

# Nature provides huge range of colour possibilities

The chemistry of natural colour cannot fail to fascinate and intrigue. Nature provides a huge portfolio of possibilities and I am pleased to report that since one of my first papers on the topic,<sup>1</sup> in 2002, the availability of natural materials for colour has increased greatly.

The chemistry of natural dyes will be focused on comprehensively, and alphabetically, in two parts – the first being this article and the second an article to be published in the September edition of *Personal Care Europe*.

## Alkanin or Anchusin

### *Alkanna tinctoria*, Alkanet

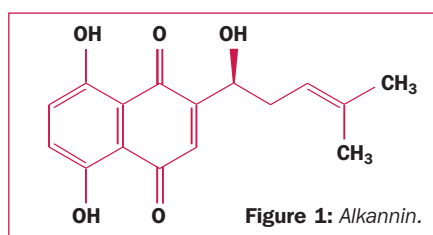
In addition to the common name, it is called Orchanet and Spanish Bugloss and by the apothecaries it was known as enchusa. It has blue or reddish-purple flowers.

Currently, alkanna root has no recognised medical uses except for its older use as an astringent. It is used as a cosmetic dye. The esteric pigments displayed excellent antibiotic and wound-healing properties in a clinical study on 72 patients with *ulcus cruris* (indolent leg ulcers).

Alkanet root contains a red colouring matter known as anchusin (alkannin or alkanet-red). Alkanet is an ancient dyestuff known throughout Europe.

## Annatto

Annatto or norbixin is extracted from the *Bixa orellana* or lipstick tree, and gives a yellow to deep orange colour. The plant



has entered into commercial cultivation for the production of this dye which is used mainly in the food industry and for colouring dairy products such as butter and cheese, margarine, edible oils, etc.

### *Bixa orellana*, Annatto

Annatto is a red to orange natural (golden yellow) pigment derived from the seed of the tropical bush *Bixa orellana*.

The major colour present is cis-bixin, the monomethyl ester of the diapocarotenoic acid norbixin, which is found as a resinous coating surrounding the seed itself. Also present, as minor constituents, are trans-bixin and cis-norbixin. The annatto bush is native to Central and South America where its seeds are used as a spice in traditional cooking.

It has been reported that the dye is also used in Brazil in pottery and as an insect-repellent, and in the Philippines in furniture and shoe polishes, nail varnish, brass lacquer, hair oil, etc. It is further stated that Jamaica and South India have been major producers of the top quality product. From other countries

the dye has lacked the bright colour required. In South America the shrub is cultivated around villages, where it is native to and widespread throughout the neotropics. It is called *kiswe* or *kyswi* by the Waimiri Atoari. A red dye is obtained from the aril of the seed that is sometimes used for body painting. It is called *urucum* in the local vernacular.

Another chemical found in the plant that is responsible for some of the colour is bixin. Bixin is one of the more stable natural yellow colours. However, it loses much of its tinctorial power gradually on storage, the process being accelerated by light and heat. Hence for manufacturing purposes fresh seeds are preferred. The tinctorial strength of bixin is comparable to that of  $\beta$ -carotene. However, bixin is the more stable.

## Anthocyanins [Category]

Anthocyanins are natural red, blue or violet plant pigments present in the cell sap of many flowers, fruits and vegetables. Anthocyanins are contained in cherries, plums, blackberries, black carrot, blueberries, cranberries, grapes, elderberry, mulberry, purple corn, rosehips, red cabbage, redcurrant, and red radish.

They have the general structure shown in Figure 4. Cyanidin is found specifically in purple corn. They are used as pH indicators and are heat, oxygen and enzyme labile, but the stability is a major

Figure 2: Norbixin.

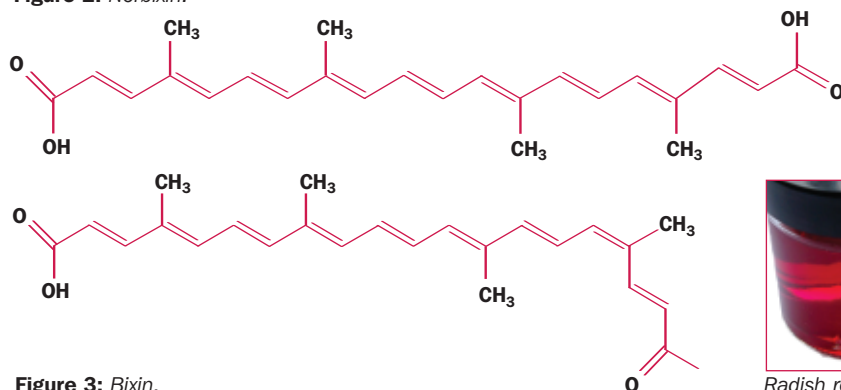
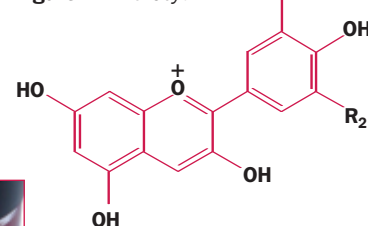


Figure 4: Anthocyanin.

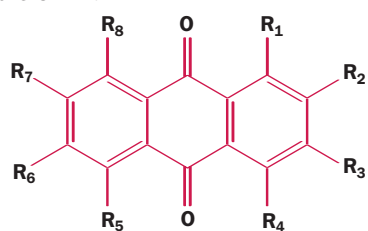


Anthocyanin	R <sub>1</sub>	R <sub>2</sub>
Pelargonidin	H	H
Cyanidin	OH	H
Delphinidin	OH	OH
Peonidin	OCH <sub>3</sub>	H
Petunidin	OCH <sub>3</sub>	OH
Malvidin	OCH <sub>3</sub>	OCH <sub>3</sub>



Radish red.

