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Review Article

Forensic Importance of Cosmetics and Cosmeceuticals

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Abstract

The branch of science which deals with the study of cosmetics is known as *cosmetology*. Women love wearing makeup, as they feel it can help them enhance their beauty and make them feel and look more attractive and gorgeous. Further, according to Locard's Principle of Exchange, "every contact leaves a trace". Many of the violent crimes such as assaults, robberies, rapes and murders involve direct contact between the assailant and a female victim. Well known examples of some trace or associative evidences are hair, fibers, paint chips, broken glass fragments, soil particles, etc. Thus, a transfer of some type of cosmetic product is possible and, consequently, the clothing or body of the suspect may bear smeared traces of a cosmetic. The analysis of these smudges can provide circumstantial evidence connecting a suspect and victim or placing a suspect at the crime scene. This review is an effort for enlisting of various cosmetics and cosmeceuticals which may helpful in solving crimes against women.

Keywords: cosmetics, cosmeceuticals, forensic investigation, chemical evidences

Introduction

The use of cosmetics is worldwide and dates from the remotest antiquity. People of all ages are aware of their appearance and give a lot of attention on grooming their looks. Cosmetics is a general term applied to all preparations which are intended to be applied externally to beautify and condition the body by cleaning, coloring, softening or protecting the skin, nail, hair, lips or eyes. *"The branch of science which deals with the study of cosmetics is known as cosmetology." As per Oxford Dictionary,* a cosmetic is defined as "a preparation applied to the body, especially the face, to improve its application. The range covers everything from the latest cosmetics to skin and hair care".

According to *Drugs and Cosmetic Act, 1940* cosmetic means "any article intended to be rubbed, poured, sprinkled, or sprayed on, or introduced into, or otherwise applicable to, the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, and includes any article intended for use as a component of cosmetic".

Different Kinds of Cosmetics

Women love wearing makeup, as they feel it can help them enhance their beauty and make them feel and look more attractive and gorgeous. While some cosmetics are useful for making the skin feel soft, healthy and flawless, others assist in adding color to the skin, thereby giving the appearance of good health and youth. Some different types of cosmetics are given below:

Solutions

The simplest kind of cosmetics, solution cosmetic

is a homogeneous mixture of soluble ingredients. These are prepared by simply filling the containers with main diluent (usually water) and mixing with the other ingredients to create the resultant cosmetic product. Examples: shampoos, body wash, hand cleansers, mascaras, eye liners, colognes, and so on.

Creams/Emulsions

Most of the cosmetics contain raw materials that are not compatible. Hence, creams or emulsions are preferred. These are pseudo stable mixtures of immiscible liquids dispersed in another liquid. Creams and emulsions are prepared by combining three formula components, such as oil phase, aqueous phase and an emulsifier. Examples: cosmetics like hand moisturizers, make up, hair conditioners, sunscreens, etc.

Lotions

Lotions are less greasy and lighter counterparts of creams that come in handy for applications, wherein creams cannot be used. Lotions are basically thin creams that undergo the same production procedure as that of creams. Moreover, they can easily be applied without worrying about them getting thick as opposed to emulsions that get thick on cooling down. Examples: facial moisturizers, leave-in hair conditioners and moisturizing cleansers.

Suspensions

Suspensions are cosmetics that are used for overcoming incompatible ingredients. Similar to creams, suspensions are clear solutions containing visible particles, such as gelatin beads or inorganic minerals, spread throughout. Examples: sunscreens, hand washes and shampoos are some such examples.

Ointments/Pastes

Ointments or pastes are extremely thick products used for dressing hair and cleaning skin. They are, generally, anhydrous (contain no water), sticky and greasy.

Powders

Powders are the most common and popular form of cosmetic products. They are an amalgamation of solid raw materials which are ground together to get a fine powder. Examples: products like baby powder, eye powder, foot powder, talcum powder, etc.

Gels

Gels are thick, clear products characterized by a property known as "shear thinning". Examples: hair products, body washes, shaving products and toothpastes.

