Sys Rev Pharm 2023; 14(10): 641-649
A multifaceted review journal in the field of pharmacy
E-ISSN 0976-2779 P-ISSN 0975-8453 / DOI: 10.31858/0975-8453.14.10.641-649

Review Article

Potential Contamination in Cosmetics: A Review

Sonal Akhand, Akash Yadav*, Dinesh Kumar Jain

Department of Pharmacy, Indore Professional Studies (IPS) Academy, College of Pharmacy, Indore, Madhya Pradesh, India

Article History: *Submitted: 25.09.2023* *Accepted: 20.10.2023* *Published: 27.10.2023*

ABSTRACT

The use cosmetics is increasing day by day, from teens to adult all are using cosmetics in their daily life. Though the demand of cosmetics also increasing. As the use of cosmetics is increasing, it is important to know the side effects and awareness regarding cosmetics. The aim of this review is to provide the information about the health risk and the harmful ingredients that are being used in the cosmetics like heavy metals, fragrances, preservatives, chemicals Some chemicals are purposely added or some or some are accidently found during the production. Consumers are advised to be aware of harmful ingredients and the side effects of using cosmetics and personal or skin care products.

Keywords: Cosmetics, Heavy metal impurities, Microbial contamination, Preservatives, Fragrances, Health risk

***Correspondence:** Akash Yadav, Department of Pharmacy, Indore Professional Studies (IPS) Academy, College of Pharmacy, Indore, Madhya Pradesh, India, E-mail: akashyadav@ipsacademy.org

INTRODUCTION

Cosmetics are products designed for personal care, beautification makeup, skin care and fragrances. While these products are generally safe for use, there is a possibility of contamination due to improper manufacturing, storage, or handling process. Contaminants include bacteria, mold or other harmful substances. To mitigate this risk, manufacturers follow strict quality control and regulatory guidelines to ensure product safety. It's important for consumers to be aware of expiration dates, storage instructions, and any adverse reactions to cosmetics. Always check for any changes in color, texture, or smell of the product, as these could indicate potential issues.

The ingredients used in cosmetic and beauty products are biodegradable, which allows bacteria to quickly degrade. When customers use cosmetics, health, beauty and personal care items, they are constantly harming (or 'challenging') the cosmetics or toiletry products with their dirty hands. Examples of these products include mascara, eye shadow, face powder, foundation, lotions, face creams, shampoos, and conditioners. With the addition of an antimicrobial, a product is made unpleasant and harmful for users. Additionally, it is acknowledged that consumer abuse may affect cosmetic items more than pharmaceutical ones. Although extreme abuse cannot be prevented, such as applying eye makeup with saliva or using shampoo in the shower with the cap off, the manufacturer should take abuse into consideration when formulating the product (Geis PA, 2020).

The possibility of undesired elements entering cosmetic goods, such as bacteria, mold, or dangerous chemicals, is known as potential contamination in cosmetics. Consumers could face health risks if products are contaminated during production, packing, storage, or usage. Manufacturers follow stringent quality control procedures, safe storage practices, and ingredient safety evaluations to reduce this danger. The safety of cosmetic items and lowering the risk of contamination depend heavily on routine product testing and adherence to regulatory regulations.

Importance of cosmetic product safety

Industries that manufacture cosmetics and personal care items take their responsibility to people and the environment seriously. Developers collaborate with engineers and scientists to test how the new product responds to light, temperature, and transportation after ingredients are assessed to ensure types their real-world use is safe for consumers and the environment. By doing this, products are more likely to be stable and perform as predicted across their entire duration (Theberge L and Kernaleguen A, 1979).

LITERATURE REVIEW

Types of contamination risk

- **Biological contamination:** The development and spread of biological contaminants is influenced by temperature, relative humidity, nutrition sources and air flow. Arachnids (dust mites), insects (cockroaches or fleas), bacteria, fungi, protozoa are examples of biological pollutants. Yeasts (unicellular creatures that reproduce by budding), molds (multicellular animals made up of long strands of cells known as the hyphen that produce spores), and other higher-level fungi (such as mushrooms) can all be classified as subcategories of fungi. Biological contamination can occur through improper handling, inadequate cooking, poor hygiene practices, and contaminated water sources (Seltzer JM, 1974).
- **Chemical contamination:** Chemical contamination is a term used to describe circumstances in which chemicals are present in places they shouldn't be or at greater concentrations than they would have naturally occurred. Both organic and inorganic compounds that are chemical contaminants can be discovered in mass-produced goods that practically everyone uses on a daily basis (https://niwa.co.nz). These include waste from land fill and incineration, as well as plastics, resins, medicines, deodorants, deodorizers, detergents, petroleum products, road runoff, pesticides and herbicides. Insecticides, veterinary medications, cleaning products, sanitizers, paint, oil, fuel, or excessive food additives are examples of man-made chemicals (Song YH, *et al.*, 2020; EFSA, 2023).
- **Environment contamination:** Compounds that are frequently released into the air, water, or soil due to industrial or agricultural activity. They can also enter into the cosmetics and skin care products. Environment contaminants such as Polychlorinated Biphenyls (PCBs), dioxins, persistent chlorinated pesticides, and brominates flame retardants but also metals such as arsenic, cadmium, lead and mercury. In environmental chemistry, the term "contamination" is sometimes almost synonymous with "pollution," where the major concern is the harm done on a broad scale to people, species, or habitats. A biological (pathogenic bacteria, viruses, invading species), physical (energy), or chemical agent can all constitute environmental contaminants (Vallero DA, 2010).

