, which is a pine-derived ingredient. (Loden and Wessman, 2002; Malik and Claoué, 2012).

**Dyes Effects:**

The use of eyelash and eyebrow dyes containing toluenediamine and para phenylenediamine can lead to the development of hypersensitivity reactions. These reactions may manifest as contact dermatitis, keratoconjunctivitis, and blepharitis. There have been documented cases of severe allergic blepharoconjunctivitis resulting from the use of eyelash color. Eye shadows and mascaras often contain coloring agents that have been linked to contact allergies. Additionally, the pigments used in these products may contain impurities, such as nickel, chromium, and cobalt, which have the potential to cause sensitization (Loden and Wessman, 2002). Certain colors found in cosmetic items have the potential to induce adverse health consequences. The primary mode of human exposure to colors found in cosmetics is through dermal contact, with particular emphasis on regions in proximity to mucous membranes.The utilization of Dye CI 60730, often known as Acid Violet 43, is strictly forbidden in eye goods and cosmetics that are in proximity to mucous membranes. (Wargala et al., 2021).

**Dry Eye Diseases:**

The utilization of eye cosmetics has been identified as a contributing element in the development of Dry Eye Diseases. Dry eye is a complex condition that arises from multiple factors and is characterized by increased tear osmolarity and irritation of the eyes. Ocular-surface hyperosmolarity and inflammation are the primary factors in DED, and they can occur alone or in combination. A variety of cellular and molecular elements, including metalloproteinases, chemokines, cytokines, and their receptors, are involved in the pathophysiology of DED. When there is hyperosmolarity brought on by either excessive water evaporation (EDE) or defective tear secretion (ADDE), an inflammatory cascade and vicious cycle ensue. Both intrinsic (such as ocular diseases and immune-mediated disorders) and extrinsic (such as chemical, environmental, and viral insults) factors can start the process or make it worse (Baudouin et al., 2018). The detrimental effects of eye cosmetics on ocular health are exacerbated by two factors: the proximity of cosmetic application to the eye and the frequency of cosmetic use. Numerous prior investigations have substantiated the higher prevalence of dry eye disease (DED) in women compared to men. This observation may be further associated with the usage of eye cosmetics, as women tend to employ such products with greater frequency. There exists a proposition that eye cosmetics may potentially interact with human meibum, resulting in a reduction in the integrity of the tear film (Ng et al., 2012; Hunter et al., 2015; Albdaya et al., 2022).

**High Levels of Lead:**

In addition to examining cosmetic items utilized in ancient times, contemporary analysis studies have been undertaken to explore the toxicological consequences of modern cosmetic products, including their application methods. Based on the findings of this research, it has been ascertained that cosmetics exhibit elevated concentrations of lead (Al-Saleh et al., 2009; Malakotian et al. 2010; Bouftini et al. 2015; Gouitaa et al. 2016).

The inclusion of copper, brass, gold, or silver powders in eyeshadow powders has the potential to leach out, hence presenting potential challenges for individuals who wear contact lenses. Adverse reactions can be caused by the presence of preservatives and rubber tipped applicators in powdered eyeshadows. Therefore, powdered substances are not appropriate for those with dermatitic skin.

**Meibum Contamination:**

The outermost layer of the tear film is comprised of an intricate combination of lipids that are produced by the meibomian glands. This layer serves the crucial function of preventing the evaporation of tears by forming a continuous lipid surface. There is a suggestion that the migration of cosmetic goods along the border of the eyelid could potentially have a role in the accumulation of debris inside the lipid layer of the tear film, the blockage of meibomian glands, and the contamination of meibum (Prabhasawat et al., 2019).

**Heavy Metal:**

The association between the presence of heavy metals in cosmetic goods and many health disorders has been attributed to the poisonous nature of these metals. Nevertheless, the regulatory authorities of numerous nations have currently prohibited or imposed restrictions on certain hazardous metals. Nevertheless, it is crucial to acknowledge that the acceptable thresholds for these metals may vary across different products and countries. The presence of metallic impurities in cosmetic products is typically evaluated against the established thresholds set by the United States Food & Drug Administration (USFDA). However, the Federal Office of Consumer Protection and Food Safety of Germany (BVL) has recently revised these standards and introduced new limits for the concentration of metals in cosmetic products. In the investigation, it was observed that eye shadow products included detectable amounts of metals, including nickel, cobalt, and chromium. The highest recorded concentrations of nickel and cobalt were found to be 21.71 and 17.64 parts per million (ppm), respectively. The concentration of chromium varied between 8.8 and 33.99 ppm. The maximum concentrations of lead and arsenic were recorded at 6.06 and 0.87 ppm, respectively. Cadmium was not detected in any of the samples. Individuals who suffer from nickel allergy and eyelid dermatitis may exhibit ectopic dermatitis, wherein allergens are transferred to the eyelids from other parts of the body through manual contact. Consequently, these individuals may also develop lesions in areas other than the eyelids.