Figure 5: Alizarin.



	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	R <sub>5</sub>	R <sub>6</sub>	R <sub>7</sub>	R <sub>8</sub>
Alizarin	OH	PH	H	H	H	H	H	H
Purpurin	OH	OH	H	OH	H	H	H	H

Figure 6: Apigenin.

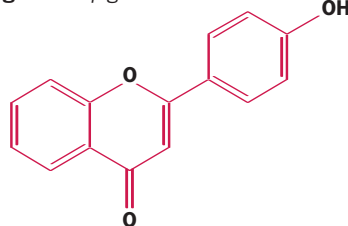
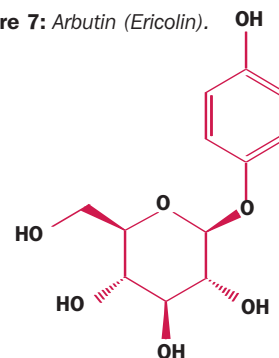


Figure 7: Arbutin (Ericolin).



limitation for use. Red cabbage “juice” has been used in barbecue sauce and for colouring pink lemonade.

### Anthraquinones [Category]

#### *Rubia tinctorum*, roots of Madder

Madder is native to the Mediterranean and the Near East and was once widely grown as a dye plant and was used in central Europe since around the 9<sup>th</sup> Century. The common name Madder comes from the Anglo-Saxon name *maedere* for the plant. The generic name, *Rubia* means red and the plant has been used as a source of a permanent red dye.

The two to three year old rootstock of the plants is used medicinally, and it remains red when dried. The constituents include anthraquinone glycosides which are two red chemical entities derived from the roots and tubers, and which are known as alizarin and purpurin. The isolation requires the prior hydrolysis of the glucoside precursor in the roots (Alizarin red from *Rubia tinctorum* occurs in nature as the glycoside and is called ruberythrinic or ruberythric acid and is its 6-O-β-D-xylopyranosyl-β-D-glucopyranoside). The Indian madder mainly yields purpurin (see Figure 5).

In the care of the skin it is considered an astringent, tonic, vulnerary and antiseptic. Madder is also used to cleanse open wounds and can remove skin blemishes if bruised leaves are applied externally. Externally, a decoction of madder can be used for skin problems, especially tubercular conditions of the skin and mucous tissue. The decoction can also be used as a bath additive.

#### *Galium mollugo*, White Bedstraw

The native Indians used Bedstraw roots (*Galium mollugo*) to obtain a red colour and the root of this plant is an important source of the dye alizarin.

#### *Galium odoratum*, Sweet Woodruff

Sweet Woodruff is similar to White Bedstraw and its roots can be used to produce a red/pink dye. It is the same family as Madder.

### Apigenin

#### *Matricaria recutita*, German Chamomile

This flavonoid, which occurs widely in plants gives a dull, golden yellow and is usually obtained from German Chamomile or *Matricaria recutita*. Apigenin and luteolin were more active than the other flavonoids tested. The spasmolytic activity of chamomile has been attributed to apigenin, apigenin-7-O-glucoside and (-) - bisabolol, which have activity similar to papaverine. Apigenin and luteolin were more active than the other flavonoids tested.

#### *Calendula officinalis*, Marigold

It is also found in Marigold (*Calendula officinalis*), where it was shown, using the mouse ear test, that the flavonoids – and not the essential oil – were responsible for the activity and, of these, apigenin was more active than indomethacin in the test.

#### *Artemisia inculta*, Artemisia

Artemisia (*Artemisia inculta*) also contains apigenin and in a recent study was demonstrated to have anti-inflammatory activity.

#### *Cuminum cyminum*, Cumin

*Cuminum cyminum* or Cumin also contains apigenin and luteolin and their derivatives in addition to plants like Carrot (*Daucus carota*), Agrimony (*Agrimonia eupatoria*), Arnica (*Arnica montana*), Purple Coneflower (*Echinacea purpurea*) and Eyebright (*Euphrasia officinalis*) – all of which have demonstrated anti-

inflammatory activity when used under the right conditions. Yellow apigenin is also found in Parsley (*Petroselinum crispum*) and Celery (*Apium graveolens*).

### Arbutin

#### *Shepherdia canadensis*, Canada Buffaloberry

The Canada Buffaloberry (*Shepherdia canadensis*), also known as Canada Buffaloberry, Soopolallie, Soapberry or Foamberry, is one of a small number of shrubs of the genus *Shepherdia* bearing edible red berries. One recognised form, however, bears yellow fruits. The fruit produces a red dye, and it contains ericolin glucoside, and chimaphilin which is a yellow naphthoquinone.

### Astacin

Astacin is found in the shells of crabs and lobsters *Homarus*, algae, sponges and fish. Is practically insoluble in water.

### Astaxanthin

Astaxanthin, a carotenoid, is classified as a xanthophyll (having yellow leaves).

### Azulene

Sadly, this wonderful blue (blue-black) no longer seems to be available commercially. Azulene is a prime component of the essential oil of chamomile flowers, *Matricaria recutita* L. and related plant species. Products containing azulene generally also contain the other characteristic components of chamomile’s essential oil. Azulene extracts are used in

Figure 8: Astaxanthin.