- **Radiological contamination:** According to the International Atomic Energy Agency (IAEA), radioactive contamination, also known as radiological pollution, is the unintended or undesirable presence of radioactive substances on surfaces or in objects that are solids, liquids, or gases such as the human body. Different factors can lead to radioactive contamination. It might happen as a result of radioactive gases, liquids, or particles being released. As an example, if a radionuclide used in nuclear medicine leaks (accidentally or, as in the case of the Goiânia accident, due to ignorance), the substance could be dispersed by individuals as they move around.
- **Cross contamination:** When bacteria or other microbes accidentally move from one thing to another, it is known as cross-contamination. The staff, clients, surfaces, and equipment inside the beauty salon are just a few of the places where germs, bacteria, and pathogens can be found. Therefore, it is obvious that there is a significant risk of contamination (Aydın S, *et al.*, 2021; Pinon A, *et al.*, 2007; Rope BL, 2002).

Sources of contamination

- **Raw materials:** Potential sources of contamination can include the raw materials utilized in manufacturing. It is not essential for raw materials used in cosmetics to be sterile. Therefore, careful handling is necessary to lower the chances of microbial growth in the materials and avoid the introduction of microorganism. For example, because fats, waxes, and refined oils do not have enough water to enable microbial growth, they only contain a small number of organisms. Natural material like gums and herbs are subjected to ambient contamination and aqueous processing which causes a wide range of yeast, molds and bacteria to extensively contaminate them. *Aloe vera* and various thixotropic substances, such as qatarized clays, are some of the raw material in cosmetics sector that are more likely to be contaminated with *Bacillus* spores.
- **Equipment:** Organisms that build up in the manufacturing facility as a result of improper or insufficient cleaning can readily contaminate the product during production. It might be challenging to adequately clean the equipment with coupling, pipes and pumps that are unreachable. Accessible grooves and dead ends should be avoided whenever it's possible in all things that come in contact with the substance and equipment should be made to make cleaning and disinfecting simple.
- **Packaging material:** Cleaning and sanitizing filling equipment is crucial since most items are exposed to additional contamination while being filled into containers. Containers and closures need to be microbiologically clean and dust free. The quality of cosmetic product is greatly influenced by packaging. It has power to create or break your safety procedures. Identifying and removing external dangers is the first step in protecting the product within.
- **Storage:** Cosmetic contamination can occur when cosmetics are improperly stored, exposing them to factors like air, moisture, heat, and light. This can lead to bacterial growth, degradation of ingredients, changes in texture, color, odor, and potentially cause skin reactions. To prevent this, store cosmetic in cool, dry places away from direct sunlight, close containers tightly, and avoid introducing water into products. Regularly check for changes in appearance, smell, or texture, and discard anything suspicious.
- **Manufacturing process:** Contamination in cosmetics can also arise during the manufacturing process. Improper handling of raw materials, inadequate sanitation practices, or insufficient quality control can lead to the presence of harmful microorganisms or foreign substances in the final products. Cosmetics manufacturing should follow Good Manufacturing Practices (GMP) to ensure cleanliness, proper equipment sterilization, and quality checks to minimize the risk of contamination during production. Regular testing and monitoring can help detect and prevent issues before products reach consumer.

Types of contamination

- **Microbial contaminants:** Cosmetics might contain microbes, due to impurity of raw only alter physical properties of the product such as color, odor and viscosity, but also deactivate crucial constituents depriving cosmetics of its features (Osungunna MO, *et al.*, 2010; Yorgancioglu A and Bayramoglu EE, 2013).

  Microbial contamination may produce endotoxins and metabolites causing irritation and allergic reaction of the skin. They can be pathogens causing hazard to the human health. Microorganism can survive in environments that fulfill their physical and chemical requirements for proliferation and further development. Most important physical requirement includes suitable temperature and pH of the environment (Lundov MD, *et al.*, 2009, Budecka A and Kunicka-Styczyńska A, 2014).

  Cosmetics can develop microbial contamination in two ways-during production or storage in container and during consumer usage. The maker must first take action to stop microbiological contamination in order to ensure that the product is of the required quality and that consumer safety is maintained. Consumers are responsible for maintaining the safety of the product while it is in use, such as by adhering to the recommendation of the safe storage. A health risk could result if cosmetic cream has bacteria in them through the manufacturing process or from improper handling. A variety of harmful bacteria discovered in cosmetics have been isolated from researchers (Becks VE, *et al.*, 1995). Show the variety and presence of the isolated bacteria and fungus in the skin and eye cosmetics purchased from beauty salons individually. The percentages of bacteria and fungi in the isolates were 9.2% (95% CI=5.1%-16.1%) and 90.8% (95% CI=83.9%-94.9%), respectively. Additionally, of the isolated bacteria, 51.5% (95% CI=41.8%-61.1%) belonged to the gram-negative category, while the remaining bacteria were gram-positive. The three most common bacteria found in skin cosmetics were *Streptococcus* spp., *Acinetobacter*, and *Pseudomonas* spp. The only isolated yeasts and fungus were *Penicillium*, *Rhodotorula*, and *Candida*. Additionally, *Escherichia coli*, *Bacillus* spp., and *Staphylococcus* spp. were isolated from the skin cosmetics. The most typical bacteria from in-use eye cosmetics were *Streptococcus* spp., *Pseudomonas* spp., and *Acinetobacter*. The only isolated yeasts were *Rhodotorula* and *Candida*. Additionally, the eye cosmetics contained isolated *Bacillus* spp., *Staphylococcus* spp., *Escherichia coli, Salmonella, Klebsiella,* and *Citrobacter* (Dadashi L and Dehghanzadeh R, 2016).

  The majority of the bacteria that were identified from the skin and eye cosmetic products in use belonged to the *Streptococcus* species. *Penicillium* (6% of the fungus isolated from skin powders in use) was unquestionably the most prevalent fungi genus, followed by *Rhodotorula* (6%) and *Candida* (3%) in that order. Additionally, the two most often isolated fungus from the mascara and eyeliner in use was *Rhodotorula* (12%) and *Candida* (4%). Furthermore, the skin powders that were currently in use had the greatest diversity of fungi. According to the isolated bacteria from the skin cosmetics in use, *Streptococcus* (32%), *Pseudomonas* (23%), *Acinetobacter* (19%), *Bacillus Streptococcus* (25%) and *Pseudomonas* (24%) dominated among the in-use eye beauty products, with *Acinetobacter* and *Staphylococcus* (10% each), *Bacillus* and *E. coli* (8% each), *Salmonella* and *Klebsiella* (4% each), and *Citrobacter* (2%), following in decreasing order. (11%), *Staphylococcus* (6%) and *E. coli* (4%), were the most prevalent bacteria (Mislivec PB, *et al.*, 1993) (*Figures 1, 2* and *Table 1*).