Based on both experimental and clinical findings, it can be inferred that the movement of these products over the eyelid edge has the potential to disrupt the stability of the tear film’s lipid layer on the ocular surface. Consequently, individuals who use such products may be more susceptible to experiencing symptoms of evaporative dry eye and reduced tear film stability. Nevertheless, clinical investigations have yielded inconsistent results, potentially due to the unavoidable presence of confounding variables, including regular digital manipulation and eyelid hygiene regimes linked to the removal of eye cosmetics (Borowska and Brzóska, 2015).

Despite the prohibition of certain heavy metals in the majority of countries, they may nevertheless be detected as contaminants in cosmetic products. Regarding the minimum levels of heavy metals permitted in cosmetics, no international agreement exists; each nation has its own set of regulations. Different nations establish their own legal limits and concentrations through the use of distinct techniques (Navarro-Tapia et al., 2021).

Cosmetics research is classified into two categories: mandatory and supplementary. Additional examinations consist of clinical, instrumental, and sensory evaluations. Application tests, dermatological tests, stability tests on recipes, and safety assessments of cosmetic products are among the mandatory examinations. The primary objective of a safety assessment of a cosmetic product is to evaluate its composition with respect to both quantity and quality. Investigation into the manufacturing process of pure kohl and the composition of eye cosmetics is necessary. Additional investigations and studies are warranted to find solutions to the prevalent eye problems of the modern era. Formulating cosmetics intended for the eye presents a formulation challenge due to the distinctive characteristics of the epidermis surrounding the eyes and the criticality of ensuring product safety. It is imperative that ocular care professionals have comprehensive understandings regarding the potential detrimental impacts of these products on the ocular surface and ocular system, especially in patients who have a susceptibility to or currently afflicted with ocular surface disease (Ng et al., 2016).

**Conclusion:**

With the transition from natural to artificial modes of existence, humanity has encountered novel obstacles and will continue to confront future difficulties if left unattended. Performing eye treatment is a daily process. Thousands of individuals routinely apply synthetic eye cosmetics. The comparative analysis between pure kohl and synthetic eye cosmetics reveals that pure kohl exhibits superior qualities for eye application.

The potential adverse effects of synthetic eye cosmetics on human health are a matter of concern. The proper utilization of these ocular cosmetics necessitates expert guidance and maintenance. Researchers should also regard this topic as a subject of investigation in order to mitigate any future losses. This review comprehensively addresses several inquiries pertaining to the quality and usage of kohl and synthetic eye cosmetics.

Following an extensive analysis of academic literature, it is clear that the use of kohl and synthetic eye makeup requires cautious thought because of the possible effects on eye health and general wellbeing. Although these products are widely utilised for visual enhancement and have been ingrained in diverse cultural practices, there are considerable issues regarding their composition and consumption patterns. Studies have shown that traditional kohl formulations contain heavy metals like lead, mercury, and antimony, which can be poisonous and have negative health effects if exposed to over an extended period of time (Dutta et al., 2015; Afifi et al., 2016). Furthermore, these dangers are made worse in some areas by a lack of regulatory supervision because unregulated products may include dangerous toxins (Shaikh et al., 2016). Comparably, synthetic eye cosmetics may contain allergens, irritants, and preservatives that cause ocular irritation, allergic reactions, and even infections—despite being thought of as safer options (Thakur & Jain, 2016; Jiwani et al., 2020). Research has shown that using these items can result in conjunctivitis, corneal abrasions, and other eye problems (Chandrasekaran et al., 2017). It is the duty of the producers to guarantee the clinical safety of the chemicals in their formulations, even if regulatory bodies are always checking ingredients. On the other hand, patients and customers should become more informed about recently introduced products, and eye care professionals need to stay informed. More studies on a wider variety of eye cosmetics with long-term exposure and possible combination toxicity will help develop more useful safety standards, especially in light of the items' widespread use (Yazdani et al., 2021).