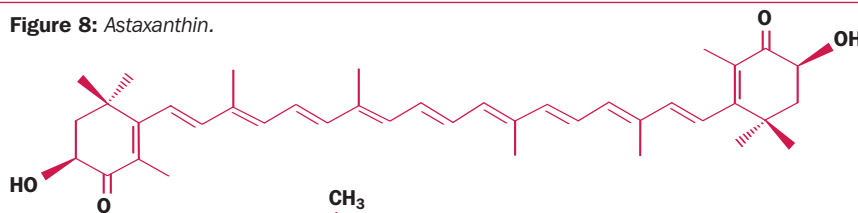


Figure 9: Chamazulene.

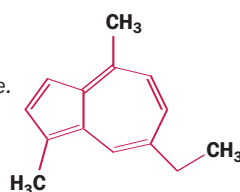
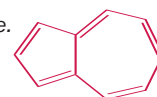


Figure 10: Azulene.



skin creams for reducing skin puffiness and wrinkles and are also known for their anti-irritant and vulnerary properties.

It has never been clear whether the material was extracted from one of the chamomiles or from *Myoporum crassifolium* Forst or *Vanillosmopsis erythropappa* Schultz-Bip in which this material is also found. Maybe the source has become too scarce for there to be a reliable commercial supply.

**Betalains and Betacyanins [Category]**

**Betain**

Dried beet juice contains 0.2%-1.0% betain and is most stable between pH 4.0-5.0. It is heat, oxygen and light labile. Beets give rust/red or pink colours, but fade with time.

This colour occurs in the fruits of *Phytolacca americana* (Phytolaccaceae) and in *Portulaca grandiflora* (Portulacaceae). It is a purple pigment. Other places where it may be found are *Carpobrotus acinaciformis*, *Drosanthemum floribundum*, *Mesembryanthemum* spp., *Opuntia bergeriana* and other *Opuntia* spp. (Cactaceae).

**Brazilein, Brazilin**

**Caesalpinia echinata, Brazilwood**

The heartwood of American Brazilwood, *Caesalpinia echinata*, contains a water-soluble compound called Brazilin, which on oxidation transforms to a red

dyestuff called Brazilein. As a mordanted dye the colours can range from purple to bright red depending on the chemicals used.

In an acidic solution Brazilin will appear yellow, but in an alkaline preparation it will appear red. Brazilin is closely related to the blue-black dye haematoxylin, having one less hydroxyl group.

**Canthaxanthin**

This is a carotenoid that naturally occurs in fungi but is more usually produced by "nature identical" synthesis. It is also a component of Spirulina-Dunaliella algae. The colour can be yellow to an almost orange red.

Canthaxanthin is a natural orange xanthophyll (E161a) isolated from some mushrooms, crustacea, fish and also flamingo feathers. It is used to enhance the colour of fish flesh, particularly trout and salmon. There is some evidence that prolonged ingestion of canthaxanthin in large amounts may cause spotting of the retina.

**Capsanthin and Capsorubin**

Capsanthin and the related capsorubin are most commonly found in paprika or *Capsicum annuum*. It is rich in carotenoid pigments, including capsanthin, capsorubrin, carotene, luteine, zeaxanthin, and cucurbitaxanthin.

As well as being a dyestuff, it is also used in cosmetics in ointments, oils and

emulsions for its stimulating effect and as a sports massage product ingredient.

**Capsicum annuum, Capsicum**

It is also called Cayenne pepper, African Pepper, Chillies, Bird Pepper. It contains 0.1% capsaicin, capsacutin, capsico (a volatile alkaloid) together with fixed oils. Capsicum in the form of an alcoholic tincture is sometimes incorporated into hair lotions as a stimulant, particularly in preparations designed for alopecia. The pigments present in paprika are a mixture of carotenoids, in which capsanthin and capsorubin dominate. These are oil-soluble, are stable to heat and pH variation but may deteriorate in light.

It is employed in preparations to prevent chilblains and is the purest and most certain stimulant in *materia medica*. It produces natural warmth and equalises the circulation. It is an important herbal remedy. It is used externally as a counter-irritant, rubefacient and antiseptic. It is recommended for use in neuralgia, rheumatic pains, unbroken chilblains and is also used in cases of lumbago.

Capsicum is especially useful for providing counter-irritation when applied to skin overlying an inflamed or irritated joint. Combined with myrrh it makes a good antiseptic wash.

**Caramel**

Caramel colouring is produced by heat treatment of carbohydrates such as glucose

Figure 11: Betain.

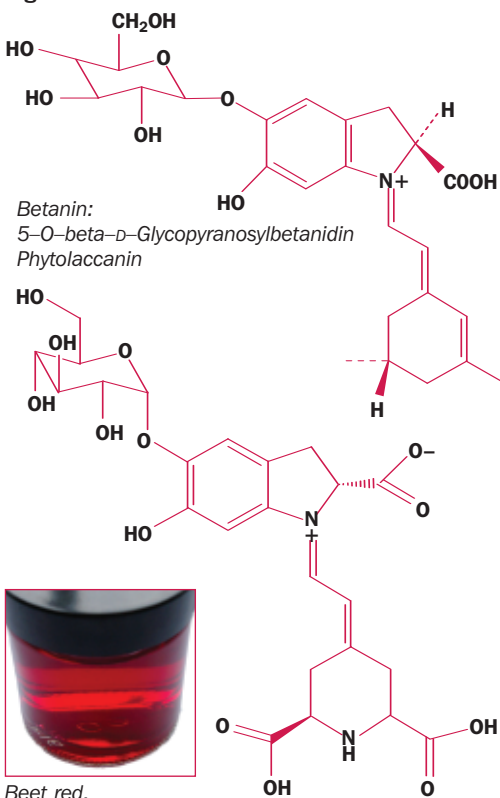


Figure 12: Brazilein.

