

FT:510

FOOD CHEMISTRY

Submitted by:

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Submitted to:-

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Topic of assignment:-

“CHEMISTRY OF FOOD COLORS”

Chemistry of food colors

- **Food color:-**

“Food color is any substance that is added to food or drink to change its color.”

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, for example in home craft projects and educational settings etc

- **Purpose of food coloring:-**

People associate certain colors with certain flavors, and the color of food can influence the perceived flavor in anything from candy to wine. For this reason, food manufacturers add dyes to their products. Sometimes the aim is to simulate a color that is perceived by the consumer as natural, such as adding red coloring to glace cherries (which would otherwise be beige), but sometimes it is for effect, like the green ketchup that Heinz launched in 2000.

While most consumers are aware that food with bright or unnatural colors (such as the green ketchup, or children's cereals such as Froot Loops) likely contain food coloring, far fewer people know that seemingly "natural" foods such as oranges and salmon are sometimes also dyed to mask natural variations in color. Color variation in foods throughout the seasons and the effects of processing and storage often make color addition commercially advantageous to maintain the color expected or preferred by the consumer. Some of the primary reasons include

- Offsetting color loss due to light, air, extremes of temperature, moisture, and storage conditions.
- Masking natural variations in color.
- Enhancing naturally occurring colors.
- Providing identity to foods.
- Protecting flavors and vitamins from damage by light.
- Decorative or artistic purposes such as cake icing.

- **Regulation:-**

Food colorings are tested for safety by various bodies around the world and sometimes different bodies have different views on food color safety. In the United States, **FD&C** numbers (which generally indicates that the FDA has approved the colorant for use in foods, drugs and cosmetics) are given to approved synthetic food dyes that do not exist in

nature, while in the European Union, **E numbers** are used for all additives, both synthetic and natural, that are approved in food applications.

Most other countries have their own regulations and list of food colors which can be used in various applications, including maximum daily intake limits. Natural colors are not required to be tested by a number of regulatory bodies throughout the world, including the United States FDA. The FDA lists "**color additives exempt from certification**" for food in subpart A of the Code of Federal Regulations - Title 21 Part 73. However, this list contains substances which may have synthetic origins. There are **26** colors permitted to be used in food and **28** to be used in cosmetics and pharmaceuticals.

There are major **three** categories of food colors;

- 1) Natural colors
- 2) Synthetic colors
- 3) Lakes and dyes

- **Natural Food Color:-**

Natural Food Color is any dye, pigment or any other substance obtained from vegetable, animal, mineral, or source capable of coloring food drug, cosmetic or any part of human body, colors come from variety of sources such as seeds, fruits, vegetables, algae & insect.

A growing number of natural food dyes are being commercially produced, partly due to consumer concerns surrounding synthetic dyes. Some examples include:

- Caramel coloring (E150), made from caramelized sugar, used in cola products and also in cosmetics.
- Annatto (E160b), a reddish-orange dye made from the seed of the Achiote.
- A green dye made from chlorella algae (chlorophyll, E140)
- Cochineal (E120), a red dye derived from the cochineal insect, *Dactylopius coccus*.
- Betanin extracted from beets.
- Turmeric (curcuminoids, E100)
- Saffron (carotenoids, E160a)
- Paprika (E160c)
- Elderberry juice

To ensure reproducibility, the colored components of these substances are often provided in highly purified form, and for increased stability and convenience, they can be formulated in suitable carrier materials (solid and liquids)

According to the application a suitable Natural Color can be achieved by keeping in mind the factors such as PH, heat, light storage and the other ingredients of the formula or recipe. The storage conditions for natural colors depend on the particular need of the product.

A tight sealed container is best to store the product in a cool storage to preserve color strength and quality, along with its degree of cooling point.

Here is a list of few natural food colors:-

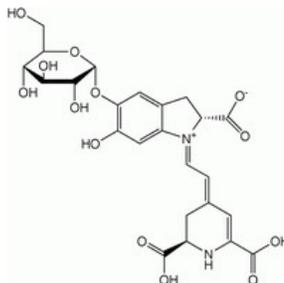
NATURAL COLOUR	EEC NO.	DESCRIPTION
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Annatto	E160b	Liquid/Powder (os) LIQUID / POWDER (WS)
Turmeric	E100	Paste, 35% Curcumin Liquid (Os) Up To 12% Curcumin Liquid (Ws) Up To 10% Curcumin Powder, Up To 95% Curcumin
COCHINEAL Carmini	E 120	Powder, N.L.T. 50% Carminic Acid Powder, 30% - 95% Carminic Acid Powder Up To 40% Carminic Acid Liquid (Ws) 2% - 10% Carminic Acid
Paprika	E 160c	Liquid (Os) 10,000 To 1,60,000 Cu Liquid (Ws) 10,000 To 50,000 Cu Powder, Spray Dried
Anthocyanins	E 163	Liquid / Powder (Ws) Liquid / Powder (Ws) Liquid / Powder (Ws)
Beta Carotenes Carotenoids	E 160a	Powder (Ws) Up To 7.5% Mix Carotenes Liquid (Os) Up To 2.5% Mix Carotenes
Gardenia	-	Liquid (Ws)
Gardenia	-	Liquid (Ws)
Gardenia	-	Liquid (Ws)
Iron Oxides	E 172	Powder
Iron Oxides	E 172	Powder
Iron Oxides	E 172	Powder
Iron Oxides	E 172	Powder
Marigold Extract Lutein	E 161b	Paste (Os) Up To 10% Xanthophylls Powder Up To 50% Lutein
Chlorophyll	E 140 E 141	Liquid Ws / Os Liquid Ws / Os - Powder Ws
Titanium Dioxide	E 172	Powder & Paste Ws & Od
Carbon Black	E 153	Powder, Paste, Emulsion In Oil
Beet Root	E 162	Liquid / Powder (Ws)
Safflower	-	Liquid / Powder (Ws)
Caramel	E 150 a,b,c,d	Liquid / Powder (Ws)
Lycopene	E 160d	Os .2 To 20%
Monascus	-	Liquid / Powder (Ws)
Red Cabbage	-	Powder
Raddish	-	Powder

Detail of few major colors:-

IUPAC name

2, 6-Pyridinedicarboxylic acid,4-(2-(2-carboxy-5-(beta-D-glucopyranosyloxy)-2,3-dihydro-6-hydroxy-1H-indol-1-yl)ethenyl)-2,3-dihydro-, (S-(R*,R*))-



Molecular formula : C₂₄H₂₇N₂O₁₃

Molar mass :551.48 g/mol

Betanin, or Beetroot Red, is a **red glycosidic food dye** obtained from beets; its aglycone, obtained by hydrolyzing away the glucose molecule, is betanidin.

As a food additive, its E number is **E162**. 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 content of water and/or containing metal cations (eg. iron and copper); antioxidants like ascorbic acid and sequestrants can slow this process down, together with suitable packaging. In dry form betanin is stable in presence of oxygen.

Betanin is usually obtained from the extract of beet juice; the concentration of betanin in red beet can reach **300-600 mg/kg**. Other dietary sources of betanin and other betalains include the opuntia cactus, Swiss chard, and the leaves of some strains of amaranth.

The color of betanin depends on pH; between **four** and **five** 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**.

- Betanin can be also used for coloring meat and sausages.
- The most common uses of betanin are in coloring ice cream and powdered soft drink beverages; other uses are in some sugar confectionery, e.g. fondants, sugar strands, sugar coatings, and fruit or cream fillings. In hot processed candies, it can be used if added at the final part of the processing. Betanin is also used in soups as well as tomato and bacon products.
- Betanin absorbs well from the gut and acts as an antioxidant.

Betanin is a betalain pigment, together with isobetainin, probetanin, and neobetainin. Other pigments contained in beet are indicaxanthin and vulgaxanthins.

▪ **CARAMEL:-**

Caramel color (150/E150) is a dark, rather bitter-tasting liquid, the highly concentrated product of near total caramelization that is bottled for commercial and industrial use. Beverages such as cola use caramel coloring, and it is also used as food coloring.

Caramel color or caramel coloring is a **soluble** food coloring. It is made by a carefully controlled heat treatment of carbohydrates, generally in the presence of acids, alkalis, or salts, in a process called caramelization. It is more fully oxidized than caramel candy and has an odor of burnt sugar and a somewhat bitter taste. Its color ranges from **pale yellow** to **amber** to **dark brown**.

Caramel color is one of the oldest and most widely-used food colorings, and is found in almost every kind of industrially produced food, including: batters, beer, brown bread, buns, chocolate, cookies, cough drops, dark liquor such as brandy, rum, and whisky, chocolate-flavored flour-based confectionery, coatings, custards, decorations, fillings and toppings, potato chips, dessert mixes, doughnuts, fish and shellfish spreads, frozen desserts, Fruit preserves, glucose tablets, gravy browning, ice cream, pickles, sauces and dressings, soft drinks (especially colas), sweets, vinegar, and wines.

Production

Caramel color is made by the **controlled heat treatment** of carbohydrates (nutritive sweeteners which are the monomers glucose and fructose or their polymers, e.g. glucose syrups, sucrose, invert syrups, and dextrose, generally in the presence of food-grade acids, alkalis, and salts, in a process called caramelization. Antifoaming agents may be used as processing aids during its manufacture.

Unlike caramel candy, it tends towards maximum oxidation of the sugar to produce a caramel concentrate that has an odor of burnt sugar and a somewhat bitter taste in its raw liquid form. Its color ranges from pale yellow to amber to dark brown.

Caramel color molecules carry either a positive or negative charge depending upon the reactants used in their manufacture. Problems such as precipitation, flocculation or migration can be eliminated with the use of a properly charged caramel color for the intended application.

Classification

Internationally, the **Joint FAO/WHO Expert Committee on Food Additives (JECFA)** recognizes **four** classes of caramel color, differing by intended application and in the reactants used in their manufacture, each with its own INS and E number, that are listed in the table below.

Class	INS No.	E Number	Description	Restrictions on preparation	Used in
I	150a	E150a	Plain caramel, caustic caramel, spirit caramel	No ammonium or sulfite compounds can be used	Whiskey among many
II	150b	E150b	Caustic sulfite caramel	In the presence of sulfite compounds but no ammonium compounds can be used	
III	150c	E150c	Ammonia caramel, baker's caramel, confectioner's caramel, beer caramel	In the presence of ammonium compounds but no sulfite compounds can be used	Beer, synthetic soy sauce , and confectionery
IV	150d	E150d	Sulfite ammonia caramel, acid-proof caramel, soft-drink caramel	In the presence of both sulfite and ammonium compounds	Acidic environments such as soft drinks

Physical properties

Caramel color is a **colloid**. Although the primary function of caramel color is for coloring, it also serves additional functions. In soft drinks, it functions as an emulsifier to help retard the formation of certain types of "floc" and its light protective quality can aid in preventing oxidation of the flavoring components in bottled beverages.

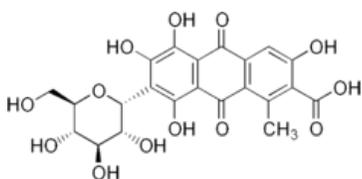
Caramel color has excellent microbiological stability. It is manufactured under very high temperature, high acidity, high pressure, and high specific gravity, it is essentially sterile as it will not support microbial growth unless in a dilute solution.

When reacted with **sulfites**, caramel color may retain traces of sulfite after processing. However, in finished food products, labeling is usually only required for sulfite levels above **10 ppm**.