In conclusion, while kohl and synthetic eye cosmetics offer cosmetic benefits, their usage should be treated with prudence. Products from reliable producers who follow safety regulations and go through extensive testing to ensure they are compatible with ocular health should be given priority by consumers. Furthermore, it is imperative to conduct education and awareness efforts to enlighten people about appropriate application methods, storage precautions, and the possible hazards linked to the use of makeup.

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**References:**

Ababneh, F.A. and Al-Momani, I.F. (2018). Assessments of toxic heavy metals contamination in cosmetic products, *Environmental Forenics*, 19(2), 134-142

Afifi, M., Abbass, A., Nassar, A., Abdel-Wahed, M., & Saad-Hussein, A. (2016). Lead in kohl: a threat to the neonatal and maternal health, *Journal of Environmental Health Science & Engineering*, 14(1), 13

Al-Ashban, R.M., Aslam, M. and Shah, A.H. (2004). Kohl (surma): a toxic traditional eye cosmetic study in Saudi Arabia, *Public Health*, 118(4), 292-298

Albdaya, N.A., Binyousef, F.H., Alrashid, M.H., Alajlan, A.A., Alsharif, F.A., Alfouzan, S.K. and Alhuthail, R.R. (2022). Prevalence of Dry Eye Disease and Its Association With the Frequent Usage of Eye Cosmetics Among Women, *Cureus*

Al-Hazzaa, S.A. and Krahn, P.M. (1995) Kohl: Hazarodous eyeliner, *Internal Ophthalmology,* 19:83–3

Al-Kaff, A., Al-Rajhi, A., Tabbara, K. and El-Kazigi, A. (1993). Kohl-The Traditional Eyeliner: Use and Analysis, *Annals of Saudi Medicine*, 13(1), 26-30

Al-Khawajah, A.M. (1992). AlKohl use in Saudi Arabia. Extent of use and possible lead toxicity, *Trop. Geogr. Med*, 44(4): 373-377

Al-Saleh, I., Al-Enazi, S. and Shenwari, N. (2009). Assessment of lead in cosmetic products, *Regulatory Toxicology and Pharmacology,* 54(2), 105-113

Andalib, S., Rizwani, G.H., Sharif, H. and Arman, M. (2018). Chemical and toxicological studies on different brands of Asmad (Antimony sulphide) available in Pakistan and Saudi Arabia, *Pakistan Journal of Pharmaceutical Sciences,* 2591

Aziz, P.A.A. and Junejo, M.S. (2022). Kohl (Surma) on CT Scan – An Incidental Finding, *Pakistan Armed Forces Medical Journal*, 72(4), 1492–1493

Badeeb, O.M., Radwan, S.A. and Mohammed, H.W. (2008). Kohl al-ethmed, *Journal of King Abdulaziz University-Medical Sciences,* 15(4), 59-67

Baudouin, C., Irkec, M., Messmer, E.M., Benitez-del-Castillo, J.M., Bonini, S., Figueiredo, F.C., Geerling, G., Labetoulle, M., Lemp, M., Rolando, M., Setten, G.V. and Aragona, P. (2018). Clinical impact of inflammation in dry eye disease:proceedings of the ODISSEY group meeting, *Acta Ophthalmologic*a, 96: 111-119

Borowska, S. and Brzóska, M.M. (2015). Metals in cosmetics: Implications for human health, *Journal of Applied Toxicology*, 35(6), 551–572

Bosworth, C.E., Donzel, E.V., Lewis, B. and Pellat, C. (1986). The Encyclopedia of Islam, Prepared under the patronage of the International Union of Academics, 5: 356-357

Bouftini, S., Bahhou, J., Lelievre, B., de la Barca, M.C., Turcant, A., Diquet, B., Abourazzak, B., Chaouki, S., Hida, M., Khattabi, A., Nejjari, C., Amarti, A. and Achour, S. (2015). Screening for Childhood Lead Poisoning in the Industrial Region of Fez, Morocco, *Archives of Environmental Contamination and Toxicology,* 68, 442-450

Buksh, E., Naz, S.A., Zubair, A., Yasmeen, K., Shafique, M., Jabeen, N. and Hamayun, M. (2020). Kohl: A Widely used eye Cosmetic with Hazardous Biochemical Composition, *Biosciences Biotechnology Research Asia*, 17(03), 621–628