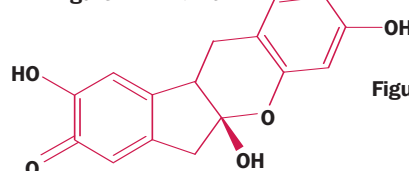


Figure 13: Brazilin, Natural Red 24.

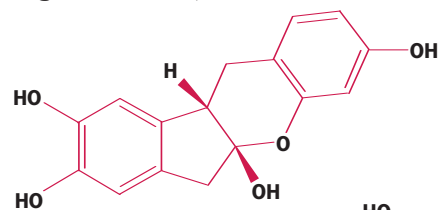


Figure 14: Capsanthin.

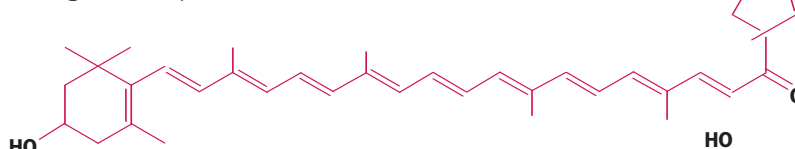


Figure 15: Capsorubin.

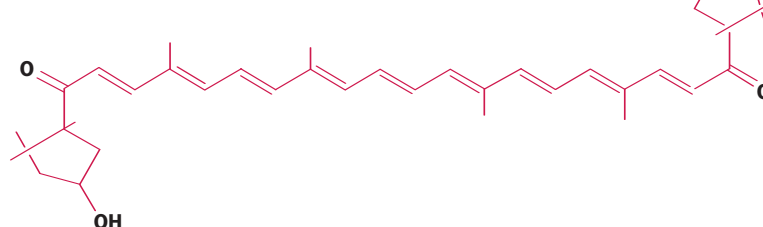


Figure 16: Carminic acid.

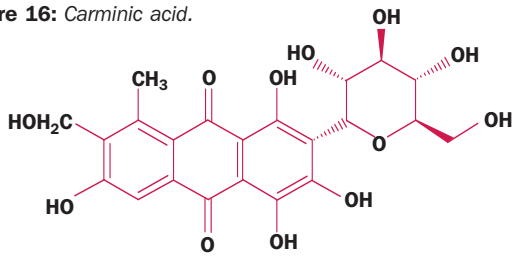
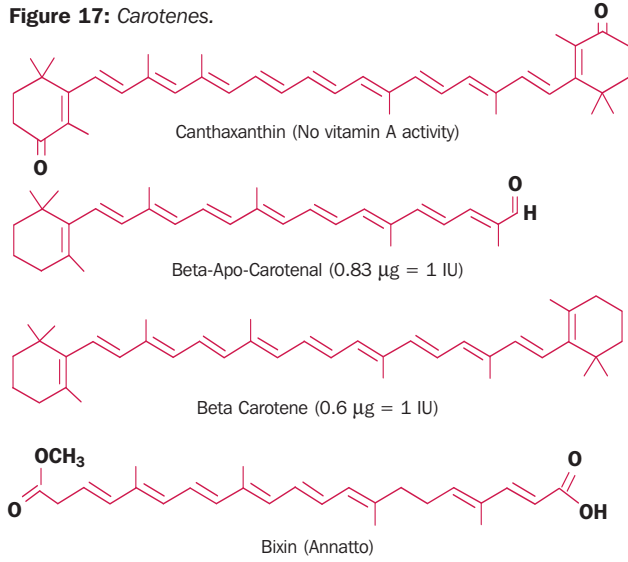


Figure 17: Carotenes.



syrup and sucrose, in the presence of ammonia, ammonium sulphate, sulphur dioxide or sodium hydroxide. The types of caramel colour available include plain (spirit) caramel (prepared by controlled heat treatment of carbohydrates with or without an acid or base), caustic sulphite caramel (produced by heat treatment of carbohydrates with sulphur containing compounds), ammonia caramel (heat treatment in the presence of ammonia) and sulphite ammonia caramel. Caramelised sugar or burnt sugar is formed by heating sugars without a catalyst.

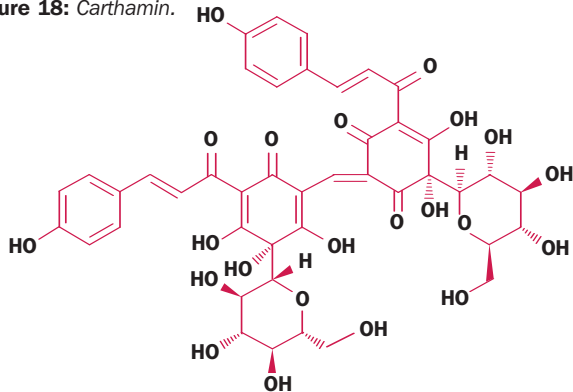
**Carminic acid**  
**Coccus cacti, Cochineal**

This extract is associated with the protein material of the cochineal beetle and gives



Carthamus yellow.

Figure 18: Carthamin.



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Figure 19: Chlorophyll.