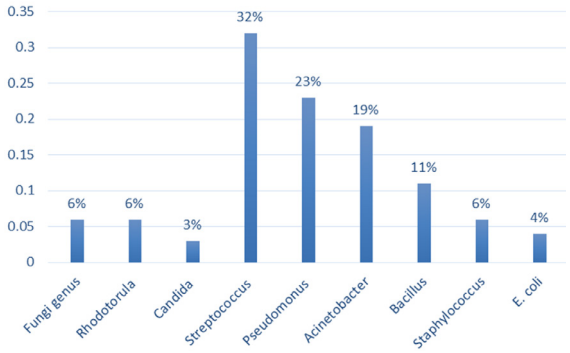

Figure 1: Microbial contamination in the skin cosmetics

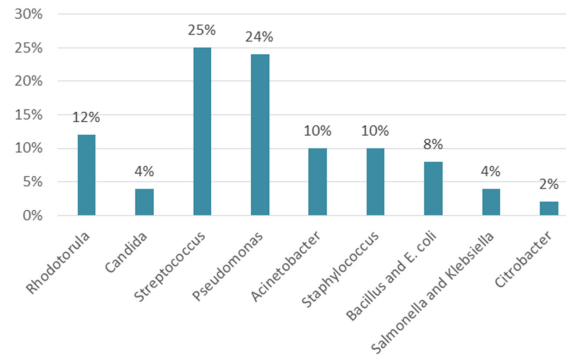

Figure 2: Microbial contamination in eye cosmetics

Table 1: Microbial counts and association between contamination by bacteria and fungi in shared cosmetics available in beauty salons or parlors

Microorganism	Powder	Cream	Mascara	Eyeliner	P value
Bacteria					
Acinetobacter	300	350	320	NC	0.255
Escherichia	NC			850	0.008
Bacillus	NC	230	320	500	0.802
Pseudonymous	208	195	180	125	576
Staphylococcus	960	544	410	144	0.518
Streptococci	NC	23	440	684	0.324
Klebsiella			21		0.233
Citrobactor			12		0.552
Salmonella			32		0.233
Alcanigenes			20		0.383
Fungi					
Candida			30		0.662
Rhodotorula	200		126	115	0.131
Penicillium	3.5				0.1

- **Chemical contaminants:** Unintentionally included compounds in cosmetics are known as chemical contaminants. These compounds may be found in cosmetics as a result of different manufacturing, processing, or transportation phases. Environmental contamination may potentially be the cause. Chemical constituent is also harmful for humans and animals. Chemical contaminants may be combining with cosmetics. These include:

  Insecticides, pesticides, veterinary medications, cleaning products, sanitizers, paint, oil, fuel, or excessive food additives are some examples of man-made chemicals. The atmosphere naturally contains heavy metals including cadmium, lead, mercury, tin, and arsenic, and when larger animals eat smaller ones, they can bioaccumulation in cosmetics. These metals may also contaminate by leaching containers, fragrance, preservatives, or industrial waste on cosmetics growing areas.

  These contaminants can pose risk to human health when absorbed through the skin or ingested. It's important to choose reputable brands and products that adhere to safety regulations and undergo rigorous testing to minimize such risks. If you're concerned about specific ingredients, it's a good idea to research and consult with dermatologist and experts in the field.

- **Heavy metals contamination:** In finishing product, heavy metals can occur as contaminants. It is either an environmental pollutant of raw ingredients or a result of the breakdown of ingredients during the manufacturing process of cosmetics. Due to the prevalence of these chemicals, heavy metal impurities are thought to be impossible to avoid in cosmetic goods, however they should be eliminated whenever technically feasible. In several countries including Canada, heavy metals like mercury, cadmium, lead, thallium, selenium, and arsenic have been forbidden as ingredients in cosmetics. Heavy metals like arsenic, cadmium, lead, mercury, beryllium, selenium, and thallium have been outlawed as intended elements in cosmetics in various nations, including Canada (Zulaikha S, 2015).

  Despite being prohibited, it is still present in cosmetic products because, under acceptable manufacturing practice settings, trace amounts of this element are impossible to exclude. Because of its purpose, some heavy metal was inserted.

  For instance, the key ingredients in press powder for eye shadow are talc with colors and zinc or magnesium stearate used as a binder. Powders made of copper, aluminum, brass, gold, or silver produce a metallic brilliant finish. Copper, lead, cadmium is among the heavy metals that are kept as impurities in eye shadow pigments or released by metallic equipment used in product manufacturing (Unsal V, 2018).

  Cobalt, a skin allergen that causes Allergic Contact Dermatitis (ACD), is more commonly found in shampoos than in relaxers and conditioners (Shah MP, *et al.*, 2017). Hindu religious and cultural rites use a correcting powder called sindoor, which contains dangerous amount of lead (Fischer A, *et al.*, 2017). Henna, a common plant dye used for temporary tattoos and hair coloring, is thought to contain high levels of metals like lead and mercury (Alissa EM and Ferns GA, 2011). Within a year and half after getting a tattoo, those who have red pigment from mercury sulfur (cinnabar-vermilion, Chinese red) may experience localized irritation (Saadatzadeh A, *et al.*, 2019). The plant used most frequently in Poland herbal cosmetics nettle, yarrow and horsetail. Arsenic, lead, mercury, cobalt, antimony, chromium, nickel and cadmium are particularly dangerous heavy metals contaminants and are not permitted to be used on purpose in cosmetics in EU or the USA (Gondal MA, *et al.*, 2012). The most significant elements in talcum powder samples are Pb and Cr. Although the use of titanium in sunscreen is restricted, some formulations also contain additional heavy metals that are not permitted (Capelli C, *et al.*, 2014; Schwalfenberg G, *et al.*, 2018). Eye shadow, blushes and concealer often have iron oxide as coloring agent. In lip glosses, lipsticks and nail polishes several aluminum compounds serve as colorants. Sunscreen, toothpaste, antiperspirant also contain aluminum (Amasa W, *et al.*, 2012).

