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Natural colorants as safe additives: A review

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Abstract
Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources roots, berries, bark, leaves, and wood and other organic sources such as fungi and lichens. The present review focuses on natural colorants and dyestuffs which are obtained from trees, shrubs and insects. Because of the enormous number of colorants and dyestuffs found in nature, an exhaustive coverage was not possible in the review and the approach has been take to provide most important and most commonly used colorants in food, textile and pharmaceutical industries.

Keywords: Colorants, Additive, Toxicity.

Introduction

A colorant is considered as an additive, which may be a dye, pigment or substance that imparts color when it is added to food stuffs, beverages, drugs and pharmaceuticals or in cosmetics. They come in many forms consisting of liquids, powders, gels, and pastes. Food coloring is used both in commercial food production and in domestic cooking. Due to its safety and general availability, food coloring is also used in a variety of non food applications including cosmetics, pharmaceuticals, home craft projects and medical devices(CFIR Title,2012) The Indian population consumes 220 mg of food colorants per year (Singh, 1997). The cost and lack of availability of natural coloring materials and difficulty in incorporating these in the modern western technology of food processing might have resulted in the shift to using synthetic food dyes (Bhat and Mathur, 1998). Synthetic food colorants are mainly derived from petroleum and commonly known as coal tar dyes. Many synthetic colors have been widely used as food additives in various processed foods for economic reasons, and for their bright colour and stability (Ozaki et al, 1998).The use of certain dyes has been banned as they are well known for their toxicity in experimental animals. Auramine is one of the additives, which was found to inhibit the growth and lead to dysfunction of liver and kidney).Metanil yellow consumption could lead to degenerative changes in the stomach Sudan dyes were found to be toxic to the liver and produce kidney lesions (Ramesh v bhat, 1998).Malachite green caused a decrease in food intake, growth rate and fertility rate. All most all the synthetic colorants are reported to be mutagenic and most of them have been identified as potential carcinogens.

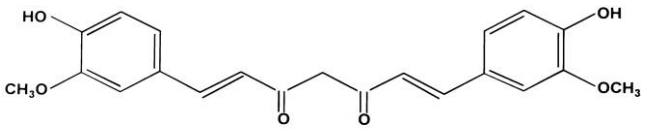
Children love bright colors, so confectionary manufacturers produce their most colorful sweets for children. Although all permitted food colorings are rigorously tested and considered safe for people to eat, there are some which are associated with adverse reactions. The most well known of these is tartrazine which can cause wheeziness in some asthmatic and exacerbate migraine in susceptible people. The orange coloring can also trigger nettle rash, runny nose and eyes and blurred vision (Alsadair M Whirter, 2002).

As compared to synthetic pigments or colorants, natural pigments have lower intensity and require large quantities of raw materials. But due to their least toxicity including carcinogenicity, natural pigments or colorants are always fascinating mankind. These plant pigments are organic coloring compounds responsible for different colors of the plant parts like leaves, flowers and fruits. The pigments obtained from plant source are grouped as chlorophylls, carotenoids, flavonoids, phytochromes, betalains, and naphthaquinones. These pigments are utilized in the preparation of various foods, cosmetics, drugs and pharmaceuticals (Khadabadi, 2011).

In this review an attempt has been made out to list the colorants obtained from various natural sources like plant and animal source, which can be utilized safely in the food, cosmetic and drug industries (Wikipedia).

Curcumin

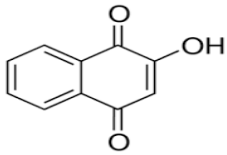
Curcumin is a bright yellow pigment from the rhizome of *Cucuma longa* (Zingiberaceae). It is the principal curcuminoid of turmeric, which is a member of the ginger family. It is sold as an herbal supplement, cosmetics ingredient, food flavoring and food coloring. It exerts potent anti-inflammatory effects, and these anti-inflammatory effects seem to be quite protective against some form of cancer progression. However, curcumin has additional anti-cancer effects that are independent of its anti-inflammatory effects and thus is a heavily researched molecule for both cancer prevention and treatment. Other areas of interest as it pertains to curcumin are alleviating cognitive decline associated with aging, being heart healthy by both electrical means and reducing lipid and plaque levels in arteries, and both reducing the risk of diabetes and being a good treatment for the side-effects associated with diabetes.