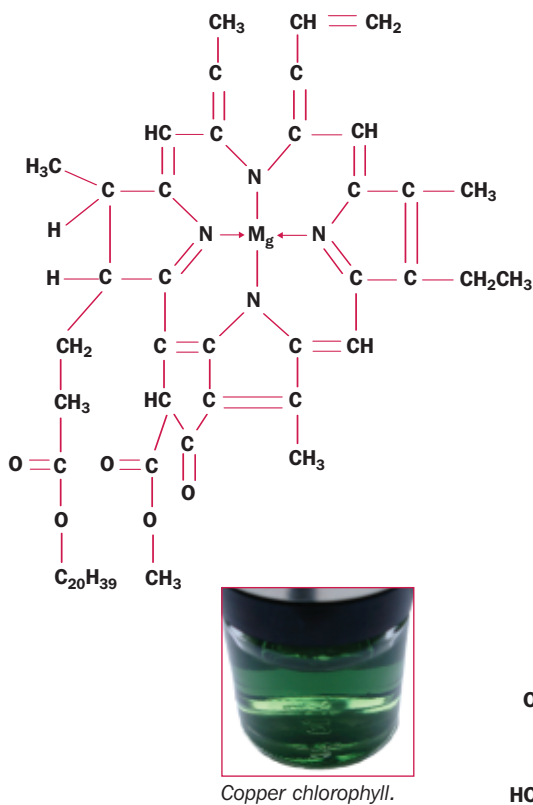


Figure 20: Chimaphilin.

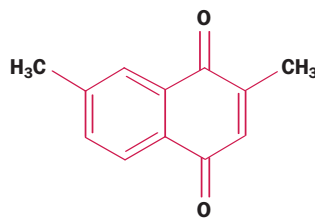


Figure 21: Chrysophanic acid.

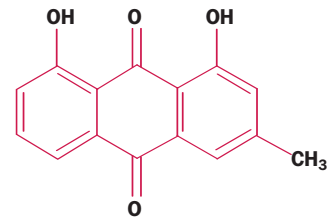


Figure 22: Citranaxanthin.

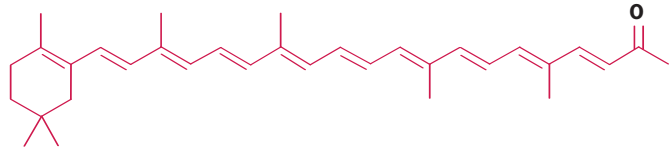


Figure 23: β-Citraurin.

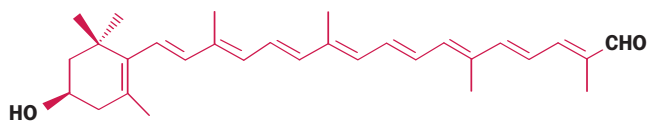
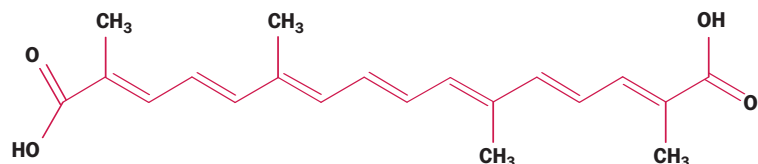


Figure 24: Crocetin.



red, yellow and orange colours depending on the products and pH. *Coccus cacti* or scale insects are insects that live and feed on the prickly pear cactus (*Opuntia megacantha*) of Mexico and Central America. They increase rapidly in size and lose their original shape until they appear as protuberances of the plant. The dried pulverised bodies of these insects yield the red dyestuff cochineal, which the Aztec Indians used as body paint and for dyeing their fabrics a brilliant crimson. They also used cochineal for medicinal purposes.

It has been used as a pigment and as a colouring agent in cosmetics, paints and beverages, but it is expensive as it takes 70,000 insects to make one pound of dye.

The homoeopathic tincture is prepared from the dried bodies of the female insects, which are larger than the male and have no wings. It is one of the main whooping cough remedies.

In both India and Australia particular attempts have been made concerning the production of cochineal, for purposes such as dyeing soldiers' uniforms red. But chaos resulted. Either the insects fed so heartily that they wiped out the cacti; or the cacti multiplied so excessively that they became a real plague.

This can be purified to yield carminic acid or reacted with alumina to produce the aluminium lake of carminic acid which is referred to as carmine.

Carminic acid is a polyhydroxy-anthraquinone acid or a red glucosidal hydroxyanthrapurin. It is water soluble, and acid stable yielding orange to red shades depending on the pH. Its aluminium lake, carmine, is soluble in alkaline media and is very stable in relation to heat, light and oxygen. In alkaline conditions carmine provides a blue-red shade which becomes progressively less blue as the pH is decreased. Under acidic conditions below pH 3 carmine becomes insoluble.

### Carotenes [Category]

Carotenes are fat soluble and often synthetically produced natural pigments. The colours range from yellow to red. The pigment is sensitive to oxidation because of the conjugated double bonds and the molecule may be isomerised if involved in heat processing.

There are a number of related chemicals:

- β-Carotene (0.6 μg = 1IU)
- β-Apo-8'-Carotenol (0.83 μg = 1IU)
- Canthaxanthin (No vitamin A activity)
- Bixin (Annatto extract) (No vitamin A activity)
- Lycopene (No vitamin A activity)

This is a group of yellow/orange colours extracted from such diverse sources as algae, carrots and palm oil. It is also available as a "nature identical" product.