▪ **CRAMINE:-**

Carmin also called **Crimson Lake**, **Cochineal**, **Natural Red 4**, **C.I. 75470**, or **E120**, is a pigment of a **bright red color** obtained from the **carminic acid** produced by some scale insects, such as the **cochineal** and the Polish cochineal, and is used as a general term for a particularly deep red color of the same name.

Carmin is used in the manufacture of artificial flowers, paints, crimson ink, rouge, and other cosmetics, and is routinely added to food products such as yogurt and certain brands of juice, most notably those of the ruby-red variety.



Production

Carmin may be prepared from cochineal, by boiling dried insects in water to extract the carminic acid and then treating the clear solution with alum, cream of tartar, stannous chloride, or potassium hydrogen oxalate; the coloring and animal matters present in the liquid are thus precipitated. Other methods are in use in which egg white, fish glue, or gelatin are sometimes added before the precipitation.

The quality of carmin is affected by the temperature and the degree of illumination during its preparation, sunlight being requisite for the production of a brilliant hue. It also differs according to the amount of alumina present in it. It is sometimes adulterated with cinnabar, starched other materials; from these the carmin can be separated by dissolving it in ammonia. Good carmin should crumble readily between the fingers when dry.

Carmin lake is a pigment obtained by adding freshly precipitated alumina to decoction of cochineal.

Carmin can be used as a staining agent in microbiology, as a **Best's carmin** to stain glycogen, **mucicarmin** to stain **acidic mucopolysaccharides**, and **carmalum** to stain **cell nuclei**. In these applications, it is applied together with a mordant, usually an Al (III) salt.

Allergy

Carmin is used as a food dye in many different products such as juices, ice cream, yogurt, and candy, and as a dye in cosmetic products such as eye shadow and lipstick. Although

principally a red dye, it is found in many foods that are shades of red, pink, and purple. As a food dye it has been known to cause severe allergic reactions and anaphylactic shock in some people.

Food products containing carmine-based food dye may prove to be a concern for people who are allergic to carmine, or people who choose not to consume any or certain animals, such as vegetarians, vegans.

▪ **CAROTENE:-**

The term **carotene** is used for several related hydrocarbon substances having the formula **C₄₀H_x**, which are synthesized by plants but cannot be made by animals.

Carotene is an **orange photosynthetic pigment** important for photosynthesis. Carotenes are all colored to the human eye. They are responsible for the orange color of the carrot, for which this class of chemicals is named, and for the colours of many other fruits and vegetables (for example, sweet potatoes and orange cantaloupe melon). Carotenes are also responsible for the orange (but not all of the yellow) colours in dry foliage. They also (in lower concentrations) impart the yellow coloration to milk-fat and butter. Omnivorous animal species which are relatively poor converters of colored dietary carotenoids to colorless retinoid have yellowed-colored body fat, as a result of the carotenoid retention from the vegetable portion of their diet. The typical yellow-colored fat of humans and chickens is a result of fat storage of carotenes from their diets.

Carotenes contribute to photosynthesis by transmitting the light energy they absorb from chlorophyll. They also protect plant tissues by helping to absorb the energy from singlet oxygen, an excited form of the oxygen molecule O₂ which is formed during photosynthesis.

β-Carotene is composed of **two retinyl groups**, and is broken down in the mucosa of the human small intestine by beta-carotene 15,15'-monooxygenase to retinal, a form of vitamin A. β-Carotene can be stored in the liver and body fat and converted to retinal as needed, thus making it a form of vitamin A for humans and some other mammals. The carotenes α-carotene and γ-carotene, due to their single retinyl group (beta-ionone ring), also have some vitamin A activity (though less than β-carotene), as does the xanthophyll carotenoid β-cryptoxanthin. All other carotenoids, including lycopene, have no beta-ring and thus **no** vitamin A activity (although they may have antioxidant activity and thus biological activity in other ways). Animal species differ greatly in their ability to convert retinyl (beta-ionone) containing carotenoids to retinals. Carnivores in general are poor converters of dietary ionine-containing carotenoids, and pure carnivores such as cats and ferrets lack beta-carotene 15,15'-monooxygenase and cannot convert any carotenoids to retinals at all (resulting in carotenes **not** being a form of vitamin A for these species).

Molecular structure

Chemically, carotenes are **polyunsaturated hydrocarbons** containing **40 carbon atoms per molecule**, variable numbers of hydrogen atoms, and no other elements. Some carotenes are **terminated by hydrocarbon rings, on one or both ends of the molecule**. All are colored to the human eye, due to extensive systems of conjugated double bonds. Structurally carotenes are **terpenes**, synthesized biochemically from **eight isoprene units**. Carotenes are found in plants in two primary forms designated by characters from the Greek alphabet:

- alpha-carotene (α-carotene)
- Beta-carotene (β-carotene).
- Gamma, delta, epsilon, and zeta (γ, δ, ε, and ζ-carotene) also exist.

Since they are hydrocarbons, and therefore contain no oxygen, carotenes are **fat-soluble** and **insoluble in water** (in contrast with other **carotenoids**,

the xanthophylls, which contain oxygen and thus are less chemically hydrophobic).

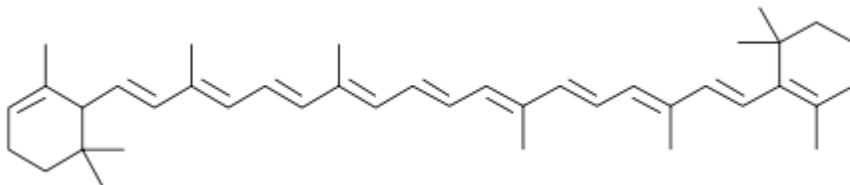
Dietary sources

The following foods are particularly rich in carotenes:

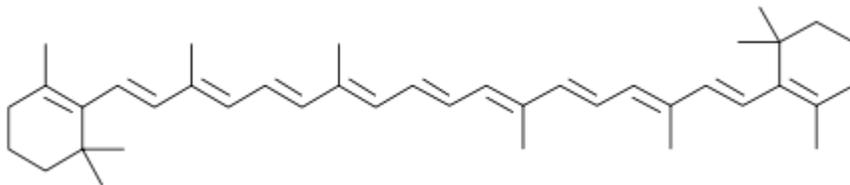
Sweet potatoes
Carrots
Cantaloupe melon
Mangoes
Apricots
Persimmon
Spinach
Kale
Turnip greens
Beet greens
Mustard greens
Broccoli
Parsley
Romaine lettuce
Ivy gourd
Winter squash
Pumpkin
Cassava

Absorption from these foods is enhanced if eaten with fats, as carotenes are fat soluble, and if the food is cooked for a few minutes until the plant cell wall splits and the color is released into any liquid. 6 μg of dietary β -carotene supplies the equivalent of 1 μg of retinol, or 1 RE (Retinol Equivalent). This is equivalent to $3\frac{1}{2}$ IU of vitamin A.

The multiple forms



α -carotene

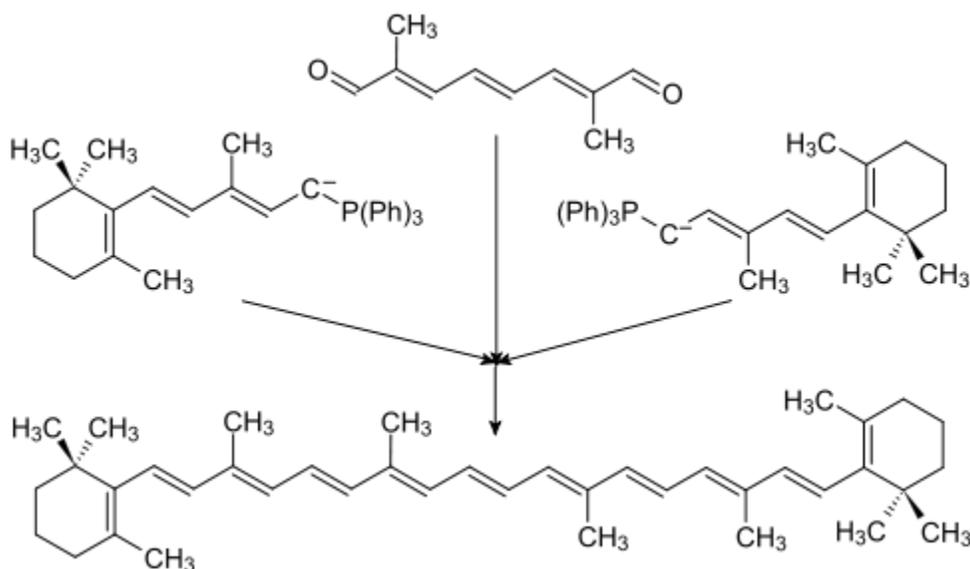


β -carotene

The two primary isomers of carotene, **α -carotene** and **β -carotene**, differ in the position of double bonds in the cyclic group at the end.

a) β -Carotene is the more common form and can be found in yellow, orange, and green leafy fruits and vegetables. As a rule of thumb, **the greater the intensity of the orange color of the fruit or vegetable, the more β -carotene it contains.**

Carotene protects plant cells against the destructive effects of ultraviolet light. **β -Carotene is an anti-oxidant**



Nomenclature

Carotenes are carotenoids containing no oxygen. Carotenoids containing some oxygen are known as xanthophylls.

The two ends of the β -carotene molecule are structurally identical, and are called **β -rings**. Specifically, **the group of nine carbon atoms at each end forms a β -ring**.

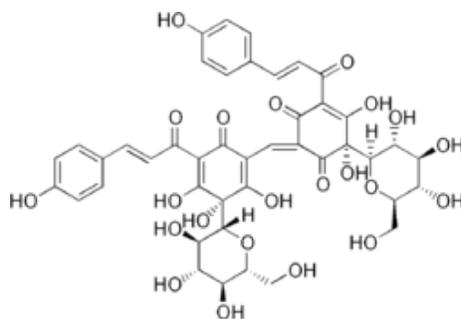
The α -carotene molecule has a **β -ring at one end**; the other end is called a **ϵ -ring**. There is no such thing as a " α -ring".

▪ **CARTHAMIN:-**

Carthamin is a natural red pigment derived from **safflower (*Carthamus tinctorius*)**, earlier known as **carthamine**. It is used as a dye and a food coloring. As a food additive, it is known as **Natural Red 26**.

Safflower has been cultivated since ancient times, and carthamin was used as a dye in ancient Egypt. It was used extensively in the past for dyeing wool for the carpet industry in European countries and to create cosmetics for geisha and kabuki artists in Japan, where the color is called **beni**. It competed with the early synthetic dye fuchsine as a silk dye after fuchsine's 1859 discovery.

It is composed of **two chalcones**; the conjugated bonds being the cause of the red color. It is derived from precarthamin by a decarboxylase. It should not be confused with carthamidin, another flavonoid.



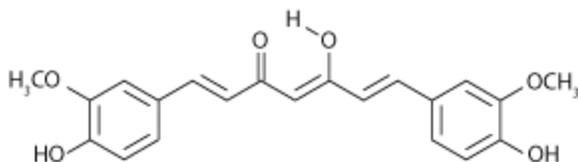
▪ **CURCUMIN:-**

Curcumin is the principal curcuminoid of the popular Indian spice turmeric, which is a member of the ginger family (Zingiberaceae). The other two curcuminoids are desmethoxycurcumin and bis-desmethoxycurcumin. The curcuminoids are **polyphenols** and are responsible for the yellow color of turmeric. Curcumin can exist in at least two tautomeric forms, **keto** and **enol**. The enol form is more energetically stable in the solid phase and in solution.

