

# USE OF NATURAL PIGMENTS AS COLORANTS IN COSMETICS – A REVIEW

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## ABSTRACT:

Color plays a vital role in marketing any product such as cosmetics, food additives, pharmaceutical products etc., It gives the attractiveness for a product. Color also helps to get the attention of the customers. Early days synthetic dyes were used as colorants in these products. The carcinogenic effect and the toxic effect of the synthetic dyes made the impact and thirst on the use of natural dyes. Natural dyes are obtained from the pigments produced by the microorganisms and the phytochemicals produced by the plants. Animal pigments are rarely used as colorants. The synthetic colorants in cosmetic industry is now replaced by the natural pigments. The colors obtained from the natural sources possess various properties like anti-cancer and so on. Some of the phytochemicals such as anthocyanins are used as colorant and also as antioxidant. Hence the natural colorants are used as a nutritional one and also it maintains in improving the health.

**Index Terms:** phytochemicals, pigments, synthetic dyes, carcinogenic, antioxidant, anti-cancer, Vitamin A.

## INTRODUCTION:

The use of colors in cosmetics was began at prehistoric times. In early days like 3000 BC, men used colors for the attention and also to attract the animals and made the hunting process in easier way (Rohit Kumar Bijauliya et al., 2017). The history of cosmetics was started from the period of hunting, fighting and later it is associated with Medicine. In Europe Dying process was the first method which use various dyes as colorants. Then the use of natural pigments as colorants was observed at China nearly in 2600 BC (Visalakshi. M et al., 2013). The use of natural colorants in India was observed in the Indus Valley Civilization. Even some of the natural pigments used as colorants was observed in the 4<sup>th</sup> century. Natural sources like Henna and Saffron which are used for colorants were used before 2500 BC (Kumar Sumit et al., 2012). In later days synthetic dyes were used. The use of blue indigoid dyes as colorants was started in 7<sup>th</sup> century. Various Analytical methods was performed for the ingredients and the colorants used in cosmetics according to European Regulation in 2009 which was reviewed in 2016. The synthetic dyes used in the cosmetics were reported in the International journals between the year 2008 and 2018. Some of the anionic dyes which were a class of clotting effects. In modern days the herbal cosmetics has a wide range of application and various impact like healing, smoothing, appearance and conditioning etc (Talal Aburjai et al., 2003).

Cosmetics is originated from a Greek word “Kosm tikos” which means having the power, arrange, skill in decorating (Rohit Kumar Bijauliya et al., 2017). Colors plays an important role in the cosmetics which attracts the customer and gets their attention. Colors plays a vital role in marketing any products such as cosmetics, textiles, food products etc. Cosmetics, now a days has become a major part in women’s life (Fathima. A et al., 2011). In a Day to Day life of women, they use number of cosmetics which includes Lipstick, Nail Lacquer (Vipin K.V et al., 2014), (Mitchell. I et al., 1980), Hair dyes, perfumes, skin care products and so on. Among these products, some products use colorants in them. Now a days, applying tattoo in skin has become one of the trends among teenagers which also uses various dyes and colors (Krishna Vamshi Allam et al., 2011).

The colors used in cosmetics are mostly synthetic colors or dyes. Some of the widely used synthetic dyes in cosmetics are azo dyes, xanthone, quinoline, Indigoid etc. Later the carcinogenic and toxic effect of the synthetic dyes were found (Visalakshi. M et al., 2013). Among these various synthetic dyes, azo dyes are found to be more dangerous and these types of azo dyes are banned in Germany in 1996. It is also found that synthetic dyes are not ecofriendly. There are several problems associated with synthetic dyes. Hence, people started to use cosmetics made with Natural pigments (Eugenia Guerra et al., 2018).

Due to health and Environmental consciousness most of the people prefer to use natural dyes. Natural dyes are biodegradable and easy to prepare. The thirst for natural colorants in cosmetic products is increasing now a days. Natural colors are the pigments produced by biological sources such as Microbes, Plant and Animals. These natural pigments are ecofriendly, non-toxic, non-carcinogenic etc. (Talal Aburjai et al., 2003), Most of these natural pigments are soluble in water, whereas the synthetic dyes are mostly soluble in oil or other solvents. As these natural pigments are ecofriendly, they have a wide variety of applications in food industry, textile industry, pharmaceutical industry and also in cosmetics. Hence in the present review, it discusses about the synthetic dyes and the problems faced due to synthetic dyes and also the natural pigments which acts as an alternate for the synthetic dyes in cosmetics (Visalakshi. M et al., 2013).