Crystalline β-carotene is sensitive to air and light. Vegetable fat and oil solutions and suspensions are quite stable in products.

The carotenoids – apart from the chlorophylls – are the largest group of oil soluble pigments found in nature. They consist of molecules with long chains made up of carbon, hydrogen and mostly oxygen (β-carotene consists of only carbon and hydrogen). One of the carotenoid's characteristics is that the colour varies (according to the type of carotenoid) from yellow to red-orange. Carotenoids, like chlorophylls, exist in green plants. They are responsible for the yellow colour of flowers and the pigments of many fruits and vegetables such as carrots, paprika and tomato. The first discovery of the colour in carrots was the reason for the generic name of carotenoids. It is converted by mammals into vitamin A and as a result is called provitamin A.

β-carotene is one of the major yellow colours used in the food industry and the largest use is by the dairy industry (for butter, cheese and ice cream). The use of β-carotene has almost entirely replaced E102 Tartrazine yellow, which for various reasons has received a bad press in recent years.

β-carotene is one of the popular free radical scavengers and antioxidants.

## Carthamin

### *Carthamus tinctoria*, Safflor

Carthamin is found in the flowers of *Carthamus tinctoria* or Safflor (Bastard Saffron), Dyer's Saffron, American Saffron, Fake Saffron, or *Flores Carthami*. It yields a pigment carthamin, which is a yellow-orange colour. On closer examination it is shown to contain two colouring matters, one yellow the other red. Safflower (*Carthamus tinctorius* L.) was formerly used as a red dyestuff for textiles and is also currently used as a colorant by the food industry in small amounts.

The florets contain three major pigments, all of which are present as chalcone glucosides: the scarlet red carthamin is water insoluble but the "safflor yellow" A and B or safflomin(e) A and B are both insoluble in water.

The seeds yield an oil which is used in India for burning and for culinary use. The flowers are used for their laxative and diaphoretic properties, and also used for children's complaints of measles, fevers and eruptive skin conditions.

Apart from the seeds for oil and the flowers for dyeing, the Egyptians found the flower pleasing to the eye and included it in garlands placed on mummies. Remains of safflower were found in the tomb of Tutankhamun.

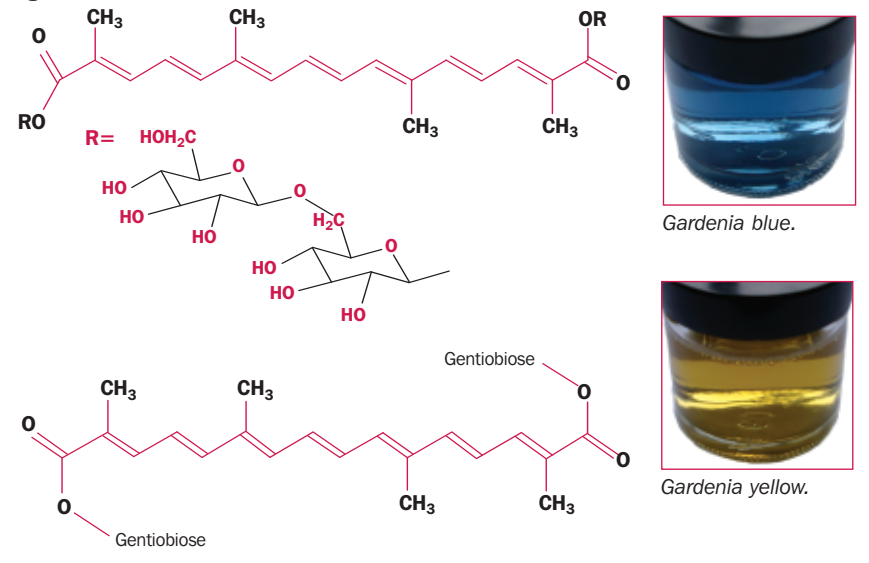
The safflower florets are gathered just before they die off, and are used for dyeing wool, silk and leather. The flowers give a yellow dye, and the Chinese used an alkaline solution to produce the bright reds and purples for their silks. Also produced is a pink dye that was used by the Indians to dye their official red tape used on legal documents. Mixed with talc it was employed as rouge by actors.

It was also the principal ingredient in Macassar Oil, the hair oil so very popular with Victorian gentlemen. Certain oil paints are based on carthamin. Another little known fact is that it was used to impart a pink-red colour to the ribbon used to bind legal documents (and is still used to this day). Hence the expression "tied up in red tape"

### Chimaphilin

Chimaphilin is a yellow naphthoquinone found in *Shepherdia canadensis* (see arbutin) [Syn: *Hippophae canadensis*]. The fruit juice has been drunk in the treatment of digestive disorders and has also been applied externally in the treatment of acne and boils. The alternative name for the plant "Soopolallie" is from the Chinook language for soap (soop) and berry (olallie) and the froth from the berries (which contain a natural saponin) or a jelly of the fruit, have been eaten as an insect repellent as it was

Figure 25: Crocin.



said that mosquitoes were far less likely to bite a person who had eaten them.

### Chlorophyll

Extracted from grass and alfalfa, this is present in all green plants and has always been a part of man's diet. It gives moss green colour. It is naturally oil soluble, and is also found in green vegetables such as spinach or *Spinacia oleracea* and the common stinging nettle or *Urtica dioica*.

### Copper chlorophyll

Derived from plants (as above) but gives a brighter more intense green colour due to the replacement of the naturally occurring magnesium in the chlorophyll by copper. It is naturally oil soluble.