CURCUMIN

Lawsone

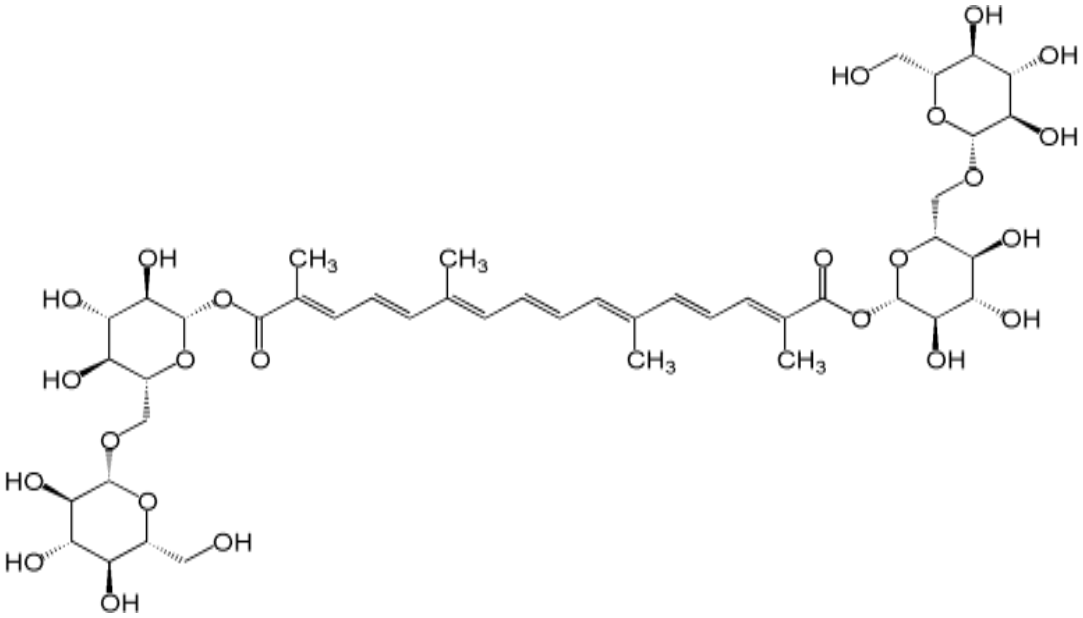
Lawsone, also known as hennotannic acid, is a red-orange dye present in the leaves of the henna plant .*Lawsonia inermis* (Lythraceae) . Henna is a flowering plant which has been used since the Bronze Age to dye skin hair, fingernails, leather, silk and wool. In several parts of the world it is traditionally used in various festivals and celebrations. The lawsone is also used for dye preparations derived from the plant.



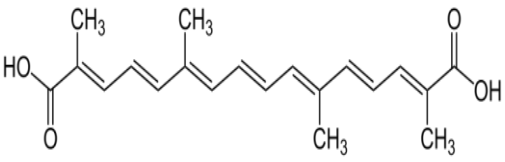
Lawsone

Crocin and Crocetin

It is a red colored pigment obtained from saffron flowers *Crocu sativus* (Iridaceae) Crocetin is a natural carotenoid dicarboxylic acid that is found in the crocus flower and *Gardenia jasminoides* (fruits). It forms brick red crystals with a melting point of 285 °C. The chemical structure of crocetin forms the central core of crocin, the compound responsible for the color of saffron. It is used as a food colorant in jams and jellies to provide rich orange red color. Apart from this crocetin is considered to be an important carotenoid constituent of saffron, has shown significant potential as an anti-tumor agent in animal models and cell culture systems. Crocetin affects the growth of cancer cells by inhibiting nucleic acid synthesis, enhancing anti-oxidative system, inducing apoptosis and hindering growth factor signaling pathways.