## **SYNTHETIC COLORANTS:**

Synthetic dyes are manufactured from the chemicals such as petroleum by products and earth minerals. These synthetic dyes are also known as ‘coal tar dyes’, hence they are obtained from coal tar. Synthetic dyes were first discovered in the year 1856. These synthetic dyes have low production costs, much brighter color and are long lasting. Synthetic dyes are more stable than the natural pigments (Simone Aparecida da Fanca et al., 2015). They are highly stable towards light, heat and also hydroxyl ion concentration. There are five major classes of synthetic dyes, they are azo dyes, xanthenes, triarylmethane, quinoline and indigoid (Eugenia Guerra et al., 2018).

## **COLOUR INDEX OF SYNTHETIC DYES:**

Azo dyes are commonly used in the cosmetics because of their low production costs, long lasting color etc., They are the derivatives of aromatic amines which has azo group as chromophore. The best example for the azo dyes is tartrazine which has the Color Index (CI) of 19140 (Captain-Vallvey L.F et al., 1997). Xanthenes

are a class of synthetic dyes which are widely used in the cosmetics. They are well known for the shades of red color. The well-known example for xanthone dyes is Acid Red 92 with the Color Index (CI) of 45410 (Eugenia Guerra et al., 2018). Triarylmethane comes under the category of synthetic dyes. The best example for triarylmethane is Brilliant Blue and the CI is 42090. The widely used quinoline type of synthetic dye is Quinoline Yellow which has the Color Index (CI) of 47005. Indigoid is also a type of synthetic dyes. The best example for Indigoid dyes is Indigotine and the CI is 73015 (Captain-Vallvey L.F et al., 1997).

## SYNTHETIC DYES IN COSMETICS:

Most of the cosmetics products uses colorants in them. There are approximately 54 synthetic dyes are available out these 54 dyes 38 dyes were used in cosmetics and among these 38 dyes 7 seven were azo dyes. Azo dyes are mostly used in cosmetics because of their bright red color. Colorants used in cosmetics vary based on the different products. Colorants are used for both lip care and hair care cosmetics products (Eugenia Guerra et al., 2018). **Lip care products:** azo dyes have brighter red color so they are used in manufacturing of lip care products such as lip gloss, lip stick, lip lacquer, etc. Xanthoness, triarylmethane, quinoline are also used in manufacturing lip care products (Captain-Vallvey L.F et al., 1997). **Hair care products:** quinoline and indigoid are mostly used in manufacturing hair care products such as hair spray, hair dye. Azo dyes are also used in manufacturing of hair care products like shampoo (Madhusudhan Rao. Y et al., 2008), (Simone Aparecida da Fanca et al., 2015), (Eugenia Guerra et al., 2018).

## PROBLEMS ASSOCIATED WITH SYNTHETIC DYES:

Synthetic dyes which are used in cosmetics have been reported for various health problems. Azo dyes which are the major class of synthetic dyes interact with the intestinal bacteria, liver cells and also the skin microflora. These dyes cause various mutagenic, genotoxic and carcinogenic effects. These azo dyes are also responsible for various types of skin problems (Bruna de Campos Ventura-Camargo et al., 2013), (Shrabana Sarkar et al., 2017). Various records have been given for the triarylmethane dyes which indicates that, this triarylmethane when taken through cosmetic products directly enters into the blood stream and causes various kinds of illness (Herbert Levitan et al., 1977). Xanthoness has a wide range of application in skin related cosmetic products. Hence these xanthoness when applied through the cosmetic products interacts with the proteins present in the skin and causes the skin to be dry forever (Visalakshi. M et al., 2013). Use of these kinds of dyes in other cosmetic products like painting also causes various types of issues like carcinoma and so on. Synthetic dyes are considered as xenobiotics which are more harmful to environment (Eugenia Guerra et al., 2018). Synthetic dyes such as azo dyes are considered as a dangerous one which when mixed with water causes serious effects on the organisms present in water resources. 1,4- diamino benzene a compound present in azo dye causes skin irritation, contact dermatitis, blindness, vomiting, hypertension etc., Dyes such as anililine are flammable which may cause several hazardous effects (Diana Kyle. J et al., 1996). Most of the synthetic dyes are harmful and causes allergic effect on human skin. Some of the synthetic dyes may contain heavy metals such as lead and cadmium which are highly toxic to human beings. (Bruna de Campos Ventura-Camargo et al., 2013), (Shrabana Sarkar et al., 2017).