Sticks

Sticks enter the cosmetic product list when consumers look out for cosmetics that they would not want to touch, say, lipstick or underarm deodorant.

Tablets & Capsules

Color cosmetics are generally found in the form of cakes, tablets or capsules. The solid ingredients are blended well with one another and pressed to get the desired shape. Examples: compact powder, eye shadow, cheek shadow cakes, etc.

Generally Available Cosmetics in Market

Cosmetic products have a history covering thousands of years with the use of many ingredients from plants, animals and mineral sources. Generally available cosmetic products in market are:

(a) Oral care products include toothpaste, toothpowder and mouthwash.

(b) Hair care products include shampoos, conditioners, serums, hair oils and sprays.

(c) Skin care products include lotions, moisturizers, sunscreens, cold creams, cleansers, face wash.

(d) Lip care products include lipsticks, lip gloss, lip balms, lip liners.

(e) Other miscellaneous products include nail lacquers, nail removers, kohl, anti-perspirants, etc.

But, once the product claims venture into diagnosis, treatment, prevention of any disease, the product is considered to be a '*DRUG*'. Therefore, products can be both cosmetic as well as drug if it fulfills the intended use.

Now-a-days a new term is gaining much more importance in the field of cosmetology i.e. '*COSMECEUTICALS*'. These are cosmetic products with biologically active ingredients purporting to have medical or drug-like benefits.

Cosmeceutical is a pragmatic term that enables us to state without pretense the benefits of a product. The FD & C Act, 1938 defines cosmetic by its intended use, meaning cleansing, beautifying, promoting attractiveness or altering appearance. Products in this

category include lipsticks, perfumes, skin moisturizers, nail polish, shampoos, deodorants, and other beautifying products.

Although there is no legal class called cosmeceuticals and the designated products stand at the border line of cosmetics and drugs. The cosmeceutical label applies only to products which are used topically, such as creams, lotions, and ointments.

Types of Cosmeceuticals

On the basis of active ingredients present, cosmeceuticals are:

A. *Antioxidants*: prevent risk of sun damage to skin.

B. *Peptide*: stimulates the production of collagen and thickens the skin.

Growth Factors–chemical messengers between cells playing a key role in cell division, blood vessel growth as well as in production and distribution of collagen and elastin.

C. *Combination Product:* includes multiple antioxidants, retinol plus antioxidants, growth factors plus vitamin C or other unique combinations.

An Industrial Overview of Cosmetics in India

The cosmetic and personal care industry has been growing at an average rate of about 15% for the last few years. This is mainly accounted from low and medium priced category products, comprises of about 90% of cosmetic market, in terms of volume.

The rising demands for cosmetic products, particularly in urban population owes to numerous reasons like mall culture, better purchasing power, awareness towards looking better, by both men and women, nature of occupation, development in advertisement technology (thanks to celebrities and people of glamour world !!) and in whole, availability of wide range of cosmetic products- from head to toe. In general, India is a very price sensitive market (Nanda *et al,* 2005).

Indian Standards

According to BIS (Bureau of Indian Standards), all the products shall meet the requirements pertaining to safety, quality and performance. These standards can be utilized in their forensic detection and identification. Table 1 describes the list of products with their IS code number.

Table 1: List of Products with their IS Code Number

S.No.	Items	Is Code No.
1.	Skin Powder	IS 3959:1978
2.	Skin Powder For Infant	IS 5399:1978
3.	Tooth Powder	IS 5383:1978
4.	Tooth Paste	IS 6356:1993
5.	Skin Cream	IS 6608:1978
6.	Hair Oil	IS 7123:1978
7.	Shampoo Soap Based	IS 7669:1990
8.	Shampoo Synthetic Detergent Based	IS 7884:1992
9.	Hair Cream	IS 7679:1978
10.	Oxidation Hair Dye Liquid	IS 8481:1993
11.	Cologne	IS 8482:1997
12.	Nail Polish (Nail Enamel)	IS 9245:1993
13.	After Shave Lotion	IS 9255:1979
14.	Pomades And Brilliantines	IS 9339:1988
15.	Depliatories Chemicals	IS 9636:1988
16.	Shaving Cream	IS 9740:1981
17.	Cosmetic Pencil	IS 9832:1981
18.	Lip Stick	IS 9875:1990

Chemicals Commonly Used in Cosmetics

Now-a-days, cosmetics are made from a range of ingredients which are deemed to be industrial chemicals. Industrial chemicals may be either synthetic chemicals or naturally occurring chemicals.