- **Preservatives:** A large numbers of chemicals are added to cosmetics products as preservatives and scents to extend their shelf lives and give them pleasing scent and appearance for costumers. Preservatives are chemical substances applied to cosmetics to stop the growth of microbes (Roden K, 2010). This is the common name for biocides. To prevent consumer contamination while a product is being used, they are meant to be applied to clean products. They are not intended to make up for sloppy production hygiene or the use of contaminated raw materials, and they shouldn't be used to clean up contaminated objects. The most widely used preservatives in cosmetics, particularly in cream-based products, are parabens (Sanchez-Prado L, *et al.*, 2011). Although cosmetic including water are vulnerable to microbial contamination, crams are essentially an emulsion of water and oil (Zhang Q, *et al.*, 2005). The antimicrobial compound paraben stops microorganism from growing in cosmetic creams. Parabens and other types of preservatives together provide potent antimicrobial activity against a wide range of microorganism (Tahiraj D, 2015). Parabens do not create coloring or hardness or mudding in the cosmetic's composition because they are fundamentally neutral, tasteless and odorless (Travassos AR, *et al.*, 2011). They also have low toxicity, good stability and non-volatility. Formaldehyde releasing chemicals frequently discovered in shampoo and other rinse off cosmetics. The term 'formaldehyde releasers' refers to chemicals that releases formaldehyde by hydrolysis in the presence of water (Nardelli A, *et al.*, 2011) (*Table 2*).

Table 2: Preservatives found in cosmetics and other skin care products in study

Preservatives used	Products
Benzalkonium chloride	Bath gel
Benzyl alcohol	Cosmetics
Benzylparaben	Creams
Bronopol	Deodorant
Butylatedhydroxytoluene	Face cream
Butylparaben	Hair conditioners
Chlorphenesin	Lipsticks
Ethyl benzoate	Lotions
Formaldehyde	Moisturizing creams
Formic acid	Oil based lotions
Imidazolidinyl urea	Baby products
Idopropynylbutylcarbmate	Shampoos
Isobutylparaben	Shower gels
Kathon CG	Skin creams
Methylchloroisothiazolineone	Sunscreen
Methyloldimethyhyndantoin	Water based lotions
Methylparabens	Wet tissues
Dimethyloldimethyl hydantoin	Liquid soaps
Chlorhexidinedigluconate	Hand soaps

- **Fragrances:** chemicals used in perfumes are the most common skin sensitizers in beauty products (Christensson JB, *et al.*, 2010). Organic compounds with attractive scents act as the basis of fragrance and the flavor components. They are frequently found in detergents, fabric softeners and other home goods, perfumes and other fragranced cosmetic products (Matura M, *et al.*, 2002). In order to cover up unwanted smells from raw materials, fragrances are utilized. Hexylcinnamal, butlyphenylmethyl propional, limonene, and linalool are some examples of some fragrances found in cosmetics products. One of the most common fragrances used in cosmetic formulations is limonene followed by linalool (Buckley DA, 2007). Both of this aroma are included in a wide variety of beauty products including shampoos, conditioners and shower gels, lotions, rinse off creams and shower gels. A terpene that occurs naturally and found in high concentrations in many different plants is linalool. However, when exposed to air, pure linolool autoxidizes and the oxidation products might lead to contact allergies. One of the least expensive fragrance ingredients is limonene, which is utilized extensively in household goods (Talagas M and Misery L, 2019). During handling and storage, this material produces allergies oxidation products. When limonene is exposed to the air for an extended period of time at room temperature and oxidized to produce allergenic compounds, its risk for exposure increases (*Figures 3-5* and *Table 3*).

Figure 3: Cosmetic contamination due to preservatives (formaldehyde releasers)

Figure 4: Cosmetic microbiological purity testing in laboratory

Figure 5: Contaminated creams

Table 3: Fragrances used in cosmetic products (Evernia prunastri)

Fragrances used	Products
Benzyl benzoate	Deodorant (roll on)
Farnesol	Mouthwashes
Hexzyl cinammal	Powder
Hedione	Perfumes
Linalool	Toothpaste
Methyleugenol	Sprays
Butyl phenyl methyl propional	Fabric conditioner
Geraniol	Massage oils
Citral	Hand creams
Citronellol	Hand soaps
Anise alcohol	Baby creams, lotions, gels
Benzyl acetate	Baby wipes
Benzyl cinnamate	Detergent
Chloroatranol	Foundations
Atranol	Baby oils
Evernia furfuracea	Lipstick
Evernia prunastri	Moisturizing creams
Evernia prunastri extract	Moisturizing lotions
Lilial	Sunscreen
Linalyl acetate	Baby toys cosmetic product
Isoeugenol	Soaps

Effects of common heavy metals present in cosmetics

Mercury (Hg): One of the heavy metals that is frequently included in cosmetic formulas. Mercury is thick, lustrous liquid that can also be found in variety of inorganic and organic compounds. In skin lightening qualities in its inorganic form such as ammoniated mercury, while its organic forms such as phenyl and ethyl mercuric salts are used as preservatives in mascara and eye removal treatment. Hg enters the body through the skin through sweat glands and hair follicles. A portion of Hg is converted during this process to the metallic form, which build up in the skin tissue. Hg is used in skin lightening cosmetics or lotions or other skin lightening

products because it inhibits the melanin forming enzyme *in situ* by blocking tyrosinase. By studies we can tell that, in most cosmetics, Hg is one of the more rarely found heavy metals but not in skin lightening products. In comparison to the items intended only for cosmetic purpose, Mercury is purposefully present in the face and skin care products.