## NATURAL COLORANTS:

Due to various problems faced by the synthetic dyes people prefer to use natural colorants in cosmetics. The use of natural colorants in cosmetics is increasing now a days. Natural colorants are obtained from a biological source and these natural colorants are mostly ecofriendly and do not cause any problems. Natural pigments can be obtained from various biological sources such as plant, microbes and so on (Manish Kumar et al., 2017). Most of the natural colorants are obtained from renewable resources. Natural colorants are obtained from plant parts such as stem, bark, leaves, fruits, flowers and seeds etc. Henna, Teak, Annatto, Paprika, Carrot, Red Cabbage, Turmeric etc. are used as natural sources to obtain color. The advantages of natural colorants include eco-friendly, non-toxic, no side effects, non-carcinogenic, it causes reduced pollution, it has more health benefits such as anti-cancer, anti-oxidant, vitamin A rich and so on (Rymbai. H et al., 2011), (Papori Bora et al., 2019).

## SOURCES OF NATURAL COLORANTS:

### MICROBIAL PIGMENTS:

Microbes are the major source of producing natural colored pigments. Some microorganisms produce colored pigments which can be used in cosmetics and other industry. These microbial pigments are stable to light and heat. Microorganisms are commonly found in the environment which can be grown easily in the suitable environment to obtain natural colored pigments. Microorganisms like fungi, bacteria and algae produce a variety of colored pigments which has various properties like anticancer property etc (Manjunath Shetty. J et al., 2017).

Various types of pigments like zeaxanthin, astaxanthin, canthaxanthin,  $\beta$ -carotene, pyocyanin blue are produced by wide variety of microorganisms. Zeaxanthin is a pigment responsible for yellow and golden yellow colors which is produced by both *Staphylococcus aureus* and *Flavobacterium sp.* Prodigiosin is a microbial pigment which is responsible for red color is produced by *Serratia marcescens*. Astaxanthins are also a microbial pigment which is responsible for red color is produced by the yeast *Phaffia rhodozyma*. Lycopene  $\beta$ -carotene is a pigment responsible for red, yellow and orange colors are produced by *Blakesela trispora*. Pyocyanin Blue is a microbial pigment responsible for green color is produced by *Pseudomonas aeruginosa*.  $\beta$ -carotene which is responsible for cream color is produced by *Dunaliella salina*. Monascorubramin and Rubropunctatin are a kind of microbial pigments responsible for yellow, orange and red colors are produced by a red mold species *Monascus purpureus*. *Rhodotorua* a kind of yeast produces Torularhodin a pigment responsible for orange-red color. *Monascus roseus* a kind of red mold produces an orange-pink colored pigment known as Canthaxanthin (Kanchan Heer et al., 2017).

## FACTORS THAT AFFECT THE PRODUCTION OF MICROBIAL PIGMENTS:

There are different types of microbial pigments. These microbial pigments production is limited by various factors such as carbon source, nitrogen source, temperature, pH and incubation time. Various types of carbon sources such as glucose, fructose, lactose, sucrose etc., are available. Hence for the pigment production

the mostly used carbon sources are glucose and its oligosaccharides. Nitrogen is important for the microbial growth hence nitrogen is needed for the synthesis of nucleic acids and amino acids. Nitrogen source is provided in the form of ammonium chloride, ammonium nitrate and glutamate. In some cases, peptone is added as the nitrogen source which yields more microbial pigments. Temperature plays a vital role in the growth of the microbes. Different microbes require different temperature for its growth. 25-28°C acts as the optimum temperature for the growth and pigment production of *Monascus* sp. While 35-36°C acts as the optimum temperature for the growth and pigment production of *Pseudomonas* sp. pH acts as an important factor for the production of microbial pigments. A slight change in the pH may cause a different shade of color in the pigment. The *Monascus* sp requires slight acidic condition for the pigment production such as 5.5-6.5. Whereas *Rhodotorula* sp requires acidic condition of 4.0-4.5. Incubation time is also an essential factor for the microbial growth. For pigment production the incubation time ranges from 24-96 hrs (Laurent Dufosse et al., 2009).

### **ANIMAL PIGMENTS:**

Animals also produce pigments. Animal pigments are produced to protect the animal from the predators, it serves as warning coloration. The animal pigments are sometimes produced to attract their mates. The best example for animal pigment is the melanin. Melanin is responsible for the color of hairs, skin and fur of the animals (Mohd Yusuf et al., 2017), (Mohamed A. Hassan et al., 2017). The blood of the insect Cochineal beetle which is present in the prickly pear plant is responsible for the production of red color (Kanchan Heer et al., 2017). This pigment is commonly used in lipsticks and rarely in eye shadow. It is also used as color additives in Cherry Coke. Some of the marine sources like fish varieties and jelly fish possess a colored pigment (Rymbai. H et al., 2011).