Chandrasekaran, S., Kavitha, S., & Gnanavel, G. (2017). Ocular complications of synthetic hair dye poisoning, *Indian Journal of Ophthalmology*, 65(6), 539–541

Draelos, Z.D. (2001). Special considerations in eye cosmetics, *Clinics in dermatology*, 19(4)

Dutta, A. K., Khan, A. K., Islam, M. A., Dey, R. K. and Chowdhury, I. A. (2015). Kohl: a dangerous eye cosmetic, *Malaysian Journal of Medical Sciences: MJMS*, 22(5), 73–75

El-Shafey, E.S.I., and Al-Kitani, B.S.H. (2017). Comparative chemical analysis of some traditional Omani-made kohl, *Toxicological and Environmental Chemistry*, *99*(2), 233–251

Engelbach, R. (1961). Introduction to Egyptian Archaeology with Special Reference to the Egyptian Museum, Cairo, Published by the Ministry of Culture and National Orientation Antiquities Department of Egypt, 343

Fischer, X. (1892). The Ancient Egyptian Eye Preparation, *Arch Pham*, 230: 9

Glanville, S.R.K. (1947). The Legacy of Egypt, Published by Oxford University Press, 123

Gouitaa, H., Bellaouchou, A., Fekhaoui, M., El Abidi, A., Mahnine, N. and Aakame, R.B. (2016). Assessment of lead levels in traditional eye cosmetic “kohl” frequently used in Morocco and Health hazard, *J. Mater. Environ. Sci.,* 7(2), 631-637

Grandjean, P. (1978). Widening perspectives of lead toxicity: A review of health effects of lead exposure in adults, *Environmental research,* 17(2), 303-321

Habib Ullah, P., Mahmood, Z.A., Sualeh, M. and Zoha, S.M.S. (2010). Studies On The Chemical Composition Of Kohl Stone By X-Ray Diffractometer, *Pak. J. Pharm. Sci*, 23(1), 48-52

Hannan, M.A., Aboul-Enien, H.Y., Amer, M.H. and Al-Dakan, A.A. (1987). Classification of Mutagenic and Nonmutagenic Kohl by Using Ames Salmonella Assay, *Annals of Saudi Medicine,* 7(3)

Hardy, A.D., Sutherland, H.H. and Vaishnav, R. (2002). A study of the composition of some eye cosmetics (kohls) used in the United Arab Emirates, *Journal of Ethnopharmacology,* 80(2-3), 137-145

Hardy, A.D., Walton, R. I. and Vaishnay, R. (2004). Composition of eye cosmetics (kohls) used in Cairo, *International Journal of Environmental Health Research*, 14(1), 83–91

Hardy, A.D., Walton, R.I., Vaishnay, R., Myers, K.A., Power, M.R. and Pirri, D. (2006), Egyptian eye cosmetics (“Kohls”): Past and present, *Physical techniques in the study of art, archaeology and cultural heritage*, 173-203

Harris, J. (1962). Ancient Egyptian Materials and Industries (Revised), (through: Bosworth et al., 1986, p.356), 195-199

Heather, C.R. (1981). Art of Arabian Costume – A Saudi Arabian Profile, Information on Kohl application, Arabesque Commercial, Saudi Arabia, 1-188

Hunter, M., Bhola, R., Yappert, M.C., Borchman, D. and Gerlach, D. (2015). Pilot Study of the Influence of Eyeliner Cosmetics on the Molecular Structure of Human Meibum, *Ophthalmic Research*, 53(3), 131-135

Jallad, K.N. and Hedderich, H.G. (2005). Characterization of a hazardous eyeliner (Kohl) by confocal Raman microscopy, *J. Hazard. Mater*, 30: 124(1-3), 236-240

Jiwani, A., Lohiya, S., & Desai, N. (2020). Ocular complications of cosmetic contact lens wear, *Clinical Ophthalmology (Auckland, N.Z.)*, 14, 1719–1726

Jones, A.L., Russell, R. and Ward, R. (2015). Cosmetics alter biologically-based factors of beauty: evidence from facial contrast, *Evol Psychol*., [13](https://doi.org/10.1177/147470491501300113)([1](https://doi.org/10.1177/147470491501300113))

Kadri, R., Achar, A., Tantry, T.P., Parameshwar, D., Kudva, A. and Hegde, S. (2013). Mascara induced milphosis, an etiological evaluation, *International Journal of Trichology*, *5*(3), 144–147