Hg can lead to variety of systemic system such as nausea, vomiting, and kidney damage as well as effects on Central Nervous System (CNS), such as irritability, tremors, weakness, irritation, exhaustion and memory loss. In addition, the sensory system including hearing, vision loss, and taste may be affected. Lastly, high Hg content can be dangerous and may leads to the death. After cutaneous absorption and systemic uptake, Hg may occasionally cause autoimmune glomerulonephritis.

Cadmium (Cd): One metal that has been used for cosmetics is cadmium, whose colored salts range from bright yellow to orange. It has been linked to a number of toxicities in people, mostly due to its absorption following topical application of a number of cosmetics, despite the fact that this is relatively low (0.5%). On the skin, it might result in irritating dermatitis. In fundamental worry with Cd is that tends to concentrate in human tissue and then discharge slowly into the systemic circulation. Usually it attaches to keratin. It primarily affects the skeletal, respiratory, metabolic, reproductive and renal system on a systemic level. Also, it accelerates the ageing process of skin by causing oxidative stress. Despite being present in cosmetics, it can also be found in variety of other products, including batteries, agrochemicals (pesticides and fertilizer) and industrial waste. The allowed limit for Cd is 0.06 mg/l. The oral intake for Cd for dietary supplement is 0.09 gm/kg to 3 ppm, according to United States Pharmacopeia (USP). The European Union bans the use of Cadmium and its salt in cosmetic product. For Cd, health Canada specified a limit of 3 ppm in beauty products.

Another element, Cadmium, is forbidden by some authorities but it is nonetheless present in some cosmetics, according to many researchers. While eye shadow may include deep yellow to orange pigment in lipstick, some researchers have indicated that Cd concentration of eye shadow does not suppress 3 ppm. However, eye shadows were discovered to have levels is 8.89 ppm and 55.59 ppm. Eyebrow pencil had maximum Cd value of 1.12 ppm, whereas mascara had reported Cd content of 0.034 ppm. They also have been reported of other facial cosmetics having Cd levels less than 0.96 ppm. The makeup foundation reported to have the highest levels which were 17 ppm. Similarly, Cd concentration in face washes and face creams were below 0.67 ppm to 0.37 ppm, respectively. In general, body cosmetic has Cd levels below 2.13 ppm, 0.12 ppm for sunscreen and 0.92 ppm for skin lightening creams. Body washes and lotions contained no cadmium. Most toothpaste did not contain more Cd than 0.058 ppm yet a maximum of 2.49 ppm was found.

Despite being one of the most prevalent and dangerous heavy metal, it appears that Cd is only occasionally used in cosmetics. It is possible to draw the conclusion that Cd is used as coloring agent but is actually considered to be contaminant in cosmetics.

Lead (Pb): Lead is heavy metal that has attracted the most research. Instead of being exploited for its potential properties, lead is typically seen as a pollutant that has negative impact on human health. Consumers who use eye cosmetics have been shown to have blood levels of Pb that are times greater than non-consumers. The establishment of Pb acceptable limits is a constant battle for authorities around the world. The FDA set a maximum permitted level of 10 ppm for Pb for color additives used in the production of cosmetics in accordance with Good Manufacturing Practices (GMP). However, the Pb concentration in color additives should not be above 20 ppm. In the EU, no cosmetic product may contain lead or it's salt. Lead in beauty products has 10 ppm limit set by health Canada. Other eye product within the FDA's 20 ppm limit includes eyebrow pencil (0.109-18.60 ppm) and mascaras (ND-12.51 ppm).

Lead is recognized as a pollutant that can be detected in various quantities in different in different cosmetic preparations. The use of Pb in cosmetics is restricted by several authorities who identify it as dangerous metal.

Lead is neurotoxic, nephrotoxic and hepatotoxic when it comes in contact with important organs and it can also have effects on reproductive system. Through the placenta, lead may affect the development of the fetus. It is thought to have potential cause human cancer, according to certain research. A 10 ppm limit was set by the World Health Organization (WHO).

Arsenic (As): A metalloid that is significant environmental pollutant and is prevalent everywhere is Arsenic. Beyond the legally permitted cosmetics that are sold in the market, As contamination is a problem. It has been discovered in significant amount in cosmetics from gray market. The FDA set a limit for As (in the range of 3 ppm) for lead acetate, as a colorant, adulterated with this metalloid, similar to what it did for Hg. In the EU, no cosmetic product may contain arsenic or its salt. An old eye makeup called kohl is still in use nowadays. There are claims that falsely suggest that kohl can be used to treat eye diseases, therefore its use as a cosmetic is not the only reason it poses a risk. In addition to eyeliner, other face cosmetics like foundation and lotions also include As. According to study, kohl contained a worrisome amount of As (810-1630 ppm). Aside from eyeliner, which contains a small amount of arsenic, other cosmetics like foundation and creams also do, which amount as high as 1.0 and 0.171 ppm, respectively. Face paints are one of the less popular cosmetics, in China, opera actors used them frequently. As concentration can go upto 25 ppm. Low As concentrations (0.71 ppm) are present in hair care products like shampoo, conditioners and colors. According to study, As content of cleansers and sunscreen is less than 0.010 ppm, however body lotions have been discovered to have larger levels (1.543 ppm). The As level in some toothpaste was 26.94 ppm.

Concerning prolonged dermal exposure, As may result in keratosis and hyperpigmentation locally, but systemically, it may also include vascular disorder and cancer. One of the elements that is infrequently used in cosmetics is As. But its presence may be a cause of concern, especially for long term users of legal products and in illegal cosmetic sold in the black market.