This is produced as the copper chlorophyll but a saponification process renders this form water soluble. The colour is a bright green to green/blue.

### Chrysophanic acid

Chrysophanic acid was discovered by Schrader, in 1819, in *Parmelia parietina*, Linné, a common wall lichen. It was purified in 1843 by Rochleder and Heldt, who gave it the name chrysophanic acid, from its yellow colour and later Schlossberger and Dopping decided the colouring matter obtained from rhubarb was identical. This colouring matter had been known under the names of rheine, rheumine, rhabarberic acid, rhubarb yellow, etc. Chrysophanic acid is chiefly obtained from a vegetable powder, called Goa or Poh di Bahia, which is the product of some unknown Brazilian plant probably *Andira araroba* (Leguminosae) and also known as Araroba. The powder contains 70% to 80% of acid.

Chrysophanic acid has been chiefly employed as a local application for certain

cutaneous conditions, e.g. eczema, various herpes conditions, psoriasis, acne and rosacea, etc.

### *Rheum rhaponticum*, Rhubarb

Rhubarb roots makes yellow, orange or red shades and were sometimes used for dyeing hair. Rhubarb root has chrysophanic acid, a yellow dye, which will bind to keratin. Chrysophanic acid, as such, does not perhaps exist to any large extent in rhubarb, but is formed by the splitting up of chrysophane.

### Citranaxanthin

This is a carotenoid pigment. There are natural sources of citranaxanthin, but it is generally prepared synthetically. It is used as an animal feed additive to impart a yellow colour to chicken fat and egg yolks.

### β-Citraurin

β-citraurin from *Citrus sinensis* (Sweet Orange, Navel Orange) is a carotenoid pigment found in orange peel.

### Crocetin

#### *Crocus sativus*, Crocus

It is also known CI Natural Yellow 6; CI 75100; Croci Stigma; Crocus; Safran. The dried stigmas and tops of the styles of the *Crocus sativus* contain crocines, crocetins and picrocrocine. They are delicate colours and should be protected from light.

Saffron is used as a food and cosmetic dye and flavouring agent. In some circles it is considered to be a food. It was once widely used for colouring medicines. There have been early reports of poisoning with saffron. This may be because of confusion with Autumn Crocus (*Colchicum autumnale*).

For years English saffron was the most

Figure 26: Curcumin.

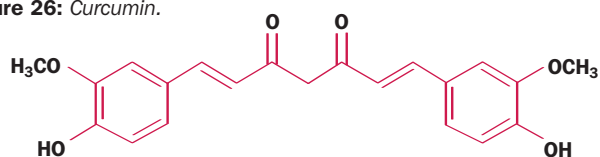


Figure 28: Flavoxanthin.

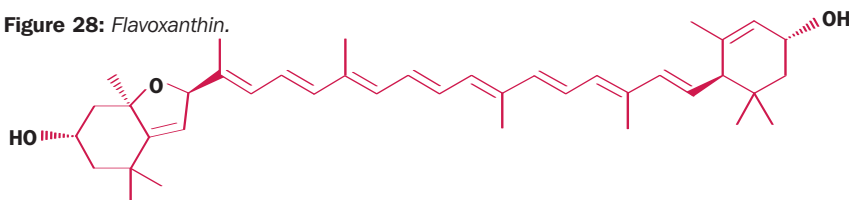


Figure 27: Datissetin.

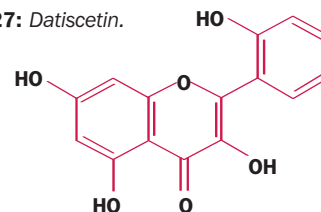
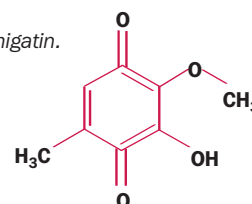


Figure 29: Fumigatin.



highly esteemed (grown in Saffron Walden from about 1350), and most expensive, in Europe. Today, however, the best saffron comes from the barren plain of La Mancha in Spain. One kilogramme of plant yields about 460,000 stigmas. The colour is due to a pigment called crocin, so strong that 1 part crocin in 100,000 parts of water is a deep golden colour. The flavour comes from a related compound called picrocrocin. Saffron also seems to contain a substance that helps blood to clot. It is as a water-soluble dye that saffron probably found most use. The colour is deep and rich, and most familiar today in the saffron robes of Buddhist monks.

Folkloric uses of saffron have included its use as a sedative, expectorant, aphrodisiac and diaphoretic. Anecdotal reports from the tropical regions of Asia describe the use of a paste composed of sandalwood and saffron as a soothing balm for dry skin.

The stigmas of *Crocus sativus* are rich in riboflavin, a yellow pigment and vitamins.

In addition, saffron contains crocin, the major source of yellow-red pigment. An hypothetical protocrocin of the fresh plant is decomposed on drying into one molecule of crocin (a coloured glycoside) and two molecules of picrocrocin (a colourless bitter glycoside). Crocin is a mixture of glycosides: crocetin, a dicarboxylic terpene lipid, and alpha-crocin, a digentiobiose ester of crocetin. In addition, cis- and trans-crocetin dimethylesters have been identified.

Similar compounds have been isolated from other members of the family. A compound named gardenidin, obtained from gardenias, has been shown to be identical with crocetin.