Karbassi, E., Amiri-Ardekani, E., Farsinezhad, A., Shahesmaeili, A., Abhari, Y., Ziaesistani, M., Pouryazdanpanah, N., Derakhshani, A, Jamshidi, F. and Tajadeni, H. (2022). The Efficacy of Kohl (Surma) and Erythromycin in Treatment of Blepharitis: An Open-Label Clinical Trial, *Evidence-Based Complementary and Alternative Medicine,* 6235857

Kaushal, D. (2008). Fashion for your eyes only, The Tribune India, (Online edition), 1-2

Lekouch, N., Sedki, A., Nejmeddine, A. and Gamon, S. (2001). Lead and traditional Moroccan Pharmacopoeia, *Sci. Total Environ*, 3: 280(1-3), 39-43

Lev, E. (2002). Reconstructed material medica of the Medieval and Ottoman Al-sham, *J. Ethnopharmacology*, 80: 167-179

Levey, M and Al-Khaledy, N. (1967). The Medical Formulary of Al-Samarquandi, Published by University of Pennsylvania Press, Pennsylvania, 136

Loden, M. and Wessman, C. (2002). Mascaras may cause irritant contact dermatitis, *International journal of cosmetic science,* 24.5

Mahmood, Z. A., Iqbal A., and Waseemuddin A. S. (2015). Kohl Use in Antiquity: Effects on the Eye, History of Toxicology and Environmental Health Toxicology. *Antiquity II*, 68-78

Mahmood, Z.A., Iqbal, A. and Ahmed, S.W. (2019). Chapter 5 - Kohl Use in Antiquity: Effects on the Eye, *Toxicology in Antiquity,* 93-103

Mahmood, Z.A., Zoha, S.M.S., Usmanghani, K., Hasan, M.M., Ali, O., Jahan, S., Saeed, A., Zaihd, R. and Zubair,M. (2009). Review: Kohl (Surma): Retrospect and Prospect, *Pakistan journal of pharmaceutical sciences*, 22(1), 107-122

Malakotian, M., Mazandarani, M.P. and Hoseini, H. (2010). Lead Levels in Powders of Surma (Kohl) Used in Kerman, *Journal of Kerman University of Medical Sciences,* 17(4), 167-174

Malik, A. and Claoué, C. (2012). Transport and interaction of cosmetic product material within the ocular surface: Beauty and the beastly symptoms of toxic tears, *In* *Contact Lens and Anterior Eye,* 35(6), 247–25

Meri, J.W. (2006). Cosmetic, In: Medieval Islamic Civilization – An Encyclopedia, 1: 177

Mesko, M.F., Novo, D.L.R., Costa, V.C., Henn, A.S. and Flores, E.M.M. (2020). Toxic and potentially toxic elements determination in cosmetics used for make-up: A critical review, *Analytica Chimica Acta,* 1098, 1-26

Monographs of Unani Medicine. (2003). Surma, Hamdard Foundation Pakistan and DC & TMD, National Institute of Health, Islamabad, Pakistan, 1-664

Nadkarni, A.K. (1954). Phimbi Sulphuratum, Indian Materia Medica, II: 87-90

Navarro-Tapia, E., Serra-Delgado, M., Fernández-López, L., Meseguer-Gilabert, M., Falcón, M., Sebastiani, G., Sailer, S., Garcia-Algar, O. and Andreu-Fernández, V. (2021). Toxic elements in traditional kohl-based eye cosmetics in spanish and German markets, *International Journal of Environmental Research and Public Health*, *18*(11)

Nigam, P.K. (2009). Adverse reactions to cosmetics and methods of testing, *Indian J Dermatol Venereol Leprol,* 75:10-19

Nir, A., Tamir, A., Zelnik, N. and Iancu, T.C. (1992). Is eye cosmetic a source of lead poisoning? *Isr. J. Med. Sci*, 28(7): 417-421

Nair, P.K., Garcia, V.M., Hernandez, A.B. and Nair, M.T.S. (1991). Photoaccelerated chemical deposition of PbS thin films: novel applications in decorative coatings and imaging, *J. Phys. D: Appl. Phys*, 24, 1466-1472

Ng, A., Evans, K., North, R. and Purslow, C. (2012). Eye cosmetic usage and associated ocular comfort, *Ophthalmic and Physiological Optics*, 32(6), 501–50