Nickel (Ni): One of the metal contaminants invariably present in many natural components used in cosmetics products is Nickel. Since the majority of Ni containing salts is green, they might also be used as colorant. Nickel can be found naturally occurring in volcanic dust and soil. The amount of nickel in products needs to be monitored because of the occurrence of potential skin sensitivity. Limits of 5 ppm and 1 ppm were advised for specific home goods and detergents. Rarely did the majority of products research by examined team have nickel level oral intake lower than 0.20 ppm. Consumers regularly use these items because lipstick only lasts for a short time on the lips. If consumed, this could cause more aggravation. Nickel allergy cannot be regarded as primary risk factor in patients reporting eyelid dermatitis, despite the fact that Ni in mascaras and eye shadows has been implicated in its role in allergic chronic dermatitis. Less than 1 ppm of nickel present in the majority of 'nickel-free' items in the market. In the EU, it is forbidden to use nickel and any of its salt in cosmetics.

However, Ni is regarded as contact allergen that causes dermatitis, allergy and sensitization through direct and frequently extended exposure. Due to ingredients popularity jewelry and topical cosmetic items, some people have been diagnosed with Ni allergies. In addition to affect the respiratory system, Ni may cause lung and nose cancer. Cosmetic may be used in order to maintain skin look young, but the Ni, they may cause oxidative stress and speeding up ageing process. This might be caused by skin's excess collagenases, which weakens the skin matrix and reduces its elasticity. Metallic nickel is categorized by International Agencies for Research Cancer (IARC) as a probable human carcinogen (Group 2B), its compounds are categorized as carcinogenic (Group 1).

Some chemicals in cosmetics that effects on health and environmental risk

- **Dibutyl Phthalate (DPB):** DPB is primarily used in nail products as a dye solvent and plasticizers to keep nail polish from hardening and becoming easily available. It has been observed that it causes sperm count reduction, prostate and testicular alteration and development problems. Due to the interference with hormone function, potential injury to the unborn child, and worsening of infertility, it has also been labeled as a suspected endocrine disruptor. Furthermore, Health Canada states that prolonged consumption of phthalate containing items can result in health problems such as liver, kidney failure in young children. In addition to numerous negative health effects, exposure to phthalates during pregnancy has been related to lower sperm counts in males and reproductive abnormalities in the growing male fetus.
- **Parabens:** The most widely used preservatives in cosmetics are paraben. Parabens are found in cosmetics in between 70 and 90 percent of cases, usually in extremely small amounts. Easily absorbed through the skin, paraben is thought to disturb the body's hormonal balance (endocrine disruption). They have the ability to mimic the main female sex hormone, oestrogen. They also may affect a male's ability to reproduce. Studies show that methylparaben applied to the skin aging. Although a synthetic preparation made from petrochemicals is used in cosmetics, parabens can be found in small amounts naturally in some foods such as barely, strawberries, carrots, onions, currents and vanilla.

  When consumed food's embedded paraben degrade, become less highly estrogenic. In contrast, paraben used in cosmetics avoid the metabolic process and enter the body stream and body organs unchanged when applied to the skin and taken up by the body. According to estimates, paraben exposure in women is 50mg per day from cosmetics. They have a negative impact on health, including neurotoxicity and cancer.
- **Petrolatum:** In many moisturizers, petroleum jelly acts as a barrier to keep moisture in the skin. It makes the hair luster and is found in hair care products. It also goes by the name mineral oil jelly. PAH often known as polycyclic aromatic hydrocarbons, can pollute petroleum. According to studies, skin contact with PAH over an extended length of time and other form of exposure have been linked to the cancer. Because of this, European Union limits the use of petroleum in cosmetics and classifies it as carcinogen. Allergies and skin irritability may also be brought on by PAHs in petroleum.
- **Polyethylene Glycols (PEGs):** Petroleum based substances known as Polyethylene Glycols (PEGs) are frequently used in creams as thickening agents, solvents, softeners and moisture-carriers. PEG may have detectable levels of 1,4-dioxane contamination depending on the production methods. It states that 1,4 dioxane has been suspended of causing cancer. It is difficult to decay and could stay in the environment for a long period of time after being flushed down the shower drain. PEGs have some genotoxic potential, and when applied to the damaged skin, they can irritate the area and be toxic to the body as a whole.
- **Diethanolamine (Cocamide DEA and Lauramide DEA):** Related substances to Diethanolamine (DEA) are used to make cosmetics sudsy or creamy as pH adjuster to decrease the acidity of other components. Shampoos, soaps and cleansers all include them. Nitrosamines are produced when DEA combines with nitrites found in cosmetics, nitrites can occasionally be found as impurities or are introduced as anticorrosive agents to products. When product is exposed to air, some compounds are employed as preservatives in cosmetics may deteriorate and emit nitrites. High dosages of DEA related chemicals have been demonstrated to cause thyroid and skin cancers as well as malignancies in clinical trials. These substances can also irritate the skin and eye to mild to moderate degrees. Because of its acute toxicity to aquatic creatures and ability to bioaccumulate, DEA is regarded as being environmentally harmful.
- **Siloxanes:** These silicon-based ingredients soften, smooth or hydrate skin care items in cosmetics. They enhance the drying process for hair products and ease the application of deodorant creams. They primarily utilized in face treatments and moisturizers. Both cyclopentasiloxane and cyclotetrasiloxane are poisonous, persistent chemicals that could bioaccumulate in aquatic species. Cyclotetrasiloxane is act as an endocrine disruptor because it interferes with the way human hormones functions and may be hazardous to reproduction, which could reduce human fertility.

Health risks

- **Allergic reactions:** Cosmetics especially leave on product, come in contact with the skin in close contact for extend period of time and many cause allergic responses (Richters R, *et al.*, 2015). People with sensitive skin have less tolerance for the use of cosmetics and more likely to experience a variety of symptoms including tightness, burning, tingling, discomfort, pruritus, and stinging, and being diagnosed with allergic reactions. Limonene, on the other hand, has one of the lowest consumption rates of any allergens (Martins MS, *et al.*, 2022). The majority of these substances were combined in the formulations of goods where they were used, resulting in the combination of allergens that could have synergistic effects and raise the risk of sensitization. Although they frequently found in cosmetic goods, fragrances are the most common source of allergic contact dermatitis. There are constantly new allergens emerging, and the cosmetovigillance system's case notification and reports from dermatologist immunoalergologists are typically used to identify them (Sun M, 1981; Moennich JN, *et al.*, 2009) (*Figure 6*).