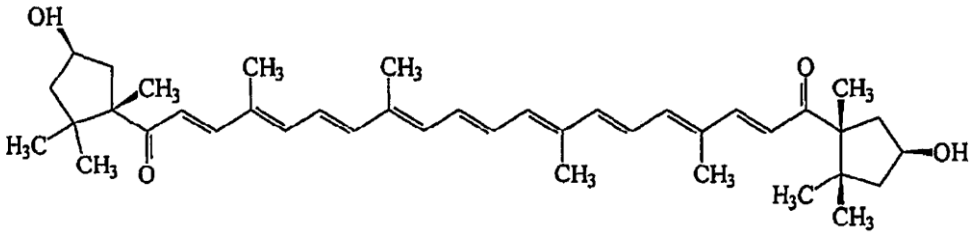
Crocin



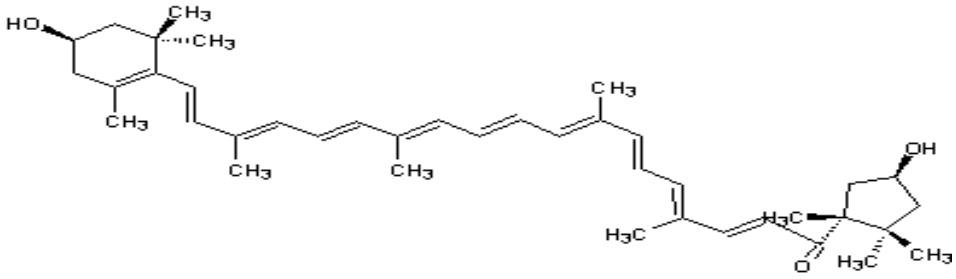
Crocetin

Capsanthin and Capsorubin

It is a red coloured pigment obtained from the fruits of *Capsicum annuum* or *Capsicum frutescence* (Solanaceae) and is primarily used as a coloring or flavoring agent in food products. It is composed of capsaicin, the main flavoring compound giving pungency in higher concentrations, and capsanthin and capsorubin, the main coloring compounds.



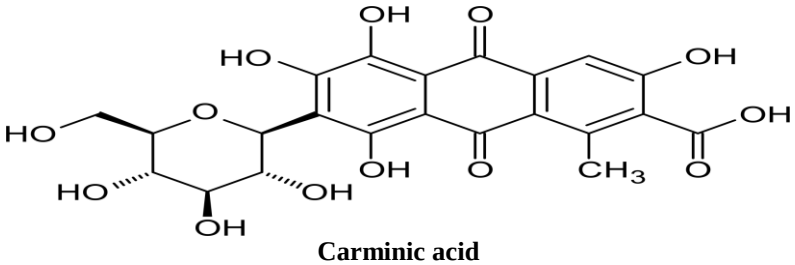
Capsorubin



Capsanthin

Carminic acid

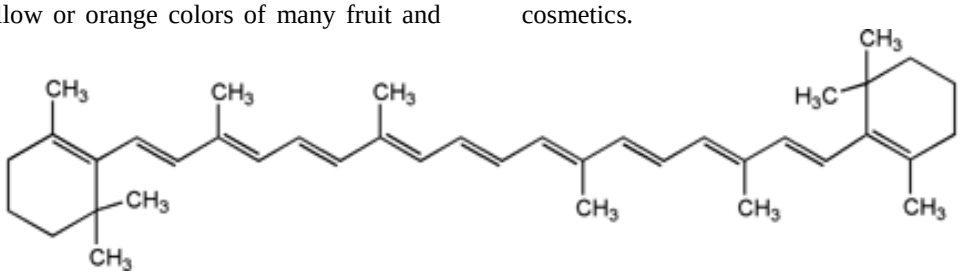
Carminic acid is a red glucosidal hydroxyanthrapurin that occurs naturally in some scale insects, such as the cochineal, *Coccus cacti* (Iridaceae). Carminic acid is a substance found in high concentration in cochineal insects. It is extracted from the insect's body and eggs and is mixed with aluminum or calcium salts to make carmine dye.



Carminic acid

Carotenoids

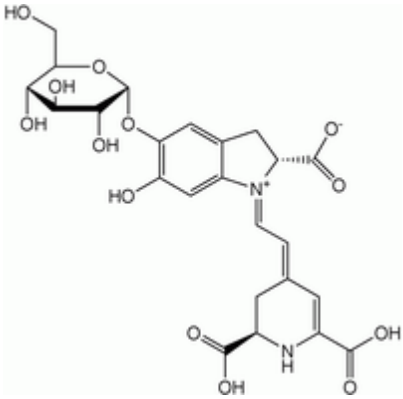
Carotenoids are one of the most important groups of natural pigments obtained from Carrots *Daucus carota* (Apiaceae) they cause the yellow or orange colors of many fruit and vegetables. Though beta-carotene is most abundant in carrots it is also found in pumpkins, apricots and nectarines. It is widely used as a safe colorant for food and cosmetics.