Ng, A., Evans, K., North, R.V., Jones, L. and Purslow, C. (2016). Impact of Eye Cosmetics on the Eye, Adnexa, and Ocular Surface, *Eye & Contact Lens: Science & Clinical Practice,* 42(4), 211-220

O'Donoghue, M.N. (2000). Eye Cosmetics, *Dermatologic Clinics*,18(4),633-663

Pauline, W.T. (2007). Ancient Egyptian costume history, Part 6- Ancient Egyptian make up and cosmetics, [www.fashion-era.com](http://www.fashion-era.com)

Parry, C. and Eaton, J. (1991). Kohl: A lead hazardous eye makeup from the third world to the first world, *Environmental Health Perspectives*, 99, 121-123

Periz, G., Misock, J., Huang, M.C.J., Dewan, K. and Sadrieh, N. (2018). FDA survey of eye area cosmetics for microbiological safety, *Letters in Applied Microbiology*, *67*(1)

Pop, I., Nascu, C. and Lonescu, V. (1997). Structural and optical properties of PbS thin films obtained by chemical deposition, *Thin Solid Films*, 307, 240-244

Prabhasawat, P., Chirapapaisan, C., Chitkornkijsin, C., Pinitpuwadol, W., Saiman, M. and Veeraburinon, A. (2019). Eyeliner Induces Tear Film Instability and Meibomian Gland Dysfunction, *Clinical Sciences*, 39(4), 473-478

Richard, W and Clara, W. (1962). Science and secrets of early medicine, Published by Helen and Kurt Wolff Book Harcourt, Brace & World Inc., New York, 82- 83

Şahin, F. (2020). A ‘kohl box’ from the cilician plain in the frame of the analytical and archaeological evidence, *Mediterranean Archaeology and Archaeometry*, *20*(1), 173–187

Soleymani, S. and Zargaran, A. (2018). Kohl: an ophthalmic dosage form in Persian medicine, *Pharmaceutical Historian,* 48(2), 43-47

Shaikh, B. T., Hatcher, J., & Humayun, Q. (2016). Kohl use in Pakistan: drivers and deterrents, *Public Health*, 140, 26–32

Sullivan, D.A., da Costa, A.X., Del Duca, E., Doll, T., Grupcheva, C.N., Lazreg, S., Liu, S.H., McGee, S.R., Murthy, R., Narang, P., Ng, A., Nistico, S., O’Dell, L., Roos, J., Shen, J. and Markoulli, M. (2023). TFOS Lifestyle: Impact of cosmetics on the ocular surface, *Ocular Surface*, 29, 77–13

Sultan, Z. and Khasawneh, A. (2015). Facial Beauty: A Collection Of Glass Kohl Containers From The North Of Jordan, *Mediterranean Archaeology and Archaeometry,* 15(1), 83-93

Sweha, F. (1982). Kohl along history in medicine and cosmetics, *Hist. Sci. Med*, 17(2), 182-183

Tapsoba, I., Arbault, S., Walter, P. and Amatore, C. (2010). Finding Out Egyptian Gods’ Secret Using Analytical Chemistry: Biomedical Properties of Egyptian Black Makeup Revealed by Amperometry at Single Cells, *Analytical Chemistry*, 82(2), 457-460

Tiffany-Castiglioni, E., Barhoumi, R. and Mouneimne, Y. (2012). Kohl and surma eye cosmetics as significant sources of lead (Pb) exposure, *Journal of Local and Global Health Science,* 2012(1)

Thakur, R., & Jain, N. (2016). Adverse effects of cosmetics and toiletries: a review, Journal of Environmental Pathology, Toxicology and Oncology: Official Organ of the International Society for Environmental Toxicology and Cancer, 35(4), 241–252

Wargala, E., Sławska, M., Zalewska, A. and Toporowska, M. (2021). Health Effects of Dyes, Minerals, and Vitamins Used in Cosmetics, *Women*, 1(4), 223–237

Yazdani, M., Elgstoen, K.B.P. and Utheim, T.P. (2021). Eye Make-up Products and Dry Eye Disease: A Mini Review, *Current Eye Research*, 47(1)

Zaheer, B.H., Mahmood, Z.A. and Zoha, S.M.S. (1991). Therapeutic evaluation of surma (Kohl) formulations, *Pak. J. Sci. Ind. Res*, 34(9), 335-338