Figure 6: Allergic contact dermatitis caused by contaminated cosmetic products

- **Carcinogenicity:** Some products like keratin hair straighteners purposefully include formaldehyde (Jacob SE and Breithaupt A, 2009). Formaldehyde-releasing preservatives are widely used in personal care products like eye shadow, mascara, nail polish, shampoo and blush to prevent bacterial growth (Fedinick KP, *et al.*, 2021). To serve as a preservatives FRP are made to release formaldehyde gradually and continuously over time (Joshua H and Hillebrand E, 2010). For-

maldehyde is classified as human carcinogen, by IARC, the National Toxicology Program (NTP) and California EPA's Preposition 65 (Prop 65) (Moennich JN, *et al.*, 2009). Formaldehyde is classified as EPA as a potential human carcinogen. Japanese cosmetics regulations restrict the use of formaldehyde, and European commission limits the amount of formaldehyde to no more than 5% in the product (CSC, 2023; Jimbow K, *et al.*, 1974).

- **Depigmentation:** By reducing the skin's production of melanin pigment hydroquinone is used topically in human medicine to lighten skin and lighten its color (CEC, 1976; Attard T and Attard E, 2022). Because hydroquinone lightens the skin by lowering melanin, it also increases the skin exposure to UV rays, raising the risk of skin cancer from UV exposure. It does not have the same tendency to lead to dermatitis as metals do. According to the directive, this use is prohibited in various nations including those that are members of European Union (JN O, *et al.*, 2015).

CONCLUSION

In conclusion, many chemicals are added to the products for cosmetic purposes. These components facilitate and development of complicated compositions that improve human life through disease prevention, health maintenance, beauty enhancement, and self-esteem building. The cosmetic industry is regulated, although only the most basic laws are in place. Consumers should play a part in the industries continued development and related organization ongoing reviews of the beauty chemicals and products and chemicals by remaining knowledgeable and aware of the ingredients present in the items or personal care product they use.

Ensuring the safety of cosmetics and preventing potential contamination is crucial to protect consumer's health. Regular quality checks, adherence to industry regulation, proper storage, and production hygiene are essential to mitigate the risk of contamination.

Consumer awareness and education also play a pivotal role in making informed choices about cosmetic product. Cosmetic items may not be necessarily be connected with a major health risk, especially when considering potential long-term impact given that the products may be extensively over an extended period of time. Ingredients that are either known to pose health hazards or whose safety is uncertain may be found in cosmetics and skincare products. Many cosmetics, especially hair colors and shampoos, may include substances that are known or suspected to cause cancer in humans. Once more, a lot of these products might have substances that increase penetration into the skin.

REFERENCES

1. Geis PA. Cosmetic microbiology: A practical approach. CRC Press. 2020.
2. Theberge L, Kernaleguen A. Importance of cosmetics related to aspects of the self. Percept Mot Skills. 1979; 48(3): 827-830.
3. Seltzer JM. Biological contaminants. J Allergy Clin Immunol. 1994; 94(2): 318-326.
4. Song YH, Yu HQ, Tan YC, Lv W, Fang DH, Liu D. Similarity matching of food safety incidents in China: Aspects of rapid emergency response and food safety. Food Control. 2020; 115: 107275.
5. EFSA. Chemical Contaminants in food and feed. European Union Food Safety and Authority. 2023.
6. Vallero DA. Environmental contaminants: Assessment and control. Elsevier. 2010.
7. Aydın S, Aksoy A, Ceylan H. Hygiene habits and infection risks of hairdressers and beauty salons employees during applications in different anatomic regions. Ann Med Res. 2021; 27(9): 2396-2403.
8. Pinon A, Alexandre V, Cupferman S, Crozier A, Vialette M. Growth, survival and inactivation of *Pseudomonas aeruginosa* and *Staphylococcus aureus* strains of various origin in the presence of ethanol. Int J Cosmet Sci. 2007; 29(2): 111-119.
9. Rope BL. Conquering contamination. Global Cosmetic Industry. 2002; 170(1): 40-43.
10. Osungunna MO, Oluremi BB, Adetuyi A. Bacteriological and antibiotic sensitivity patterns of bacterial isolates from creams and lotions hawked in Sagamu, Ogun State. Pak J Nutr. 2010; 9: 773-775.
11. Yorgancioglu A, Bayramoglu EE. Production of cosmetic purpose collagen containing antimicrobial emulsion with certain essential oils. Ind Crops Prod. 2013; 44: 378-382.
12. Lundov MD, Moesby L, Zachariae C, Johansen JD. Contamination versus preservation of cosmetics: A review on legislation, usage, infections, and contact allergy. Contact Dermatitis. 2009; 60(2): 70-78.
13. Budecka A, Kunicka-Styczyńska A. Microbiological contaminants in cosmetics-isolation and characterization. Biotechnol Food Sci. 2014; 78(1): 15-23.
14. Becks VE, Lorenzoni NM. *Pseudomonas aeruginosa* outbreak in a neonatal intensive care unit: A possible link to contaminated hand lotion. Am J Infect Control. 1995; 23(6): 396-398.
15. Dadashi L, Dehghanzadeh R. Investigating incidence of bacterial and fungal contamination in shared cosmetic kits available in the women beauty salons. Health Promot Perspect. 2016; 6(3): 159.
16. Mislivec PB, Bandler R, Allen G. Incidence of fungi in shared-use cosmetics available to the public. J AOAC Int. 1993;76(2):430-6.
17. Zulaikha S. Hazardous ingredients in cosmetics and personal care products and health concern: A review. J. Public Health Res. 2015; 5: 7.
18. Unsal V. Natural phytotherapeutic antioxidants in the treatment of mercury intoxication-a review. Adv Pharm Bull. 2018; 8(3): 365.
19. Shah MP, Shendell DG, Strickland PO, Bogden JD, Kemp FW, Halperin W. Lead content of sindoor, a Hindu religious powder and cosmetic: New Jersey and India, 2014-2015. Am J Public Health. 2017; 107(10): 1630-1632.
20. Fischer A, Brodziak-Dopierała B, Loska K, Stojko J. The assessment of toxic metals in plants used in cosmetics and cosmetology. Int J Environ Res Public Health. 2017; 14(10): 1280.
21. Alissa EM, Ferns GA. Heavy metal poisoning and cardiovascular disease. J Toxicol. 2011;2011.
22. Saadatzadeh A, Afzalan S, Zadehdabagh R, Tishezan L, Najafi N, Seyedtabib M, *et al.* Determination of heavy metals (lead, cadmium, arsenic, and mercury) in authorized and unauthorized cosmetics. Cutan Ocul Toxicol. 2019; 38(3): 207-211.
23. Gondal MA, Dastageer MA, Naqvi AA, Isab AA, Maganda YW. Detection of toxic metals (lead and chromium) in talcum powder using laser induced breakdown spectroscopy. Appl Opt. 2012; 51(30): 7395-7401.
24. Capelli C, Foppiano D, Venturelli G, Carlini E, Magi E, Ianni C. Determination of arsenic, cadmium, cobalt, chromium, nickel, and lead in cosmetic face-powders: Optimization of extraction and validation. Anal Lett. 2014; 47(7): 1201-1209.
25. Schwalfenberg G, Rodushkin I, Genuis SJ. Heavy metal contamination of prenatal vitamins. Toxicol Rep. 2018; 5: 390-395.
26. Amasa W, Santiago D, Mekonen S, Ambelu A. Are cosmetics used in developing countries safe? Use and dermal irritation of body care products in Jimma Town, Southwestern Ethiopia. J Toxicol. 2012.