Beta carotene

Betanin

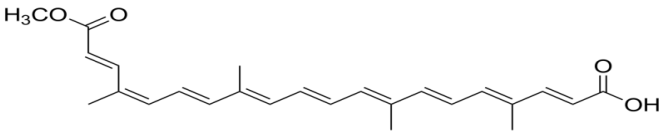
Beta vulgaris (Amaranthaceae) is a plant has numerous cultivated varieties, the best known of which is the root vegetable known as the beetroot. Betanin s a red glycosidic food dye obtained from beetroot. Betanin degrades when subjected to light, heat, and oxygen, therefore, it is used in frozen products, products with short shelf life, or products sold in dry state. Betanin can survive pasteurization when in products with high sugar content. Its sensitivity to oxygen is highest in products with high water content or products containing metal cations; antioxidants like ascorbic acid and sequestrants can slow this process down, together with suitable packaging. In dry form betanin is stable in the presence of oxygen. The color of betanin depends on pH; between 4 and 5 it is bright bluish-red, becoming blue-violet as the pH increases. Once the pH reaches alkaline levels betanin degrades by hydrolysis, resulting in a yellow-brown color. The most common uses of betanins are in coloring ice cream and powdered soft drink beverages.



Betanin

Bixin

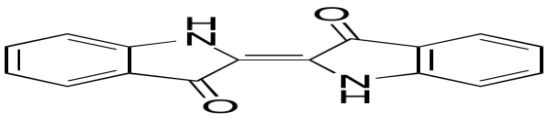
Bixin is an apocarotenoid found in annatto, a natural food coloring obtained from the seeds of the achiote tree. Annatto seeds contain about 5% pigments, which consist of 70-80% bixin. *Bixa orellana* (Bixaceae) is a shrub or small tree originating from the tropical region of the Americas. North, Central and South American natives originally used the seeds to make red body paint and lipstick. For this reason, *Bixa orellna* is sometimes called the lipstick tree. Annatto and its extracts are now widely used in an artisanal or industrial scale as a coloring agent in many processed food products. Annatto is a natural alternative to synthetic food coloring compounds, but it has been linked to cases of food-related allergies. Annatto is of particular commercial value in the United States because the Food and Drug Administration considers colorants derived from it to be "exempt of certification".



Bixin

Indigo

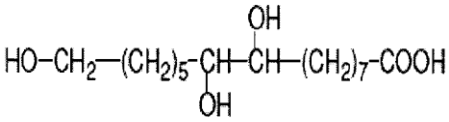
A variety of plants have provided indigo throughout history, but most natural indigo was obtained from those in the genus *Indigo fera*, which are native to the tropics. *Indigo fera* is a large genus of over 750 species of flowering plants belonging to the family Fabaceae. They are widely distributed throughout the tropical and subtropical regions of the world. The color indigo is named after the indigo dye derived from the plant *Indigo fera.* The primary use for indigo is as a dye for cotton yarn, which is mainly for the production of denim cloth for blue jeans. On average, a pair of blue jean trousers requires 3–12 gm of indigo. Small amounts are used for dyeing wool and silk.



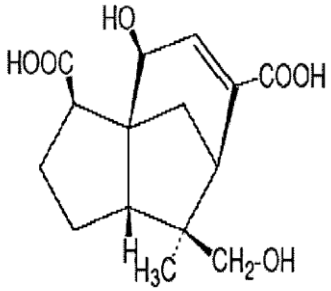
Indigo

Shellac

It is resinous waxy secretion obtained from the insect *Laccifer lacca* (Lacciferidae) used for making dyes. It is mainly utilsed in cosmetics especially in the production of nail polishes. Shellac has been used in the pharmaceutical industry as a tablet coating, often for enteric coating on tablets. In the cosmetics industry, shellac has been used in mascara, hair spray, nail polish and eyeliner. Traditionally, shellac has been used in the furniture industry as a wood or paint sealant. Because of its FDA approval, shellac is used to coat apples and other fruits to make them shiner. Shellac is used to coat enteric pills so that they do not dissolve in the stomach, but in the lower intestine. It is also used as a coating on pills to time release medication



aleuritic acid (III)