Alcohol – isopropyl alcohol

Isopropyl alcohol, also known as isopropanol, is an alcohol that evaporates quickly. Isopropyl alcohol is a widely used ingredient in cosmetics and personal care products and can be found in products such as aftershave lotions, bath products, eye makeup, other makeup products, cleansing products, as well as nail, hair and skin care products.

Cetyl alcohol

Extracted from coconut oil, it is an emollient that is included in skin care products to stabilize the formulations or to alter their consistencies, or to increase their foaming capacity. It is often included in baby lotions, hand creams, foundation, lipsticks, shampoos, mascara, deodorants, nail polish removers etc.

Stearyl alcohol

Stearyl alcohol is also derived from coconut oil. Because it is an emollient as well as an emulsifier, it can be substituted for cetyl alcohol to firm skin care formulations. It is mostly found in creams, lubricants, depilatories and conditioners.

Cetearyl alcohol

Cetearyl alcohol is an emulsifying wax that is used to soften thick formulas like skin ointments. Derived from natural oils and fats, it is very efficient in stabilizing skin care formulations because it imparts an emollient feel to the skin. It can be used in water-in-oil emulsions, oil-in-water emulsions and anhydrous formulations. Cetearyl alcohol is widely used in cleansers, permanent hair color, face creams, eye make-up and sunblocks.

Ammonium lauryl sulfate

Ammonium lauryl sulfate (ALS) is an anionic surfactant used in cosmetics such as cleansing agents, hair shampoos, bubble baths and hair bleaches.

Butylated hydroxytoluene

Butylated hydroxytoluene (BHT) is used as an antioxidant in food, animal feed and cosmetics. Primarily acts as an antioxidant food additive because of its ability to preserve fats. In cosmetics, it is also used as a preservative. As an antioxidant, it helps fight against the deterioration of cosmetic products caused by chemical reactions with oxygen. It is mostly used in makeup products such as eyeliner, lipstick, blush and foundation, but you can also find it in various other cosmetic products like moisturizer, cleanser and perfume.

Triethanolamine, Diethanolamine & Monoethanolamine

Triethanolamine, diethanolamine and ethanolamine are clear, colorless, viscous liquids with ammonia-like odors. In cosmetics and personal care products, triethanolamine is used in makeup products such as eyeliners, mascara, eye shadows, blushers, make-up bases and foundations, as well as in fragrances, hair care products, hair dyes, wave sets, shaving products, sunscreens, and skin care and skin cleansing products. Diethanolamine and ethanolamine are used mostly in permanent waves and hair dyes and colors.

Ethoxylated Surfactants–PEG

1, 4-dioxane is produced in trace amounts as an unwanted by-product in the manufacture of ethoxylated substances (for example, as impurity in PEG). Polyethylene glycols (PEGs) and their anionic or nonionic derivatives are widely used in cosmetics as surfactants, cleansing agents, emulsifiers, skin conditioners, and humectants. Exposure to trace amounts of 1,4-dioxane can potentially occur when using products that contain ethoxylated substances such as detergents, cosmetics, toiletries, etc.

Formaldehyde

Formaldehyde is a colorless, flammable gas often used in cosmetics. It is most commonly used as a water solution called formalin, rather than in its pure form. With the help of preservatives, formaldehyde is released in small amounts over time to help protect cosmetic products against contamination by bacteria during storage and during continued use. Formaldehyde can be found in nail polishes, nail hardeners, eyelash glues, hair gels, soaps, makeup, shampoos, lotions, and deodorants, among other products.

Imidazolidinyl urea

Imidazolidinyl urea is an odorless white powder. In cosmetics and personal care products, Imidazolidinyl urea can be found in many product types including lotions, creams, hair conditioners, shampoos and deodorants.