Curcumin can be used for boron quantification in the so-called curcumin method. It reacts with boric acid forming a red colored compound, known as rosocyanine. Curcumin is brightly colored and may be used as a food coloring. As a food additive, its E number is **E100**

Chemistry

Curcumin incorporates several functional groups. The aromatic ring systems, which are polyphenols are connected by two α,β -unsaturated carbonyl groups. The two carbonyl groups form a diketone. The diketone form stable enols or are easily deprotonated and form enolates, while the α,β -unsaturated carbonyl is a good Michael acceptor and undergoes nucleophilic addition.



The structure was first identified in **1910** by **Kazimierz Kostanecki, J. Miłobędzka** and **Wiktor Lampe**.

Curcumin is used as a reagent for Boron in EPA Method 212.3: Boron by Colorimetry.

▪ **TURMERIC:-**

Turmeric (*Curcuma longa*) is a rhizomatous herbaceous perennial plant of the ginger family, **Zingiberaceae**. It is native to tropical South Asia and needs temperatures between 20°C and 30°C, and a considerable amount of annual rainfall to thrive. Plants are gathered annually for their rhizomes, and re-seeded from some of those rhizomes in the following season. The rhizomes are boiled for several hours and then dried in hot ovens, after which they are ground into a deep orange-yellow powder commonly used as a spice in curries and other South

Asian and Middle Eastern cuisine, for dyeing, and to impart color to mustard condiments. Its active ingredient is curcumin and it has a distinctly earthy, slightly bitter, slightly hot peppery flavor and a mustardy smell.

In medieval Europe, turmeric became known as Indian Saffron, since it was widely used as an alternative to the far more expensive saffron spice.



In non-South Asian recipes, turmeric is sometimes used as an agent to impart a rich, custard-like yellow color. It is used in canned beverages and baked products, dairy products, ice, yogurt, yellow cakes, orange juice, biscuits, popcorn color, sweets, cake icings, cereals, sauces, gelatins, etc. It is a significant ingredient in most commercial curry powders. Turmeric is mostly used in savory dishes, as well as some sweet dishes such as the cake Sfouf. Although usually used in its dried, powdered form, turmeric is also used fresh, much like ginger. It has numerous uses in Far Eastern recipes, such as fresh turmeric pickle which contains large chunks of soft turmeric.

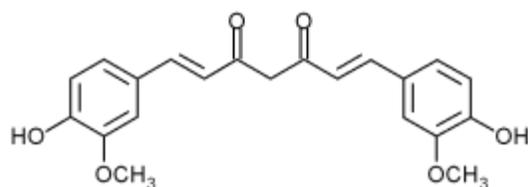
Turmeric (coded as **E100** when used as a food additive) is used to protect food products from sunlight. The oleoresin is used for oil-containing products. The curcumin/ polysorbate solution or curcumin powder dissolved in alcohol is used for water-containing products. Over-coloring, such as in pickles, relishes, and mustard, is sometimes used to compensate for fading.

In combination with annatto (E160b), turmeric has been used to color cheeses, yogurt, dry mixes, salad dressings, winter butter and margarine. Turmeric is also used to give a yellow color to some prepared mustards, canned chicken broths and other foods (often as a much cheaper replacement for saffron).

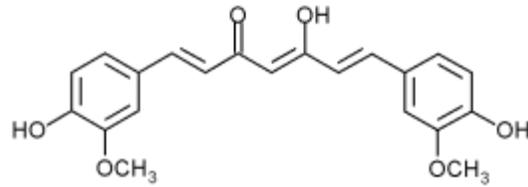
Turmeric is widely used as a spice in South Asian and Middle Eastern cooking.

Many Persian dishes use Turmeric, for the coloring of rice bottoms as well as as a starter ingredient for almost all Iranian fry ups (which typically consist of oil, onions and turmeric followed by any other ingredients that are to be included). In Nepal, turmeric is widely grown and is extensively used in almost every vegetable and meat dish in the country for its color as well as for its medicinal value. In South Africa turmeric is traditionally used to give boiled white rice a golden color.

Composition



Curcumin Keto form



Curcumin Enol form

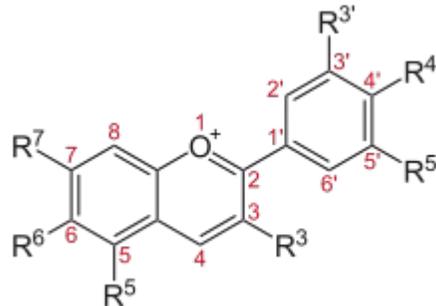
Turmeric contains up to 5% essential oils and up to 3% curcumin, a polyphenol. It is the active substance of turmeric and it is also known as C.I. 75300, or Natural Yellow 3. The systematic chemical name is (1*E*, 6*E*)-1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione.

It can exist at least in two tautomeric forms, keto and enol. The keto form is preferred in solid phase and the enol form in solution.

Curcumin is a pH indicator. In acidic solutions (pH <7.4) it turns yellow whereas in basic (pH > 8.6) solutions it turns bright red.

▪ **ANTHOCYANIN:-**

Anthocyanins (from Greek: **(anthos) = flower + (kyanos) = blue**) are **water-soluble vacuolar pigments** that may appear red, purple, or blue according to pH. They belong to a parent class of molecules called flavonoids synthesized via the phenylpropanoid pathway; they are odorless and nearly flavorless, contributing to taste as a moderately astringent sensation. Anthocyanins occur in all tissues of higher plants, including leaves, stems, roots, flowers, and fruits. Anthoxanthins are their clear, white to yellow counterparts occurring in plants. Anthocyanins are derivatives of anthocyanidins which include pendant sugars.



Function

In flowers, bright reds and purples are adaptive for attracting pollinators. In fruits, the colorful skins also attract the attention of animals, which may eat the fruits and disperse the seeds. In photosynthetic tissues (such as leaves and sometimes stems), anthocyanins have been shown to act as a "sunscreen", protecting cells from high-light damage by absorbing blue-green and UV light, thereby protecting the tissues from photo inhibition, or high-light stress. This has been shown to occur in red juvenile leaves, autumn leaves, and broad-leaved evergreen leaves that turn red during the winter. It has also been proposed that red coloration of leaves may camouflage leaves from herbivores blind to red wavelengths, or signal unpalatability, since anthocyanin synthesis often coincides with synthesis of unpalatable phenolic compounds.

In addition to their role as light-attenuators, anthocyanins also act as powerful antioxidants. However, it is not clear whether anthocyanins can significantly contribute to scavenging of free-radicals produced through metabolic processes in leaves, since they are located in the vacuole, and thus, spatially separated from metabolic reactive oxygen species. Some studies

have shown that hydrogen peroxide produced in other organelles can be neutralized by vacuolar anthocyanin.

Occurrence

Anthocyanins are found in the cell vacuole, mostly in flowers and fruits but also in leaves, stems, and roots. In these parts they are found predominantly in outer cell layers such as the epidermis and peripheral mesophyll cells.

Most frequent in nature are the glycosides of cyanidin, delphinidin, malvidin, pelargonidin, peonidin and petunidin. Roughly 2% of all hydrocarbons fixated in photosynthesis are converted into flavonoids and their derivatives such as the anthocyanins. There is no less than 10^9 tons of anthocyanins produced in nature per year. Not all land plants contain anthocyanin; in the Caryophyllales (including cactus, beets, and amaranth), they are replaced by betalains. Plants rich in anthocyanins are Vaccinium species, such as blueberry, cranberry and bilberry, Rubus berries including black rasp berry, red raspberry and blackberry, blackcurrant, cherry, eggplant peel, black rice, Concord grape and muscadine grape, red cabbage and violet petals. Anthocyanins are less abundant in banana, asparagus, pea, fennel, pear and potato, and may be totally absent in certain cultivars of green gooseberries.

The highest recorded amount appears to be specifically in the seed coat of black soybean (**Glycine max L. Merr.**) containing some **2,000 mg per 100 g** and in skins and pulp of black chokeberry (**Aronia melanocarpa L.**). However, the Amazonian palm berry, açai, having about 320 mg per 100 g of which cyanidin-3-glucoside is the most prevalent individual anthocyanin (approximately 10 mg per 100 g), is also a high-content source for which only a small fraction of total anthocyanins has been determined to date.

▪ **CHLOROPHYLL:-**

Chlorophyll is a green pigment found in most plants, algae, and cyanobacteria. Its name is derived from the Greek (**chloros "green"**) and (**phyllon "leaf"**). Chlorophyll absorbs light most strongly in the blue portion of the electromagnetic spectrum, followed by the red portion. However, it is a poor absorber of green and near-green portions of the spectrum, hence the green color of chlorophyll-containing tissues. Chlorophyll was first isolated by Joseph Bienaimé Caventou and Pierre Joseph Pelletier in 1817.

Chlorophyll and photosynthesis

Chlorophyll is vital for photosynthesis, which allows plants to obtain energy from light. Chlorophyll molecules are specifically arranged in and around photosystems which are embedded in the thylakoid membranes of chloroplasts. In these complexes, chlorophyll serves two primary functions. The function of the vast majority of chlorophyll (up to several hundred molecules per photosystem) is to absorb light and transfer that light energy by resonance energy transfer to a specific chlorophyll pair in the reaction center of the photosystems. Because of chlorophyll's selectivity regarding the wavelength of light it absorbs, areas of a leaf containing the molecule will appear green.

The two currently accepted photosystem units are Photosystem II and Photosystem I, which have their own distinct reaction center chlorophylls, named P680 and P700, respectively. These pigments are named after the wavelength (in nanometers) of their red-peak absorption maximum. The identity, function and spectral properties of the types of chlorophyll in each photosystem are distinct and determined by each other and the protein structure surrounding them. Once extracted from the protein into a solvent (such as acetone or methanol), these chlorophyll pigments can be separated in a simple paper chromatography experiment, and, based on the number of polar groups between chlorophyll a and chlorophyll b, will chemically separate out on the paper.

The function of the reaction center chlorophyll is to use the energy absorbed by and transferred to it from the other chlorophyll pigments in the photosystems to undergo a charge

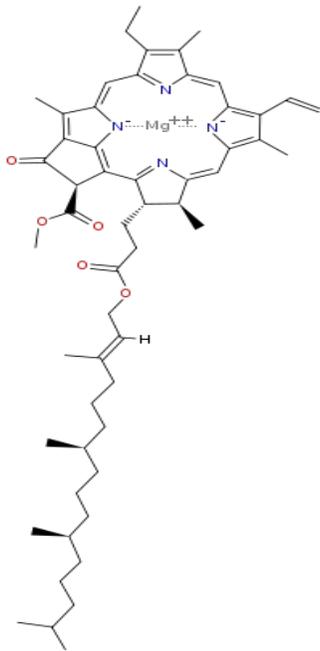
separation, a specific redox reaction in which the chlorophyll donates an electron into a series of molecular intermediates called an electron transport chain. The charged reaction center chlorophyll (P680⁺) is then reduced back to its ground state by accepting an electron. In Photosystem II, the electron which reduces P680⁺ ultimately comes from the oxidation of water into O₂ and H⁺ through several intermediates. This reaction is how photosynthetic organisms like plants produce O₂ gas, and is the source for practically all the O₂ in Earth's atmosphere. Photosystem I typically work in series with Photosystem II, thus the P700⁺ of Photosystem I is usually reduced, via many intermediates in the thylakoid membrane, by electrons ultimately from Photosystem II. Electron transfer reactions in the thylakoid membranes are complex, however, and the source of electrons used to reduce P700⁺ can vary.