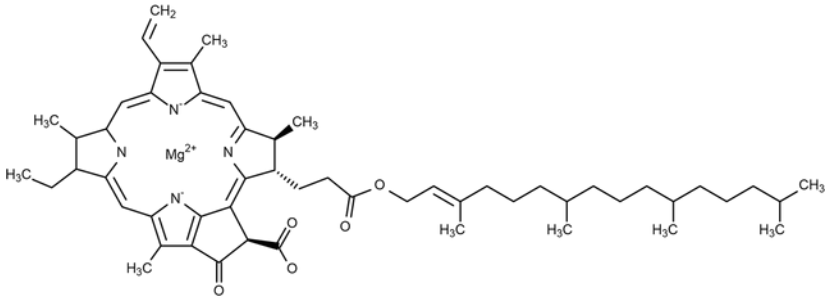


shellolic acid (IV)

Chlrophyll

It is green colored pigment which is used a safe colorant from various green plants. Chlorophyll is a green pigment found in plants. Plants use chlorophyll and light to make food. People use chlorophyll as medicine. Common sources of chlorophyll used for medicine include alfalfa (Medicago sativa) and silkworm droppings. Chlorophyll's status as a super food is due to its nutritional and potent antioxidant properties. It protects cells from oxidative damage by eliminating free radicals. In the food industry, chlorophyll is used as a natural pigment ingredient in processed foods. Because of its strong green pigment and consumers growing preference for natural foods, chlorophyll is gaining importance as food additive. Increasing number of researches are also reporting health benefits from consumption of high chlorophyll diet. This in turn is encouraging food processors to switch from artificial pigments to chlorophyll-based natural coloring. In the cosmetics industry, chlorophyll a is used in soaps and cosmetics products. The function of chlorophyll in animals is suggested to be inhibition of lipid peroxidation and protection of mitochondria from oxidative damage induced by various free-radicals and other reactive oxygen species. Chlorophyll has also been reported to inhibit radiation-

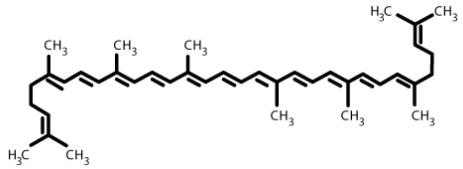
induced DNA and mitochondrial membrane damage and it would also appear to be a potent protector of DNA with regard to oxidative damage. Chlorophyll is sometimes called `green blood" because of its similarity to the hemoglobin molecule found in human blood cells. Chlorophyll increases peristaltic action and thus relieves constipation, and also normalizes the secretion of digestive acids. It soothes the inflammation and reduces the excess pepsin secretion associated with gastric ulcers. Chlorophyll actually helps remove heavy metals from the body that have accumulated due to the ingestion of contaminated food products.



Chlorophyll

Lycopene

It is a bright red coloured carotenoid pigment obtained from tomatoes *Lycopersicon lycopersicum* (Solanaceae). Owing to the strong color, lycopene is used as food colorant. Lycopene is a powerful antioxidant that may help protect cells from damage. Other than tomatoes, lycopene is also found in water melons, pink grape fruits, apricots, and pink guavas.



Lycopene

Conclusion

Even though these natural colurants are having least toxicity, they have limitations too. Most of the natural colourants are having varying solubility factor hence there will not be uniformity in colouring a particular product. Some of the natural pigment even can produce certain chemical reactions with the other components of the product also. Natural colours have been relatively free of criticism because most are derived from food sources that have been consumed for many years (Francis, 1989). Besides giving colour to the food, many of them have been reported to be beneficial to health, due to potential physiological effect such as anti inflammatory, hepato protective and vasotonic effects (Kamei et al, 1995). It could be concluded that the present review highlighted that synthetic colorants are adversely affecting hepatic and renal parameters comparing to natural colorants. Hence the consumption of synthetic colorants has to be avoided and one should do the promotion of natural colorants.

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