Lanolin

Lanolin is an ointment-like material isolated from

wool that is sheared from sheep. Lanolin can be separated into lanolin oil, a liquid phase, and lanolin wax a solid phase. Heating Lanolin with water produces a mixture of organic acids (lanolin acid) and a mixture of organic alcohols (lanolin alcohol). Lanolin and its related ingredients are widely used in the formulation of cosmetics and personal care products. These ingredients can be found in baby products, skin care, shaving, manicuring, hair care, suntan and sunscreen products, as well as eye, lip and facial makeup.

Lead

Lead is a bluish-gray, heavy metal that occurs naturally in the Earth's crust and is present in trace amount in the environment, in numerous foods and in some natural products. Lead can be present in nearly all things we use and consume on a daily basis, including food and cosmetics. The toxicity of lead compounds is mostly related to the lead portion in the compound.

Mercury

Mercury is a common ingredient found in skin lightening soaps and creams. It is also found in other cosmetics, such as eye makeup cleansing products and mascara. Mercury salts inhibit the formation of melanin, resulting in a lighter skin tone. Mercury in cosmetics exists in two forms: inorganic and organic. Inorganic mercury (e.g. ammoniated mercury) is used in skin lightening soaps and creams. Organic mercury compounds (thiomersal [ethyl mercury] and phenyl mercuric salts) are used as cosmetic preservatives in eye makeup cleansing products and mascara.

Mineral oil/waxes – including liquidum paraffinum, paraffin oil, paraffin wax

White mineral oil is a mixture of liquid hydrocarbons, essentially paraffinic and naphthenic in nature. It is obtained from petroleum, and is intensively refined following several steps including atmospheric and vacuum distillation, removal of aromatic and unsaturated compounds, de waxing and further processing. Some petroleum oil derivatives may contain polycyclic aromatic hydrocarbons, some of which are known to be carcinogens. Only the highest purity medicinal-grade white mineral oil, with extremely low levels of harmful hydrocarbons, is used in cosmetics.

Oxybenzone

Oxybenzone (also called "benzophenone-33 or "BP-33) is an organic compound used as an ingredient in sunscreens because it absorbs UVB and UVA rays. The ingredient easily dissolves into lotions and creams. Oxybenzone is also used in lip balms, lipstick, moisturizers, anti-aging creams, conditioners, and fragrances.

Paraben preservatives: methyl, propyl, butyl, and ethyl

Paraben preservatives are widely used in makeup, moisturizers, shampoos and conditioners, and shaving products but they have hormone-like activities. Parabens are chemicals that slow down the growth of mold in personal care products, pharmaceuticals, and foods.

Phthalates: diethylphthalate (DEP) and dimethylphthalate (DMP)

Phthalates are a group of chemicals that are used predominantly as solvents and plasticisers (plastic softeners) in both industrial and consumer products. There are many phthalate chemicals in use worldwide.

Propylene/butylene glycol

Propylene glycol is widely used as a food additive and in pharmaceutical preparations.

Sodium lauryl sulfate

Sodium lauryl sulfate (SLS) is a widely used surfactant. In cosmetics and personal care products, sodium lauryl sulfate is used primarily in shampoos, bath products, hair colorings, facial makeup, deodorants, perfumes, and shaving preparations, but can also be found in other product formulations. Sodium lauryl sulfate cleans the skin and hair by helping water to mix with oil and dirt so that they can be rinsed away.

Toluene

Toluene is a clear liquid with an aromatic odor. In cosmetics and personal care products, the use of toluene is limited to nail products. Toluene is used as a solvent to dissolve other substances, such as resins and plasticizers, used in the formulation of nail products.

Apart from the above mentioned chemicals, some more chemicals and their approximate concentrations are given in Table 2. These chemicals can be chemically analyzed in cosmetic products for evidential value.