Chemical structure

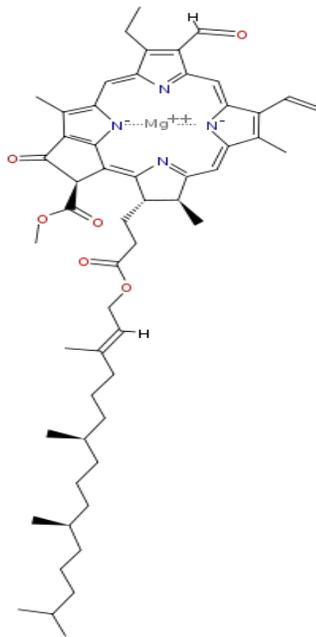
Chlorophyll is a **chlorin** pigment, which is structurally similar to and produced through the same metabolic pathway as other **porphyrin** pigments such as heme. At the **center of the chlorin ring is a magnesium ion**. The chlorin ring can have several different side chains, usually including a **long phytol chain**. There are a few different forms that occur naturally, but the most widely distributed form in terrestrial plants is chlorophyll *a*. The general structure of chlorophyll *a* was elucidated by Hans Fischer in 1940, and by 1960, when most of the stereochemistry of chlorophyll *a* was known, Robert Burns Woodward published a total synthesis of the molecule as then known. In 1967, the last remaining stereochemical elucidation was completed by Ian Fleming, and in 1990 Woodward and co-authors published an updated synthesis.

The different structures of chlorophyll are summarized below:

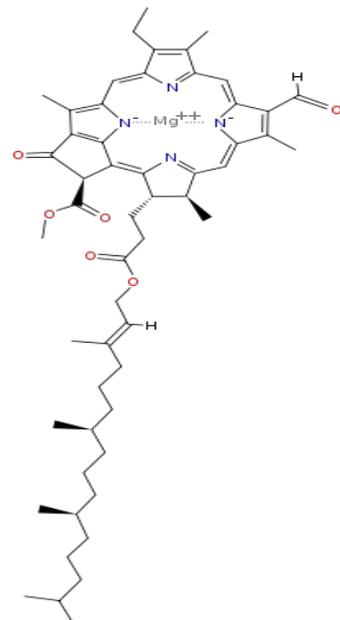
	Chlorophyll a	Chlorophyll b	Chlorophyll c1	Chlorophyll c2	Chlorophyll d
Molecular formula	C ₅₅ H ₇₂ O ₅ N ₄ Mg	C ₅₅ H ₇₀ O ₆ N ₄ Mg	C ₃₅ H ₃₀ O ₅ N ₄ Mg	C ₃₅ H ₂₈ O ₅ N ₄ Mg	C ₅₄ H ₇₀ O ₆ N ₄ Mg
C3 group	-CH=CH ₂	-CH=CH ₂	-CH=CH ₂	-CH=CH ₂	-CHO
C7 group	-CH ₃	-CHO	-CH ₃	-CH ₃	-CH ₃
C8 group	-CH ₂ CH ₃	-CH ₂ CH ₃	-CH ₂ CH ₃	-CH=CH ₂	-CH ₂ CH ₃
C17 group	-CH ₂ CH ₂ COO-Phytol	-CH ₂ CH ₂ COO-Phytol	-CH=CHCOOH	-CH=CHCOOH	-CH ₂ CH ₂ COO-Phytol
C17-C18 bond	Single	Single	Double	Double	Single
Occurrence	Universal	Mostly plants	Various algae	Various algae	Cyanobacteria



Structure of chlorophyll a

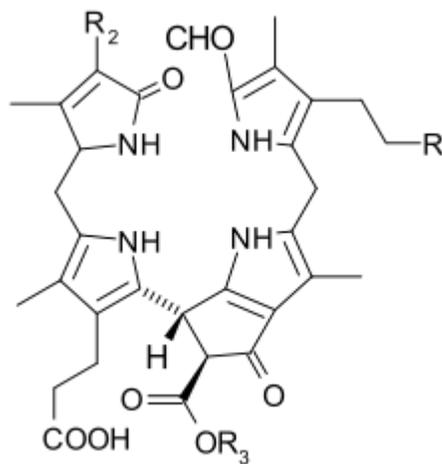


Structure of chlorophyll b

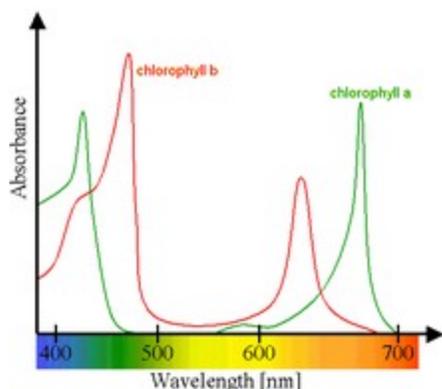


Structure of chlorophyll d

When leaves degreen in the process of plant senescence chlorophyll is converted to a group of colourless tetrapyrroles known as **nonfluorescent chlorophyll catabolites (NCC's)**. These compounds have also been identified in several ripening fruits. General structure of NCC's:



Spectrophotometry:-



Measurement of the absorption of light is complicated by the solvent used to extract it from plant material, which affects the values obtained. In diethyl ether, chlorophyll *a* has approximate absorbance maxima of 430 nm and 662 nm, while chlorophyll *b* has approximate maxima of 453 nm and 642 nm.

The absorption peaks of chlorophyll *a* are at 665 nm and 465 nm. Chlorophyll *a* fluoresces at 673 nm (maximum) and 726 nm. The peak molar absorption coefficient of chlorophyll *a* exceeds $10^5 \text{ M}^{-1} \text{ cm}^{-1}$, which is among the highest for small-molecule organic compounds.

Biosynthesis

In plants, chlorophyll may be synthesized from succinyl-CoA and glycine, although the immediate precursor to chlorophyll *a* and *b* is protochlorophyllide. In Angiosperms, the last step, conversion of protochlorophyllide to chlorophyll, is light-dependent and such plants are pale (etiolated) if grown in the darkness. Non-vascular plants and green algae have an additional light-independent enzyme and grow green in the darkness as well.

Chlorophyll itself is bound to proteins and can transfer the absorbed energy in the required direction. Protochlorophyllide, differently, mostly occur in the free form and under light conditions act as photosensitizer, forming highly toxic free radicals. Hence plants need an efficient mechanism of regulating the amount of chlorophyll precursor. In angiosperms, this is done at the step of aminolevulinic acid (ALA), one of the intermediate compounds in the biosynthesis pathway. Plants that are fed by ALA accumulate high and toxic levels of protochlorophyllide, so do the mutants with the damaged regulatory system.

- **BETALAIN:-**

Betalains are a class of **red and yellow indole-derived pigments** found in plants of the Caryophyllales, where they replace anthocyanin pigments, as well as some higher order fungi. They are most often noticeable in the petals of flowers, but may color the fruits, leaves, stems, and roots of plants that contain them. They include powerful antioxidant pigments such as those found in beets.

Description

The name "betalain" comes from the **Latin** name of the common beet (**Beta vulgaris**), from which betalains were first extracted. The deep red color of beets, bougainvillea, amaranth, and many cacti results from the presence of betalain pigments. The particular shades of **red to purple** are **distinctive** and unlike that of anthocyanin pigments found in most plants. Betalains may occur in any part of the plant, including the petals of flowers, fruits, leaves, stems, and roots.

There are two categories of betalains:

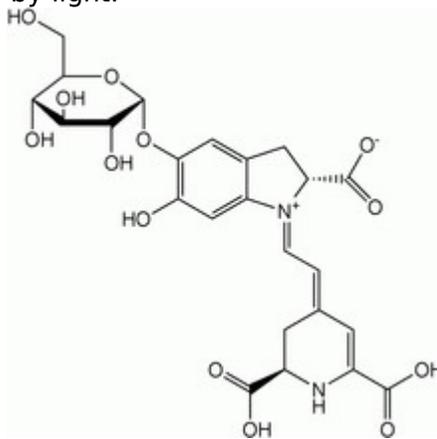
- Betacyanins include the reddish to violet betalain pigments.
- Betaxanthins are those betalain pigments which appear yellow to orange.

Among the betaxanthins present in plants include vulgaxanthin, miraxanthin and portulaxanthin, and indicaxanthin.

Plant physiologists are uncertain of the function that betalains serve in those plants which possess them, but there is some preliminary evidence that they may have fungicidal properties.

Chemistry

It was once thought that betalains were related to anthocyanins, the reddish pigments found in most plants. Both betalains and anthocyanins are water-soluble pigments found in the vacuoles of plant cells. However, betalains are structurally and chemically unlike anthocyanins. For example, betalains contain nitrogen whereas anthocyanins do not. It is now known that betalains are **aromatic indole derivatives synthesized from tyrosine**. They are not related chemically to the anthocyanins and **are not even flavonoids**. Each **betalain is a glycoside**, and consists of a **sugar and a colored portion**. Their synthesis is promoted by light.



The most heavily studied betalain is betanin, also called beetroot red after the fact that it may be extracted from red beet roots. Betanin is a glucoside, and hydrolyzes into the sugar glucose and betanidin. It is used as a food coloring agent, and the color is sensitive to pH. Other betalains known to occur in beets are isobetanin, probetanin, and neobetanin. Other important betacyanins are amaranthine and isoamaranthine, isolated from species of Amaranthus.

▪ **MYOGLOBIN:-**

Myoglobin is **an oxygen-binding protein** found in the muscle tissue of vertebrates in general and in almost all mammals. It is the heme portion of iron that gives both red blood cells and red muscle their color. In blood, the hemoglobin contains iron, whereas in muscle cells it is the myoglobin that contains the iron. Red blood cells contain hemoglobin, not myoglobin, and so it is hemoglobin that gives red blood cells their color. The only time myoglobin is found in the bloodstream is following muscle injury, when it is released as the result. It is an abnormal finding, and can be diagnostically relevant when found in blood. Myoglobin (**abbreviated Mb**) is a **single-chain globular protein of 153 or 154 amino acids, containing a heme (iron-containing porphyrin) prosthetic group in the center**

around which the remaining apoprotein folds. It has **eight alpha helices and a hydrophobic core.** It has a molecular weight of **16,700 daltons**, and is the **primary oxygen-carrying pigment** of muscle tissues. Unlike the blood-borne hemoglobin, to which it is structurally related, this protein does not exhibit cooperative binding of oxygen, since positive cooperativity is a property of multimeric/oligomeric proteins only. Instead, the binding of oxygen by myoglobin is unaffected by the oxygen pressure in the surrounding tissue. Myoglobin is often cited as having an "instant binding tenacity" to oxygen given its hyperbolic oxygen dissociation curve. High concentrations of myoglobin in muscle cells allow organisms to hold their breaths longer. Diving mammals such as whales and seals have muscles with particularly high myoglobin abundance.



Myoglobin was the first protein to have its three-dimensional structure revealed. In 1958, John Kendrew and associates successfully determined the structure of myoglobin by high-resolution X-ray crystallography. For this discovery, John Kendrew shared the 1962 Nobel Prize in chemistry with Max Perutz.

Meat color

Myoglobin forms pigments responsible for making meat red. The color that meat takes is partly determined by the charge of the iron atom in myoglobin and the oxygen attached to it. When meat is in its raw state, the iron atom is in the +2 oxidation state, and is bound to a dioxygen molecule (O_2). Meat cooked well done is brown because the iron atom is now in the +3 oxidation state, having lost an electron, and is now coordinated by a water molecule. Under some conditions, meat can also remain pink all through cooking, despite being heated to high temperatures. If meat has been exposed to nitrites, it will remain pink because the iron atom is bound to NO, nitric oxide (true of, e.g., corned beef or cured hams). Grilled meats can also take on a pink "smoke ring" that comes from the iron binding a molecule of carbon monoxide to give metmyoglobin. Raw meat packed in a carbon monoxide atmosphere also shows this same pink "smoke ring" due to the same coordination chemistry. Notably, the surface of the raw meat also displays the pink color, which is usually associated in consumers' minds with fresh meat. This artificially-induced pink color can persist in the meat for a very long time, reportedly up to one year. Hormel and Cargill are both reported to use this meat-packing process, and meat treated this way has been in the consumer market since 2003. Myoglobin is found in Type I muscle, Type II A and Type II B, but most texts consider myoglobin not to be found in smooth muscle.