### **PLANT PIGMENTS:**

Plants produce lot of secondary metabolites which are known as phytochemicals. These phytochemicals are not essential for the growth and development of the plant. The phytochemicals have medicinal property which tends them to be used in pharmaceutical industry (Rubia, Aman Bhardwaj et al., 2016). Phytochemicals also possess different attractive colors and flavors which tends them to be used in the cosmetics and food industry. The pigments are produced in different parts of the plants including stem, bark, leaves and flowers (Manish Kumar et al., 2017). Plants approximately produce 2,00,000 compounds among which few compounds are said to be colored compounds. Major classes of plant pigments include Anthocyanins, Carotenoids, Betalains, Flavones, Chlorophylls, Lycopene etc. (Manjunath Shetty. J et al., 2017)

### **ANTHOCYANINS:**

Anthocyanin is derived from two Greek words anthos which means flower and cyanin which means blue. Anthocyanins are flavonoids which contains phenolics as their substituents (Ibrahim I.A.A et al., 2015), (Sreelekha Lakshmi. D et al., 2016). These anthocyanins are found in different chemical forms depending on the pH of the solution. At low pH like 3-5 favylium cation is more predominant which gives rise to red, pink and purple colors. When the pH increases proton, transfer takes place between the hydroxyl groups where the

quinonoidal bases are more predominant which gives rise to dark purple, blue and black colors (Marcelo Fonseca Xavier et al., 2008). Anthocyanins are present in blue grape, blueberry, red cabbage, jamun, plum etc. The anthocyanins are found abundant in purple corn. Anthocyanin are responsible for coloration in leaves, fruits, tubers and flowers (Neela Chigurupati et al., 2002). There are about 19 classes and sub classes of anthocyanins are available (Kristen Oerlemans et al., 2006). Among these six classes of anthocyanins are most commonly found. The six classes of anthocyanins include pelargonidin, cyanidin, peonidin, delphinidin, petunidin and malvidin (Umami Kalthum Ibrahim et al, 2011). Anthocyanins are widely used as pH indicator. They are used as a natural colorant in food industry. Anthocyanins possess various properties such as anticancer, antioxidant, anti-obesity, anti-inflammatory and anti-diabetic etc., (Sami Rokayya et al., 2013), (Hock Eng Khoo et al., 2017).

## **CAROTENOIDS:**

Carotenoids are responsible for the various colors such as orange, yellow and red. Carotenoids are mostly lipid secondary metabolites (Abhijeet A. Aher et al., 2012). There are approximately more than 700 carotenoids are available. Carotenoids are also responsible for the vitamin A content in some of the vegetables and fruits like carrot. They are responsible for colors in cheese and some grains. These carotenoids are found in annatto seeds, saffron, carrot, tomato, pumpkins, corns and marigold etc (Kiokias. S et al., 2016). Various types of carotenoids such as  $\alpha$ -carotene,  $\beta$ -carotene, Astaxanthin, Zeaxanthin, Antheraxanthin, Violaxanthin and Neoxanthin etc., are widely used. Carotenoids are responsible for the yellow color of the autumn leaves and flowers. These carotenoids have more nutritional benefits and they are used directly as dietary supplements (Ramaraj Sathasivam et al., 2018). Carotenoids possess various properties like anti-oxidant and free radical scavenging and destroying activities. Hence carotenoids scavenge and destroy the free radicals, they also tend to have anticancer activity (Yoshikazu Tanaka et al., 2008), (Irwandi Jasvir et al., 2011), (Kiokias. S et al., 2016).

## **BETALAINS:**

Betalains are phytochemicals responsible for red and purple colors. These betalains are found in cactus, beetroot and amaranths etc., These pigments are water soluble pigments (Swetha Kruthika. V et al., 2014). They are not stable to heat. The food items containing these pigments are kept in low level of light, oxygen and humidity. When compared to anthocyanin betalains are more stable. Betalains possess a major advantage that it is highly stable in different pH. Betalains are classified into two major groups such as betacyanins and betaxanthins. Betacyanins are responsible for the red color in the fruits and vegetables, whereas betaxanthins are responsible for yellow color in certain flowers. Betalains are mainly synthesized from the enzyme tyrosine hydrolase. These betalain pigments are found only in the Caryophyllales (Yoshikazu Tanaka et al., 2008), (Irwandi Jasvir et al., 2011).