27. Roden K. Preservatives in personal care products. Microbiol Aust. 2010; 31(4): 195-197.
28. Sanchez-Prado L, Alvarez-Rivera G, Lamas JP, Lores M, Garcia-Jares C, Llompart M. Analysis of multi-class preservatives in leave-on and rinse-off cosmetics by matrix solid-phase dispersion. Anal Bioanal Chem. 2011; 401: 3293-3304.
29. Zhang Q, Lian M, Liu L, Cui H. High-performance liquid chromatographic assay of parabens in wash-off cosmetic products and foods using chemiluminescence detection. Anal Chim Acta. 2005; 537(1-2): 31-39.
30. Tahiraj D. Dermatoses due to cleaning and cosmetic products. Journal of the Association-Institute for English Language and American Studies. 2015; 4(6): 78-83.
31. Travassos AR, Claes L, Boey L, Drieghe J, Goossens A. Non-fragrance allergens in specific cosmetic products. Contact Dermatitis. 2011; 65(5): 276-285.
32. Nardelli A, Drieghe J, Claes L, Boey L, Goossens A. Fragrance allergens in 'specific' cosmetic products. Contact Dermatitis. 2011; 64(4): 212-219.
33. Christensson JB, Matura M, Gruvberger B, Bruze M, Karlberg AT. Linalool-a significant contact sensitizer after air exposure. Contact Dermatitis. 2010; 62(1): 32-41.
34. Matura M, Goossens A, Bordalo O, Garcia-Bravo B, Magnussona K, Wrangsjö K, *et al.* Oxidized citrus oil (R-limonene): A frequent skin sensitizer in Europe. J Am Acad Dermatol. 2002; 47(5): 709-714.
35. Buckley DA. Fragrance ingredient labelling in products on sale in the UK. Br J Dermatol. 2007; 157(2): 295-300.
36. Talagas M, Misery L. Role of keratinocytes in sensitive skin. Front Med. 2019; 6: 108.
37. Richters R, Falcone D, Uzunbajakava N, Verkruysse W, van Erp P, van de Kerkhof P. What is sensitive skin? A systematic literature review of objective measurements. Skin Pharmacol Physiol. 2015; 28(2): 75-83.
38. Martins MS, Ferreira MS, Almeida IF, Sousa E. Occurrence of allergens in cosmetics for sensitive skin. Cosmetics. 2022; 9(2): 32.
39. Sun M. Study shows formaldehyde is carcinogenic. Science. 1981; 213(4513): 1232.
40. Moennich JN, Hanna DM, Jacob SE. Formaldehyde-releasing preservative in baby and cosmetic products: Health risks related to exposure during infancy. J Dermatol Nurses Assoc. 2009; 1(3): 211-214.
41. Jacob SE, Breithaupt A. Environmental exposures-a pediatric perspective on allergic contact dermatitis. Skin Aging. 2009; 17(7): 28-36.
42. Fedinick KP, Yiliqi I, Lam Y, Lennett D, Singla V, Rotkin-Ellman M, *et al.* A cumulative framework for identifying overburdened populations under the toxic substances control act: Formaldehyde case study. Int J Environ Res Public Health. 2021; 18(11): 6002.
43. Joshua H, Hillebrand E. Determination of free formaldehyde in cosmetic preservatives and surfactants by HPLC with postcolumn derivatization. Am Lab. 2010; 42(8): 14-15.
44. CSC. Carcinogens in cosmetics. Campaign for safe cosmetics. 2023.
45. Jimbow K, Obata H, Pathak MA, Fitzpatrick TB. Mechanism of depigmentation by hydroquinone. J Invest Dermatol. 1974; 62(4): 436-449.
46. CEC. Council directive of 27 July 1976 on the approximation of the laws of the Member States relating to cosmetic products. The Council of the European Communities. 1976.
47. Attard T, Attard E. Heavy metals in cosmetics. Environmental Impact and Remediation of Heavy Metals. 2022.
48. JN O, Udebuani AC, Ezeji EU, Obasi KO, Nnoli MC. Possible health implications associated with cosmetics: A review. Science. 2015; 3(5-1): 58-63.