Structure and bonding

Myoglobin contains a **porphyrin ring** with an **iron center**. There is a **proximal histidine** group attached directly to the iron center, and a **distal histidine** group on the opposite face, not bonded to the iron.

Many functional models of myoglobin have been studied. One of the most important is that of **picket fence porphyrin** by **James Collman**. This model was used to show the importance of the distal prosthetic group. It serves three functions:

To form hydrogen bonds with the dioxygen moiety, increasing the O₂ binding constant

To prevent the binding of carbon monoxide, whether from within or without the body. Carbon monoxide binds to iron in an end-on fashion, and is hindered by the presence of the distal histidine, which forces it into a bent conformation. CO binds to heme 23,000 times better than O₂, but only 200 times better in hemoglobin and myoglobin. Oxygen binds in a bent fashion, which can fit with the distal histidine.

To prevent irreversible dimerization of the oxymyoglobin with another deoxymyoglobin species.

- **PAPRIKA:-**

Paprika is a spice made from the grinding of dried fruits of **Capsicum annuum** (e.g., bell peppers or chili peppers). In many European languages, the word paprika refers to bell peppers themselves. The seasoning is used in many cuisines to add color and flavor to dishes. Paprika can range from sweet (mild, not hot) to spicy (hot). Flavors also vary from country to country.



Usage

Paprika is used as an ingredient in a broad variety of dishes throughout the world. Paprika is principally used to season and color rices, stews, and soups, such as goulash, and in the preparation of

Sausages as an ingredient that is mixed with meats and other spices.

Paprika was first produced in Spain, as that country was also responsible for the introduction of the bell pepper into Europe. The highest quality paprika and most expensive paprika comes from Spain.

Nutrition

Capsicum peppers used for paprika are unusually rich in **vitamin C**, a fact discovered in **1932** by **Hungary's 1937 Nobel prize-winner Albert Szent-Györgyi**. Much of the vitamin C content is retained in paprika, which contains more vitamin C than lemon juice by weight. Paprika is also high in other antioxidants, containing about 10% of the level found in açai berries. Prevalence of nutrients, however, must be balanced against quantities ingested, which are generally negligible for spices.

- **Synthetic Food Colors**

Synthetic Food Colors also known as Artificial Food Colours, are manufactured chemically and are the most commonly used dyes in the food, pharmaceutical and cosmetic industries. Seven dyes were initially approved under the Pure Food and Drug Act of 1906, but several have been delisted and replacements have been found.

- **Current seven**

In the USA, the following seven artificial colorings are permitted in food under act of 2007:

- **FD&C Blue No. 1 - Brilliant Blue FCF, E133** (Blue shade)
- FD&C Blue No. 2 - Indigotine, E132 (Dark Blue shade)
- FD&C Green No. 3 - Fast Green FCF, E143 (Bluish green shade)
- **FD&C Red No. 40 - Allura Red AC, E129** (Red shade)
- FD&C Red No. 3 - Erythrosine, E127 (Pink shade)
- **FD&C Yellow No. 5 - Tartrazine, E102** (Yellow shade)
- FD&C Yellow No. 6 - Sunset Yellow FCF, E110 (Orange shade)

- **Delisted**

- FD&C Red No. 2 - Amaranth (dye)
- FD&C Red No. 4
- FD&C Red No. 32 was used to color Florida oranges.
- FD&C Orange No. 1, was one of the first water soluble dyes to be commercialized, and one of seven original food dyes allowed under the Pure Food and Drug Act of June 30, 1906.
- FD&C Orange No. 2 was used to color Florida oranges.
- FD&C Yellows No. 1, 2, 3, and 4
- FD&C Violet No. 1

Synthetic colors are of two types;

- **Primary Food Colors**

Primary colors are those when they are mixed produce other colors.

A list of primary colours is given below:-

	Product/Colour Shade	C.I.No.	F.D. & C.No	E.No.
	QUINOLINE YELLOW	47005	-	E 104
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	TARTRAZINE	19140	Yellow 5	E 102
	(Tri sodium salt of 5-hydroxy (1-p-sulphophenyl 4- (p-sulphophenylazo) pyrazol -3- carboxylic acid			
	SUNSET YELLOW FCF	15985	Yellow 6	E 110
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	ERYTHROSINE	45430	Red 3	E 127
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	PONCEAU 4R	16255	-	E 124
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			

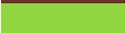
	ALLURA RED	16035	Red 40	E 129
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	CARMOISINE	14720	-	E 122
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	AMARANTH	16185	Red 2	E 123
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	CHOCOLATE BROWN HT	20285	-	E 155
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	BRILLIANT BLUE FCF	42090	Blue 1	E 133
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	PATENT BLUE V	42015	-	E 131
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	INDIGO CARMINE	73015	Blue 2	E 132
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	BLACK PN	28440	-	E 151
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	FAST RED E	16045	-	-
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	GREEN S	44090	-	E 142
	(Di sodium salt of disulfonates of 2-(2quinoly) - 1, 3 indandione.)			
	RED 2G	18050	-	E 128
	(Di sodium salt of 8-actamido-1-hydroxy-2- phenylazonaphthalene-3,6 disulphonate)			

▪ Blended Food Colors

Blended Colors are prepared from mixing of previously certified batches of primary colors. Blends can be made available to meet specific requirements of a customer in terms of shade and strength.

Widely used blends are:-

	EGG YELLOW	VC 10
	YOLK YELLOW	VC 11
	ORANGE RED	VC 12
	STRAWBERRY RED	VC 13
	ROSE PINK	VC 14
	RASPBERRY RED	VC 15
	GRAPE	VC 16
	VIOLET	VC 17

	COFFEE BROWN	VC 18
	CHOCOLATE BROWN	VC 19
	DARK CHOCOLATE	VC 20
	LIME GREEN	VC 21
	APPLE GREEN	VC 22
	PEA GREEN	VC 23
	BLACK CURRANT	VC 24

Detail of few synthetic colors is here;

▪ **TARTRAZINE:-**

Tartrazine (**E number E102 or C.I. 19140**) is a **synthetic lemon yellow** azo dye used as a food coloring. It is **water soluble** and has a maximum absorbance in an aqueous solution at 427 ± 2 nm.

Tartrazine is a commonly used color all over the world, mainly for yellow, but can also be used with Brilliant Blue FCF (FD&C Blue 1, E133) or Green S (E142) to produce various green shades.

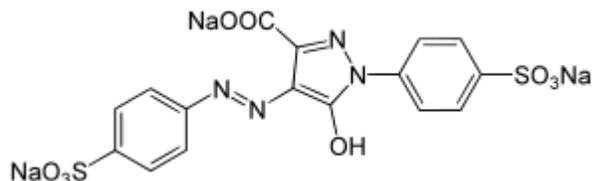
IUPAC NAME

Trisodium (4*E*)-5-oxo- 1-(4-sulfonatophenyl)- 4-[(4-sulfonatophenyl)hydrazono]- 3-pyrazolecarboxylate

Other name: FD&C Yellow 5

Molecular formula: $C_{16}H_9N_4Na_3O_9S_2$

Molar mass: 534.3 g/ mol



Products including tartrazine commonly include confectionery, cotton candy, soft drinks (Mountain Dew), energy drinks, instant puddings, flavored corn chips, cereals (corn flakes, muesli, etc.), cake mixes, pastries, custard powder, soups (particularly instant or "cube" soups), sauces, some rices (like paella, risotto, etc.), powdered drink mixes, sports drinks, ice cream, ice pops, candy, chewing gum, marzipan, jam, jelly, gelatins, marmalade, mustard, yogurt, noodles such as Kraft Dinner, pickles and other pickled products, certain brands of fruit squash, fruit cordial, potato chips, Biscuits, and many convenience together with glycerin, lemon and honey products.

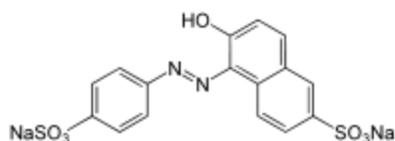
▪ **SUNSET YELLOW FCF:-**

IUPAC name

Disodium 6-hydroxy-5-[(4-sulfophenyl)azo]-2-naphthalenesulfonate

Other names:

Orange Yellow S; FD&C Yellow 6; C.I. 15985; E110



Molecular formula : $C_{16}H_{10}Na_2O_7S_2N_2$

Molar mass: 452.37 g/mol

Melting point 300 °C

Sunset Yellow FCF (also known as **Orange Yellow S**, **FD&C Yellow 6** or **C.I. 15985**) is a colorant that may be added to foods to induce a color change. It is denoted by **E Number E110**, and has the capacity for inducing an allergic reaction:

It is a synthetic coal tar and azo yellow dye useful in **fermented foods** which must be heat treated. It may be found in orange squash, orange jelly, marzipan, Swiss roll, apricot jam, citrus marmalade, lemon curd, sweets, hot chocolate mix and packet soups, trifle mix, breadcrumbs and cheese sauce mix and soft drinks. Specifically it can be found in the capsules of Dayquil (in high concentrations), some extra strength Tylenol, Astro peach yogurt, fortune cookies, some red sauces, certain pound cakes, Cheetos, snack chips, and other yellow, orange, and red food products.

Sunset Yellow is often used in conjunction with E123, Amaranth, in order to produce a brown colouring in both chocolates and caramel:

At high concentrations, Sunset Yellow in solution with water undergoes a phase change from **anisotropic liquid** to a **nematic liquid crystal**. This occurs between **0.8 M and 0.9 M** at room temperature.

Sunset Yellow is a **sulfonated version of Sudan I**, a possible carcinogen, which is frequently present in it as an impurity. Sunset Yellow itself may be responsible for causing an allergic reaction in people with an aspirin intolerance, resulting in various symptoms including gastric upset, diarrhoea, vomiting, nettle rash (urticaria) and swelling of the skin (angioedema). The coloring has also been linked to hyperactivity in young children. As a result of these problems, there have been repeated calls for the total withdrawal of Sunset Yellow from food use.

▪ **ALLURA RED AC:-**

IUPAC name

Disodium 6-hydroxy-5-((2-methoxy-5-methyl-4-sulfophenyl)azo)-2-naphthalene-sulfonate

Other names : Allura Red, Food Red 17, C.I. 16035, FD&C Red 40, E129, 2-naphthalenesulfonic acid disodium salt

Molecular formula : $C_{18}H_{14}N_2Na_2O_8S_2$

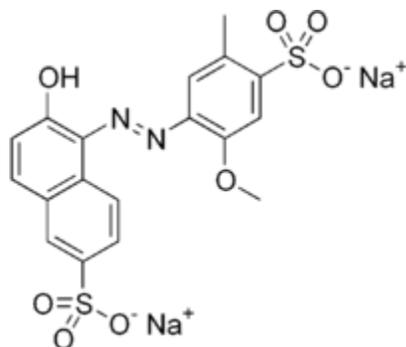
Molar mass: 496.42 g mol⁻¹

Appearance: dark red powder

Melting point>300 °C

Allura Red AC is a red azo dye that goes by several names including: Allura Red, Food Red 17, C.I. 16035, FD&C Red 40, 2-naphthalenesulfonic acid, 6-hydroxy-5-((2-methoxy-5-methyl-4-sulfophenyl)azo)-, disodium salt, and disodium 6-hydroxy-5-((2-methoxy-5-methyl-4-sulfophenyl)azo)-2-naphthalene-sulfonate. It is used as a food dye and has the E

number **E129**. Allura Red AC was originally introduced in the United States as a replacement for the use of amaranth as a food coloring. It has the appearance of a dark red powder. It usually comes as a **sodium salt** but can also be used as both calcium and potassium salts.