Table 2: List of Chemicals Commonly Used in Cosmetic Products

S/No.	Substance	Max. Concentration
1	Chlorates of Alkali Metal	5%
2	H_2O_2	0.1% H_2O_2 Present or Release
3	Ammonium Monofluorophosphate	0.15% Calculated as "F" when mixed with other Fluorine compound, Total F Conc. must not exceed 0.15%
4	Sodium Monofluorophosphate	0.15%
5	Potassium Monofluorophosphate	0.15%
6	Calcium Monofluorophosphate	0.15%
7	Calcium Fluoride	0.15%
8	Potassium Fluoride	0.15%
9	Sodium Fluoride	0.15%
10	Ammonium Fluoride	0.15%
11	Magnissium Afluoride	0.15%
12	Aluminium Fluoride	0.15%
13	Stannous Fluoride	0.15%
14	Hexadecyl Ammonium Fluorode	0.15%
15	3-(N-Hexadecyl-N-2hydroxyethyammonia) Propybis (2-Hydroxyethyl) Ammonia Dihydrofluoride	0.15%
16	Nn'n'-Tris(Polyethylene)-N-Hexadepropylene Diamine Dihydrofluoride	0.15%
17	Octadecenyl-Ammonium Fluoride	0.15%
18	Sodium Fluorosilicate	0.15%
19	Potassium Fluorosilicate	0.15%
20	Ammonium Fluorosilicate	0.15%
21	Magnesium Fluorosilicate	0.15%
22	6 Methylcoumarin	0.03%
23	Nicomethanol Hydrofluoride	0.15%
24	Strontium Chloride Hexahydrate	3.5%
25	Strontium Acetate Hemihydrate	3.5%

Importance of Cosmetics and Cosmeceuticals in Forensic Investigations

With a population of over 1 billion people in India, the cosmetic and personal care industry has been growing at an average rate of about 15% for the last few years. The present article is a brief overview of cosmetics, differences between cosmetics and cosmeceuticals, and they can be utilized in forensic detection and identification.

Further, according to Locard's Principle of Exchange, "every contact leaves a trace", many of the violent crimes such as assaults, robberies, rapes and murders involve direct contact between the assailant and a female victim. Well known examples of some trace or associative evidences are hair, fibers, paint chips, broken glass fragments, soil particles, etc. Thus, a transfer of some type of cosmetic product is possible and, consequently, the clothing or body of the suspect may bear smeared traces of a cosmetic. The analysis of these smudges could provide circumstantial evidence connecting a suspect and victim or placing a suspect at the crime scene.

Forensic scientists are assigned the task to examine the physical evidence with a range of analytical techniques to potentially identify trace amounts of evidence. Analysis of cosmetic traces from crime scenes can be used to establish physical contact between two individuals, such as a victim and a suspect, or to place an individual at a crime scene. The majority of techniques which are employed in forensic investigations of cosmetics are Gas Chromatography and Fourier Transform Infrared

Spectroscopy. Current cosmetics are mass produced by a range of manufacturers, and each manufacturer lists generic ingredients on the packaging, which are common amongst all their competitors. Some of these generic ingredients include organic dyes, inorganic pigments, oils, minerals, waxes and emollients. However the quantitative composition which each manufacturer uses, usually vary. Analysis of cosmetic products, therefore require a multivariate approach. Forensic scientists use cosmetics as evidence in solving crimes. Here are some examples:

Lipstick prints

By comparing the composition of a lipstick smear with that of a victim, forensic scientists can demonstrate indirect proof of contact or a relationship between victim and suspect. Also, it is sometimes possible to extract saliva DNA from the print.

Foundation smears

Like lipstick smears, make-up foundation can easily be transferred to clothing or other surfaces just through contact. Forensic scientists can discriminate between different types by using FTIR, SEM-EDX and GC-FID analysis.

Shampoo identifications

Although it is thought to be a myth that your hair gets "used to" a certain shampoo, there is some evidence that components from your shampoo will accumulate in your hair. Using HPLC, forensic scientists have found that they can determine the type of shampoo that may have been used on a hair sample.

Hair bleach interference

Forensic scientists can use hair to determine whether a person has been taking illicit drugs. They analyze samples using GC-MS and can detect codeine, morphine, cocaine, and opiates.

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