## **CHLOROPHYLLS:**

Chlorophylls are responsible for green color in leaves of the plants. They are mostly present in all the plants. These chlorophyll pigments are very important in plants which helps to carry out an important process known as photosynthesis. Chlorophyll pigment is an oil - soluble pigment (Manisha Parmar et al., 2015). There are seven different forms of chlorophyll are available. Only the chlorophyll a and b are used for the color production. Chlorophyll pigment is found abundant in leafy vegetables such as spinach, lettuce and broccoli. Chlorophyll is less stable to heat, light, oxygen, acids and enzymes. Chlorophyll is extracted mainly by using acetone. They are not widely used in the industries due to their complex structure (Dipti Sharma et al., 2014).

## **LYCOPENE:**

Lycopene is a class of carotenoids. It is a fat-soluble pigment. Lycopene is responsible for the production of bright red color. It is mostly found in fruits and vegetables. Tomato and watermelon are red in color due to the presence of lycopene pigment. This lycopene pigment is also found in microbes (Dipti Sharma et al., 2014). Lycopene is found mostly in red carrots, watermelons, tomatoes, papayas, gac melons, asparagus and parsley. Although lycopene is a class of carotenoids, it does not possess Vitamin A activity. Lycopene has potential effects on cardiovascular diseases and prostate cancer. The research is on progress for the adverse effects of lycopene on human health (Venkata Naveen Kumar. P et al., 2017).

## **PLANT PIGMENTS IN COSMETICS:**

Annatto seed powder, caramel, red carmine, pink carmine, purple carmine and beta carotene are widely used in cosmetics (Fathima. A et al., 2011). The color index of annatto seed powder is 75120, whereas the color index for red carmine, pink carmine and purple carmine are 75470. The color index for beta carotene is 40800 or 7513 (Manisha Parmar et al., 2015). The annatto seed powder and beet juice are said to have a bright red color; hence they are used in making herbal lipsticks. Various sources such as henna are used in making hair care products. Natural pigments are considered to be safe and non-toxic than the synthetic dyes (Richa Kothari et al., 2018).

## **CONCLUSION:**

Synthetic dyes were widely used as colorants in most of the sectors like food industry, pharmaceutical industry and also in cosmetics. These synthetic dyes have various limitations and problems. They are not eco-friendly. Synthetic dyes are toxic as they possess a carcinogenic property, they are non-degradable. Most of the synthetic dyes are considered as xenobiotics. Synthetic dyes like azo dyes have numerous effects on the human health. Due to these reasons people prefer to use natural pigments as colorants. Natural pigments are obtained from various sources like microorganisms, plants and animals. Majorly used natural pigments are plant pigments and microbial pigments. Animal pigments are not used widely due to some ethical issues. These natural pigments are ecofriendly and they do not cause any effects to people. Hence these natural pigments are obtained from different sources and used in various sectors like food industry as coloring and flavoring agent, in

cosmetics as antioxidants and coloring agents, in pharmaceutical industry as coloring and due to their medicinal property.

Natural pigments such as betalains, carotenoids and anthocyanins possess various properties like anticancer, anti-inflammatory, anti-obesity, anti-diabetic and antioxidant etc., Carotenoids which possess yellow color are rich in Vitamin A and also has free radical scavenging activity which helps to fight cancer. Some natural pigments from annatto seeds, beta carotene etc., are approved to be safe to use in cosmetics by FDA and have given color index. Anthocyanins are used as pH indicators and colorants in food industry, textile industry etc., They can be used in cosmetics for their color and antioxidant property. Lycopene and chlorophyll also possess a bright color which can be used in cosmetic industry.

Microbial pigments are also a good and cheap source of natural pigments. Microbial pigments such as prodigiosin are responsible for bright red color. This prodigiosin is used in the manufacturing cosmetic products and soaps. Other microbial pigments such as violacein are used to make inks in highlighter pens and papers. Animal pigments such as pigment from beetles are used in the production of cosmetic products like lipstick and eye shades as they are bright red in color. Hence most of the natural pigments are used in cosmetic products. Natural pigments also have some issues that they are not stable for long time and it does not possess much brighter color than the synthetic dyes. Although the natural dyes have some disadvantages, they have numerous health benefits and they are considered to be safe and non-toxic when compared to synthetic dyes. It is better to use natural pigments and natural substances in cosmetics to avoid major health problems. Thus, further research can be focused on the benefits and use of natural colorants in cosmetics and other sectors.

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