It is **soluble in water**. In water solution, its **maximum absorbance** lies at about **504 nm**. Its melting point is at >300 degrees Celsius.

Allura Red AC is one of many High Production Volume Chemicals.

Red AC was originally manufactured from **coal tar** but is now mostly made from petroleum. Despite the popular misconception, Allura Red AC is not derived from any insect, unlike the food coloring carmine which is derived from the female cochineal insect.

Related dyes include Sunset Yellow FCF, Scarlet GN, tartrazine, and Orange B.

Allura Red AC has fewer health risks associated with it in comparison to other azo dyes. However, some studies have found some adverse health effects that may be associated with the dye.

Regulation

In Europe, Allura Red AC is not recommended for consumption by children. It is banned in Denmark, Belgium, France, Switzerland, and Sweden. The European Union approves Allura Red AC as a food colorant, but EU countries' local laws banning food colorants are preserved. In Norway, it was banned between 1978 and 2001, a period in which azo dyes were only legally used in alcoholic beverages and some fish products.

In the United States, Allura Red AC is approved by the Food and Drug Administration for use in cosmetics, drugs, and food. It is used in some tattoo inks and is used in many products, such as soft drinks, children's medications, and cotton candy.

▪ **BRILLIANT BLUE FCF:-**

Other names

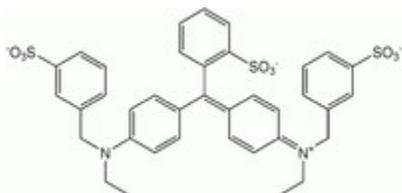
FD&C Blue No.1, Acid Blue 9, D&C Blue No. 4, Alzen Food Blue No. 1, Atracid Blue FG, Erioglaucine Eriosky blue, Patent Blue AR, Xylene Blue VSG

Molecular formula ; $C_{37}H_{34}N_2Na_2O_9S_3$

Brilliant Blue FCF, also known under commercial names, is a colorant for foods and other substances to induce a color change. It is denoted by E number **E133** and has a **color index of 42090**. It has the appearance of a **reddish-blue powder**. It is **soluble in water**, and the solution has a **maximum absorption** at about **628 nanometer**.

Chemistry

It is a synthetic dye derived from coal tar. It can be combined with tartrazine (E102) to produce various shades of green.



It is usually a **disodium salt**. The diammonium salt has CAS number [2650-18-2]. Calcium and potassium salts are also permitted. It can also appear as an **aluminium lake**. The dye is poorly absorbed from the gastro-intestinal tract and 95% of the absorbed dye can be found in the feces. It also reacts with certain bile pigments to form green feces.

Applications

As a blue color, Brilliant Blue FCF is often found in ice cream, tinned processed peas, dairy products, sweets and drinks. It is also used in soaps, shampoos, and other hygiene and cosmetics applications. In soil science, Brilliant Blue is applied in tracing studies to visualize infiltration and water distribution in the soil. It is used as the stain in Listerine's Agent Cool Blue mouthwash.

Health and safety

Brilliant Blue FCF has previously been banned in Austria, Belgium, Denmark, France, Germany, Greece, Italy, Norway, Spain, Sweden, and Switzerland among others but has been certified as a safe food additive in the EU and is today unbanned in most of the countries. It has the capacity for inducing an allergic reaction in individuals with pre-existing moderate asthma.

▪ **BRILLIANT BLACK BN:-**

IUPAC name

Tetra sodium (6Z)-4-acetamido-5-oxo-6-[[7-sulfonato-4-(4-sulfonatophenyl)azo-1-naphthyl]hydrazono]naphthalene-1,7-disulfonate

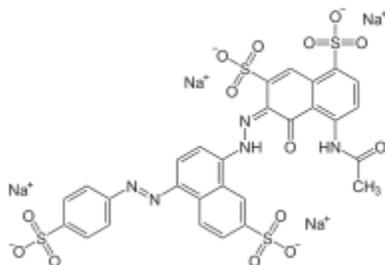
Other names

C.I. Food Black 1; 1743 Black; Black PN; Blue Black BN; Brilliant Acid Black; C.I. 28440; Certicol Black PNW; Cilefa Black B; E 151; Edicol Supra Black BN; Hexacol Black PN; L Black 8000; Melan Black; Xylene Black F

Molecular formula :C₂₈H₁₇N₅Na₄O₁₄S₄

Molar mass: 867.68 g/mol

Brilliant Black BN is a synthetic black diazo dye. It is **soluble** in water. It usually comes as **tetrasodium** salt. It has the appearance of **solid, fine powder** or **granules**. Calcium and potassium salts are allowed as well.



When used as a food dye, its E number is **E151**. It is used in food decorations and coatings, desserts, sweets, ice cream, mustard, red fruit jams, soft drinks, flavored milk drinks, fish paste, lumpfish caviar and other foods.

It appears to cause allergic or intolerance reactions, particularly amongst those with an aspirin intolerance. It is a histamine liberator, and may worsen the symptoms of asthma.

It is one of the colorants that the Hyperactive Children's Support Group recommends be eliminated from the diet of children. It is banned in Canada, United States, Finland and Japan.

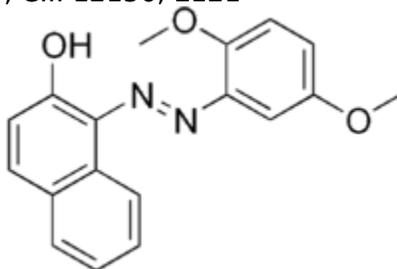
- **CITRUS RED2:-**

IUPAC name

1-(2,5-Dimethoxy-phenylazo)-naphthalen-2-ol

Other names

Citrus Red No. 2, C.I. Solvent Red 80, C.I. 12156, E121

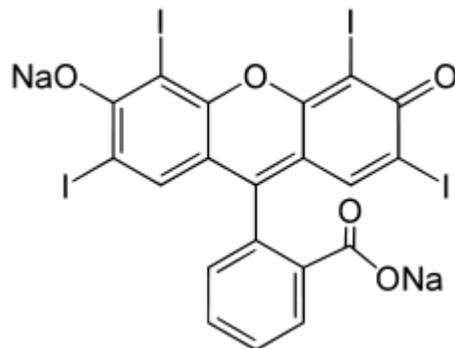


Citrus Red 2, Citrus Red No. 2, C.I. Solvent Red 80, or C.I. 12156 is an artificial dye. As a food dye, it is permitted by Food and Drug Administration (FDA) since 1956 only for use in the United States on skin on some oranges. While the dye is a carcinogen, it does not penetrate the orange peel into the pulp¹. It is an **orange to yellow solid or a dark red powder** with a **melting point of 156 °C**.

Citrus Red 2 is **not water-soluble**, but readily soluble in many organic solvents.

- **ERYTHROSINE:-**

Erythrosine, also known as Red No. 3, is a **cherry-pink synthetic fluorine** food coloring. It is the **disodium salt** of **2,4,5,7-tetraiodofluorescein**.



Its maximum absorbance is at **530 nm** in an aqueous solution, and it is subject to photo degradation.

Uses

It is used as a food coloring, in printing inks, as a biological stain, a dental plaque disclosing agent and a radiopaque medium. Erythrosine is commonly used in sweets such as some candies and popsicles, and even more widely used in cake-decorating gels. It is also used to color pistachio shells. As a food additive, it has the E number **E127**.

▪ **FAST GREENFCF:-**

IUPAC name :ethyl - [4 - [[4 - [ethyl -[(3 - sulfophenyl) methyl] amino] phenyl] - (4 - hydroxy - 2 - sulfophenyl) methylidene] - 1 - cyclohexa - 2, 5 - dienylidene] - [(3 - sulfophenyl) methyl] azanium

Other names

Food green 3, FD&C Green No. 3, Green 1724, Solid Green FCF, and C.I. 42053

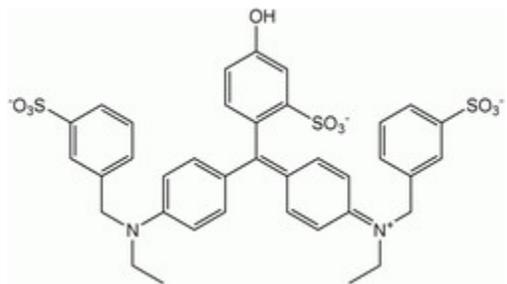
Molecular formula : **C₃₇H₃₇N₂O₁₀S₃⁺**

Fast Green FCF is a **sea green triarylmethane** food dye. Its E number is **E143**.

Its absorption maximum is at 625 nm.

Fast Green FCF is poorly absorbed by the intestines. Its use as a food dye is prohibited in European Union and some other countries.

It can be used for tinned green peas and other vegetables, jellies, sauces, fish, desserts, and dry bakery mixes at level of up to 100 mg/kg.



Toxicology

This substance has been found to have Tumorigenic effects in experimental animals, as well as Mutagenic effects in both experimental animals and humans. It furthermore risks irritation of eyes, skin, digestive tract, and respiratory tract in its undiluted form.

▪ **GREEN S:-**

IUPAC name:-

Sodium 4-[(4-dimethylaminophenyl)-(4-dimethylazaniumylidene-1-cyclohexa-2,5-dienylidene)methyl]-3-hydroxynaphthalene-2,7-disulfonate

Other names

Food Green S; FD&C Green 4; Acid green 50; Lissamine Green B; Wool Green S; C.I. 44090; E142

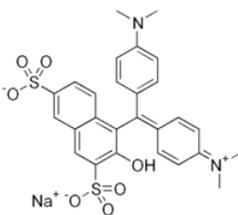
Green S is a green synthetic coal tar triarylmethane dye with the molecular formula

C₂₇H₂₅N₂O₇S₂Na.

As a food dye, it has **E number E142**. It can be used in mint sauce, desserts, gravy granules, sweets, ice creams, and tinned peas. Green S is prohibited as a food additive in Canada, United States, Japan, and Norway.

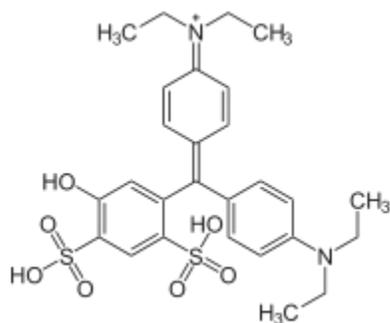
Green S is a vital dye, meaning it can be used to stain living cells. It is used in ophthalmology, among fluorescein and rose Bengal, to diagnose various disorders of the eye's surface.

Green S may cause allergic reactions and is one of the colorants that the Hyperactive Children's Support Group recommends to be eliminated from the diet of children.



▪ **PATENT BLUE V:-**

Patent Blue V, also called Food Blue 5 or Sulphan Blue, is a dark bluish synthetic dye used as a food coloring. As a food additive, it has E number **E131**. It is a **sodium or calcium salt** of [4-(α-(4-diethylaminophenyl)-5-hydroxy- 2,4-disulfophenyl-methylidene)-2,5-cyclohexadien-1-ylidene] diethyl ammonium hydroxide inner salt. It has the appearance of a **violet powder**.



Its CAS number is [3536-49-0] and its SMILES structure

is CCN(CC)c1ccc(cc1)C(=C2C=CC(=C2)=[N+](CC)CC)c3cc(O)c(OS([O-])=O)cc3OS([O-])=O. It is not widely used, but can be found in Scotch eggs and certain jelly sweets. Patent Blue V is banned as a food dye in Australia, USA, and Norway.

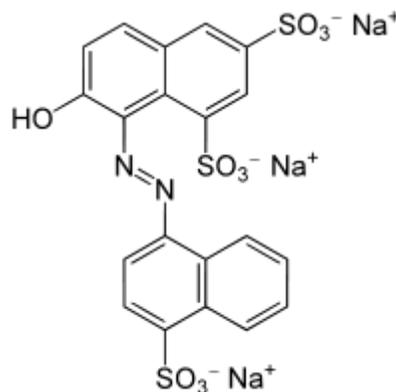
▪ **PONCEAU 4R:-**

IUPAC name

Trisodium (8Z)-7-oxo-8-[(4-sulfonatophenyl)hydrazinylidene]naphthalene-1,3-disulfonate

Ponceau 4R (also known as C.I. 16255 · Cochineal Red A · C.I. Acid Red 18, Brilliant Scarlet 3R, Brilliant Scarlet 4R, New Cochineal, SX purple) is a synthetic colorant that may be added to foods to induce a color change. It is denoted by E Number **E124**. Its chemical name is trisodium salt of 1-(4-sulpho-1-naphthylazo)-2-naphthol-6,8-disulphonic acid.

Ponceau 4R is a **red azo dye** usually synthesized from coal tar which can be used in a variety of food products.

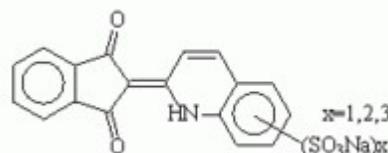


Health effects

Because it is an azo dye, it may elicit intolerance in people allergic to salicylates (aspirin). Additionally, it is a histamine liberator, and may intensify symptoms of asthma. Ponceau 4R is considered carcinogenic in some countries, including the USA, Norway, and Finland, and it is currently listed as a banned substance by the U.S. Food and Drug Administration (FDA).

▪ **QUINOLINE YELLOW WS:-**

Quinoline yellow, Quinoline Yellow WS, C.I. 47005, or Food Yellow 13, is a **yellow food dye**. Chemically it is a mixture of **disulfonates** (principally), monosulfonates and trisulfonates of 2-(2-quinolylyl)indan-1,3-dione.



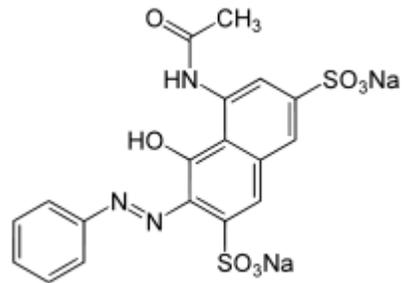
The color Quinoline Yellow SS (Spirit Soluble), which lacks the sulfonate groups, is a related form that is insoluble in water.

Uses

As a food additive with the **E number E104**, it is used as colorant that induces a **dull yellow**, or **greenish yellow color**.

▪ **RED 2G:-**

Red 2G is a synthetic red azo dye. It is **soluble in water** and **slightly soluble in ethanol**. It usually comes as a **disodium salt** of 8-acetamido-1-hydroxy-2-phenylazonaphthalene-3,6-disulphonate.



Food dye

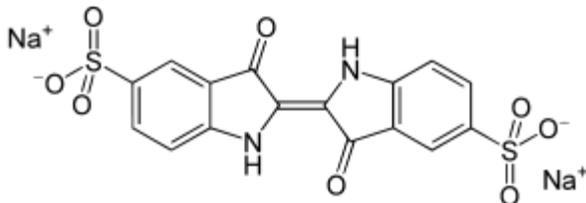
In the European Union, Red 2G is used as a food dye **E number E128**. However, it is only permitted for use in breakfast sausages with a minimum cereal content of 6% and burger meat with a minimum vegetable and/or cereal content of 4%.

Red 2G is banned in Australia, Austria, Canada, Japan, Norway, Sweden, Malaysia and the United. It was banned in Ireland, Israel and Greece in July 2007.

It is relatively insensitive to the bleaching effect of sulfur dioxide (E220) and sodium metabisulfite (E223). In the intestines, Red 2G can be converted to the toxic compound aniline, so there are concerns Red 2G may ultimately interfere with blood hemoglobin, as well as cause cancer.

▪ **INDIGO CARMINE:-**

Indigo Carmine, or 5,5'-indigodisulfonic acid **sodium salt**, is a pH indicator with the chemical formula **C₁₆H₈N₂Na₂O₈S₂**



Uses

The primary use of Indigo carmine is as a pH indicator. It is blue at pH 11.4 and yellow at 13.0. Indigo carmine is also a redox indicator, turning yellow upon reduction. Another use is as a dissolved ozone indicator. It is also used as a dye in the manufacturing of capsules.

Indigo Carmine (pH indicator)	
below pH 11.4	above pH 13.0
11.4	13.0

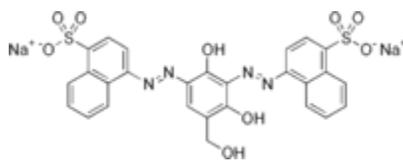
Health concerns

Indigo carmine is harmful to the respiratory tract if swallowed. It is also an irritant to the skin and eyes. Proper laboratory cautions (lab coat, gloves, and goggles) are advised.

- **CHOCLATE BROWN :-**

IUPAC name

Disodium 4-[(2E)-2-[(5Z)-3-(hydroxymethyl)-2,6-dioxo-5-[(4-sulfonatophthalen-1-yl)hydrazinylidene]-1-cyclohex-3-enylidene]hydrazinyl]naphthalene-1-sulfonate



Other names: Chocolate Brown HT, Food Brown 3, C.I. 20285, E155

Molecular formula : C₂₇H₁₈N₄Na₂O₉S₂

Molar mass: 652.56 g/mol

Chocolate Brown is a **brown synthetic coal tar diazo dye**.

When used as a food dye, its E number is **E155**. It is used to substitute **cocoa or caramel** as a colorant. It is used mainly in chocolate cakes, but also in milk and cheeses, yoghurts, jams, fruit products, fish, and other products. It may provoke allergic reactions in asthmatics, people sensitive to aspirin, and other sensitive individuals, and may induce skin sensitivity.

It is one of the food colorings that the Hyperactive Children's Support Group recommends be eliminated from the diet of children. It is banned in Austria, Belgium, Denmark, France, Germany, United States, Norway, Switzerland, and Sweden.

It is used in nearly every major brand of chocolate flavored milk in Australia.

- **Dyes and lakes**

Color additives are available for use in food as either "dyes" or lake pigments (commonly known as "lakes").

Dyes dissolve in water, but are not soluble in oil. Dyes are manufactured as **powders, granules, liquids** or other special purpose forms. They can be used in beverages, dry mixes, baked goods, confections, dairy products, pet foods, and a variety of other products. Dyes also have side effects which lakes do not, including the fact that large amounts of dyes ingested can color stools.

Lakes are made by combining dyes with salts to make insoluble compounds. Lakes tint by **dispersion**. Lakes are **not oil soluble**, but are **oil dispersible**. Lakes are more stable than dyes and are ideal for coloring products containing fats and oils or items lacking sufficient moisture to dissolve dyes. Typical uses include coated tablets, cake and doughnut mixes, hard candies and chewing gums, lipsticks, soaps, shampoos, talc, etc.

	LAKE QUINOLINE YELLOW	47005:1	E 104
	LAKE TARTRAZINE	19140:1	E 102
	LAKE SUNSET YELLOW FCF	15985:1	E 110
	LAKE ERYTHROSINE	45430:1	E 127
	LAKE PONCEAU 4R	16255:1	E 124
	LAKE ALLURA RED	16035:1	E 129

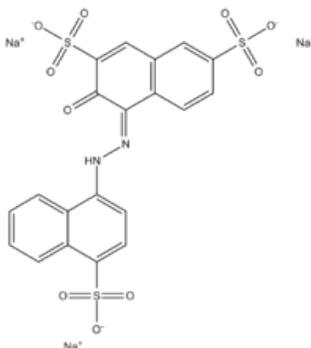
	LAKE CARMOISINE	14720:1	E 128
	LAKE AMARANTH	16185:1	E 123
	LAKE CHOCOLATE BROWN HT	20285:1	E 155
	LAKE BRILLIANT BLUE FCF	42090:1	E 133
	LAKE INDIGO CARMINE	73015:1	E 132

Lake pigments find wide usage in areas like foodstuffs, pet foods, drugs and pharmaceuticals, cosmetics, plastics, plastic films, can linings, plastic food containers, inks and stationery.

- **AMARANTH (DYE):-**

IUPAC name

trisodium (4E)-3-oxo-4-[(4-sulfonato-1-naphthyl)hydrazono]naphthalene-2,7-disulfonate



Other names:

FD&C Red No. 2, E123, C.I. Food Red 9, Acid Red 27, Azorubin S, C.I. 16185

Molecular formula : C₂₀H₁₁N₂Na₃O₁₀S₃

Molar mass : 604.47305

Melting point 120 °C (decomposes)

Amaranth is a dark red to purple azo dye in powder form.

once used as a food dye and to color cosmetics, but since 1976 it has been banned in the United States by the Food and Drug Administration (FDA) as it is a suspected carcinogen.

It usually comes as a **trisodium salt**. It has the appearance of **reddish-brown, dark red to purple water-soluble powder** that **decomposes at 120 °C without melting**. Its water solution has absorption maximum at about **520 nm**. Amaranth is made from **coal tar**. Amaranth is **an anionic dye**. It can be applied to natural and synthetic fibers, leather, paper, and phenol-formaldehyde resins. As a food additive it has E number **E123**. Amaranth's use is still legal in some countries, notably in the United Kingdom where it is most commonly used to give glace cherries their distinctive color.

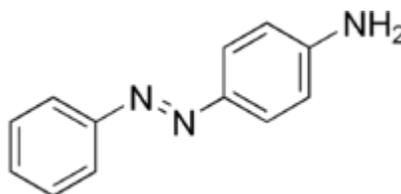
- **ANILINE YELLOW:-**

IUPAC name

4-Phenyldiazenylaniline

Other names:-

Ceres Yellow, Fast spirit Yellow, Oil Yellow AAB, Oil Yellow AN, Organol Yellow, Solvent Yellow, C.I. 11000

**Molecular formula :** $C_6H_5N=NC_6H_4NH_2$ **Molar mass :** 197.24 g/mol**Melting point :** 123-126 °C**Boiling point** > 360 °C

Aniline Yellow is a **yellow azo dye** and an **aromatic amine**. It is a **derivate of azobenzene**. It has the appearance of **an orange powder**. It is a carcinogen.

Aniline Yellow was the first azo dye. it was first produced in **1861 by C. Mene**. The second azo dye was Bismarck Brown in 1863. Aniline Yellow was commercialized in 1864 as the first commercial azo dye, a year after Aniline Black. It is manufactured from aniline.

Uses

Aniline Yellow is used in microscopy for vital staining. It is also used in insecticides, lacquers, varnishes, waxes, oil stains, and styrene resins. It is also an intermediate in synthesis of other dyes, eg. chrysoidin e, indulines, Solid Yellow, and Acid Yellow.

▪ AZO VOILET:-**IUPAC name**

4-(4-nitrophenyl) azobenzene-1, 3-diol

Other names

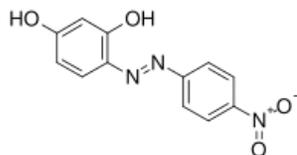
Azoviolet; Magneson

Molecular formula : $C_{12}H_9N_3O_4$ **Appearance:** dark red to brown crystalline powder**Density :** 1.45 g/cm³**Flash point :** 261.7 °C

Azo violet is an organic compound with the chemical formula $C_{12}H_9N_3O_4$. It is used as a dye and a pH indicator. It Forms **blue color** with **magnesium in slightly alkaline medium**. This reaction depends on adsorption of the dye on magnesium hydroxide. Ammonium ions reduce sensitivity of reaction.

Any salt or salt solution containing Magnesium will give this Violet coloring of solution.

However, ammonium compounds such as Ammonium Chloride or Ammonium Hydroxide will give a different color based on amount used. Still, it is used as identification test for Magnesium

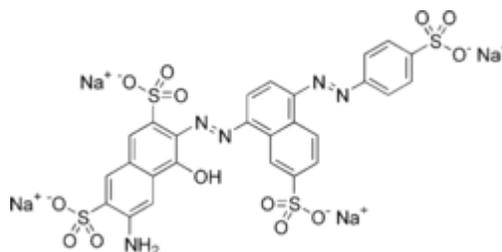


▪ **BLACK 7984:-**

IUPAC name

Tetra sodium 6-amino-4-hydroxy-3-[[7-sulfonato-4-[(4-sulfonatophenyl)azo]-1-naphthyl]azo]naphthalene-2,7-disulfonate

Other names: Food Black 2 , C.I. 27755



Molecular formula : $C_{26}H_{19}N_5Na_4O_{13}S_4$

Molar mass : 733.69 g/mol

Black 7984, Food Black 2, or C.I. 27755, is a **brown-to-black synthetic diazo dye**. It is often used as the **tetra sodium salt**.

When used as a food dye, it has E number **E152**. Its use in food is discontinued in USA and EU since 1984. It is also not permitted in Australia and Japan.

Black 7984 is also used in cosmetics.

Black 7984 may cause allergic or intolerance reactions, particularly amongst those with an aspirin intolerance. It is a histamine liberator, and may worsen the symptoms of asthma. It is one of the colorants that the Group recommends be eliminated from the diet of children.

▪ **FD&C Orange Number 1:-**

FD&C Orange Number 1 was one of the **first water soluble dyes** to be commercialized, and one of seven original food dyes allowed under the Pure of June 30, 1906. ^[1] In the early 1950s, after several cases were reported of sickness in children who had eaten foods with excessive amounts of dye, the FDA conducted new, more thorough and rigorous testing on food dyes. Orange 1 was outlawed for food use in 1956.

▪ **FAST YELLOW AB:-**

IUPAC name

2-amino-5-[(E)-(4-sulfophenyl) diazenyl]- benzenesulfonic acid

Other names:

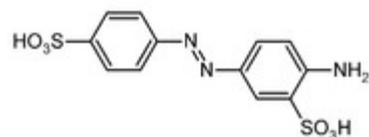
Fast Yellow, Acid Yellow, C.I. 13015, Food Yellow 2

Molecular formula : $C_{12}H_{11}N_3O_6S_2$

Molar mass : 357.36

Fast Yellow AB is an azo dye denoted by **E number E105**. It was used as a food dye.

It is now delisted in both Europe and USA and is forbidden if used in foods and drinks, as toxicological data has shown it is harmful.



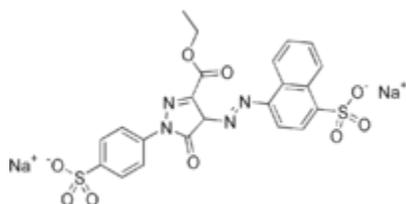
▪ ORANGE B:-

IUPAC name:

Disodium 4-[N'-[3-ethoxycarbonyl-5-oxo-1-(4-sulfonatophenyl)-4-pyrazolylidene]hydrazino]-1-naphthalenesulfonate

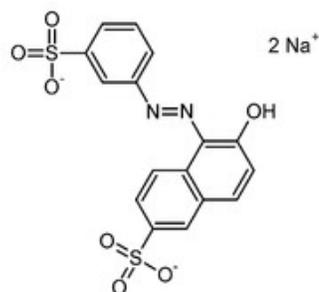
Other names: C.I. Acid Orange 137

Orange B is a food dye from the azo dye group. It is approved by Food and Drug Administration (FDA) for use only in hot dog and sausage casings or surfaces, only up to 150 ppm of the finished food weight. It usually comes as **disodium salt**.



ORANGE GGN:-

Orange GGN, also known as **alpha-naphthol orange**, is a food dye. In Europe it is denoted by the E Number **E111**. It is the **disodium salt of 1-(m-sulfophenylazo)-2-naphthol-6-sulfonic acid**.



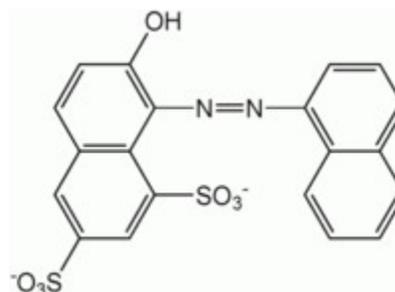
It is currently delisted in Europe and USA, because toxicological data has shown it is harmful. The absorption spectrum of Orange GGN and Sunset Yellow is nearly identical in **visible** and **ultraviolet** range, but they can be distinguished by their **IR spectra**.

▪ PONCEAU 6R:-

Ponceau 6R, or Crystal ponceau 6R, Crystal scarlet, Brilliant crystal scarlet 6R, Acid Red 44, or C.I. 16250, is a **red azo dye**. It is **soluble in water** and **slightly soluble in ethanol**. It is used as a food dye, with E number **E126**. It is also used in histology, for staining fibrin with the MSB Trichromestain. It usually comes as **disodium salt**.

Amaranth is a closely related azo dye, also usable in trichrome staining.

Its CAS number is [2766-77-0] and its SMILES structure is OC1=C(N=N C3=C(C=CC=C4) C4=CC=C3)C2=C (C=C(S(=O) ([O-])=O)C=C2 S(=O)([O-]) =O)C=C1.

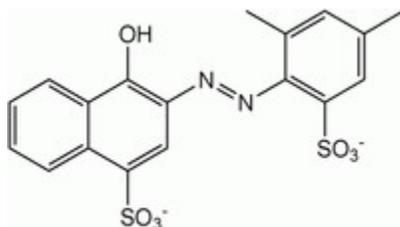


▪ **SCARLET GN:-**

Scarlet GN or C.I. Food Red 2, Ponceau SX, FD&C Red No. 4, or C.I. 14700 is a red azo dye used as a food dye. When used as a food additive, it has the E number **E125**. It usually comes as a **disodium salt**.

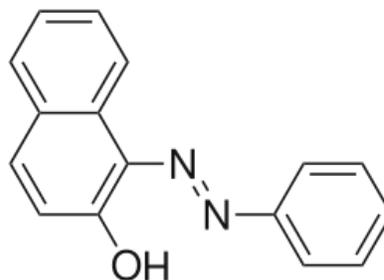
It is permitted in fruit peels and maraschino cherries.

Its CAS number is [4548-53-2] and its SMILES structure is OC2=C(/N=N/C3=C (S(=O)([O-])=O) C=C(C)C=C3)C=C (S(=O)([O-])=O) C1=CC=CC=C12.



▪ **SUDAN I:-**

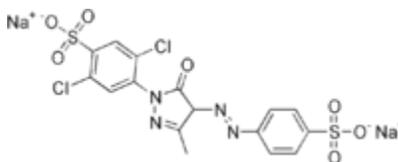
Sudan I (also commonly known as CI Solvent Yellow 14 and Solvent Orange R), is **alysochrome**, a **diazo-conjugate dye** with a **chemical formula of 1-phenylazo-2-naphthol**. Sudan I is a **powdered substance** with an **orange-red appearance**.



The additive is mainly used to color waxes, oils, petrol, solvents and polishes. Sudan I has also been adopted for coloring various foodstuffs, including particular brands of curry powder and chili powder, although the use of Sudan I in foods is now banned in many countries because Sudan I, Sudan III, and Sudan IV have been classified as category 3 carcinogens by the International Agency for Research on Cancer. Sudan I is also present as an impurity in Sunset Yellow, which is its disulfonated water-soluble version.

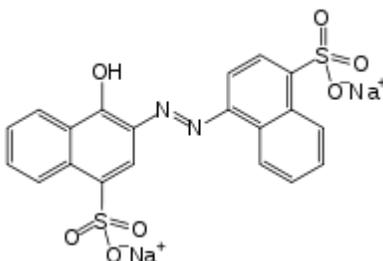
▪ **YELLOW 2G:-**

Yellow 2G is a colorant in food denoted by E number **E107**. It has the appearance of a **yellow powder, soluble in water**. It is a synthetic coal tar and yellow azo dye. It appears to cause allergic or intolerant reactions, particularly amongst those with an aspirin intolerance and asthma sufferers. It is one of the colours that the Hyperactive Children's Support Group recommends be eliminated from the diet of children. Currently only the UK in the European Union uses this dye and the EU is proposing a total ban. Its use is banned in Austria, Japan, Norway, Sweden, Switzerland and the United States.



▪ **AZORUBINE:-**

Azorubine, carmoisine, Food Red 3, Azorubin S, Brillantcarmoisin O, Acid Red 14, or C.I. 14720 is a **synthetic red food dye** from the azo dye group. It usually comes as a **disodium salt**.



It is a **red to maroon powder**. It is used for the purposes where the food is heat-treated after fermentation. It has E number **E122**. Some of the foods it can be present in Swiss roll, jams, preserves, yoghurts, jellies, breadcrumbs, and cheesecake mixes.

Possible health effects

It appears to cause allergic or intolerance reactions, particularly amongst those with an aspirin intolerance. Other reactions can include a rash similar to nettle rash and skin swelling. Asthmatics sometimes react badly to it.

- **Criticism and health implications:-**

Though past research showed no correlation between **Attention-deficit hyperactivity disorder (ADHD)** and **food dyes**, new studies now point to synthetic preservatives and artificial coloring agents as aggravating ADD and ADHD symptoms, both in those affected by these disorders and in the general population. Older studies were inconclusive quite possibly due to inadequate clinical methods of measuring offending behavior. Parental reports were more accurate indicators of the presence of additives than clinical tests.

- Norway banned all products containing coal tar and coal tar derivatives in **1978**. New legislation lifted this ban in 2001 after EU regulations. As such, many FD&C approved colorings have been banned.
- Tartrazine causes hives in less than 0.01% of those exposed to it.
- Erythrosine is linked to thyroid tumors in rats.
- Cochineal, also known as carmine, is derived from insects and therefore is neither vegan nor vegetarian. It has also been known to cause severe, even life-threatening, allergic reactions in rare cases.

This criticism originated during the **1950s**. In effect, many foods that used dye became less popular.

Brilliant Blue (BBG) food coloring was cited in a recent study in which rats that had suffered a spinal injury were given an injection of the dye immediately after the injury, and were able to regain or retain motor control. BBG helps protect spine from ATP (adenosine triphosphate), which the body sends to the area after a spinal injury, which further damages the spine by killing motor neurons at the site of the injury.

- **REFERENCES:-**

- **www.foodadditivesworld.com**
- **http://en.wikipedia.org/wiki/Category:Food_colorings**
- **www.scribd.com**