### Crocin

Crocin extract is the trade term for the yellow, water-soluble food colorant obtained from cape jasmine (*Gardenia jasminoides* L.) and from red stigmas of

saffron (*Crocus sativus* L.). However, the extracts are not used interchangeably in all applications since saffron is valued as much for its aroma and flavour as for its colouring properties. It is an expensive spice which may prohibit its commercial use as a natural colorant.

### Gardenia jasminoides, Gardenia

A bright yellow colour that has been in use for over a thousand years. Extracted from the fruit of *Gardenia jasminoides*. *Gardenia florida* [possibly a synonym for *G. jasminoides*] also contains crocin and is prescribed as an antipyretic, haemostatic, and antiphlogistic, and in cases of jaundice.

A paste of the herb with flour and wine is used as a poultice on twists, sprains, strains, bruises, and abscesses. It is very effective in cases of injury to tendons, ligaments, joints and muscles. Chinese medicine considers it to have anti-inflammatory, antipyretic, astringent, and haemostatic functions as well as use in the treatment of mastitis. The main component of its yellow pigment is crocin, which is now generally used as a natural yellow pigment. It is also used for irritation, sore and swollen eyes and abscesses. *Fructus gardeeniae* is widely used in Chinese medicine. The fruits of *Gardenia jasminoides* also contain ursolic acid which possesses hypothermic, sedative and anticonvulsant characteristics. The attributes of this plant may, therefore, be in part due to the ursolic acid present. Gardenia Blue is derived from *Gardenia jasminoides* Ellis.

### Crocus sativus, Crocus

The characteristic yellow-orange colour of saffron (*Crocus sativus* L.) comes from water-soluble pigment, the carotenoid crocin. Saffron carotenoids with ethanol-extractable mostly contain safranal as an antibacterial, and were used in Persian traditional medicine to treat some skin disorders. The extracted carotenoids from

saffron as an antioxidant prevent many common diseases by taming harmful molecules known as free radicals.

Crocin is 8,8'-Diapo- $\psi$ , $\psi$ -carotenedioic acid bis (6-O- $\beta$ -D-glucopyranosyl- $\beta$ -D-glucopyranosyl) ester;  $\alpha$ -crocin; digentiobiose ester of crocetin. It is also the colouring principal of saffron and also occurs in crocus.

### Cryptoxanthin

Cryptoxanthin is a xanthophyll (E161a) and is found naturally in members of the potato and tomato family, as well as in egg yolks and butter. It provides a natural yellow colour but is not available for commercial colouring use. Cryptoxanthin is also found in corn and strawberries.

### Curcumin

Curcumin provides a water soluble orange-yellow colour. It is a natural extract obtained by solvent extraction from the dried rhizomes of turmeric (used in Indian cuisine as a flavouring agent). Curcumin may be used to compensate for fading of natural colouring in pre-packed foods. It was recognised as an anticarcinogenic agent during laboratory tests.

This is the pigment of the spice turmeric and will give a range of colour from yellow to a deep orange.

This has been in use as a food ingredient for over 2,000 years. It also contains a closely related chemical called desmethoxycurcumin, where one of the methoxy groups is replaced with a hydrogen atom.

### Curcuma longa, Turmeric

The rhizome of *Curcuma longa* has been used as a medicine, spice and colouring agent for thousands of years. Turmeric was listed in an Assyrian herbal reference work dating from about 600 BC and was also mentioned by Dioscorides. It has many medicinal properties including those of being an antioxidant and an anti-inflammatory.

The anti-inflammatory activity of curcumin was first reported in 1971. In an extension of this work, it was reported that oral doses of curcumin possess significant anti-inflammatory action in both acute and chronic animal models. Curcumin was as potent as cortisone in the acute test (carrageenan oedema), but only about half as potent as phenylbutazone in chronic tests.

The Negritos of the Philippines utilise the fresh rhizome to treat recent wounds, bumps, bruises and leech bites. Mixed with gingly oil (a locally produced oil), it is applied to the body to prevent further skin eruptions. Turmeric paste mixed with a little lime and saltpetre and applied hot is a popular application for sprains and bruises among other Filipino blacks. In smallpox and chickenpox, the Negritos make a thin paste of turmeric powder and apply it to the entire body in order to prevent pock marks from occurring by facilitating the scabbing process. It is also used for ringworm.

The blacks of Trinidad in the West Indies use turmeric rhizome poultices to reduce the swellings of sprains and pulled tendons, while the rhizome juice and oil is used for its antiseptic properties on various skin affections – i.e. razor bumps, herpes lesions and venereal sores.

Among the dark races of India, turmeric has been used since time immemorial to treat skin problems. Both the Ayurvedic and the Unani practitioners have used a paste of powdered turmeric or its fresh juice made into a paste or a decoction of the whole plant as a local application in the treatment of leprosy and cobra bites. It is especially useful for indolent ulcers on the surface of the skin and gangrene in the flesh. A paste made from the powdered rhizomes along with caustic lime forms a soothing remedy for inflamed joints.

Turmeric is also used as an external application of “rouge” and is utilised by some women in India to suppress the unwelcome growth of facial hairs and upper lip moustaches.

In Northern India the rhizome is used by many natives for treating cuts, burns and scalds.

The natives of Samoa use the powdered rhizome to sprinkle on newborn infants to help heal a recently cut umbilical cord, to prevent nappy rash from occurring, and to keep the skin continually soft and resilient. The powder is also used as a paste or poultice to treat skin ulcers and to help heal extensive skin eruptions.

In parts of Africa, turmeric has been successfully tested for healing rashes due to allergies and psoriasis inflammation and itching accompanying arthritis.

Figure 30: Fustin.

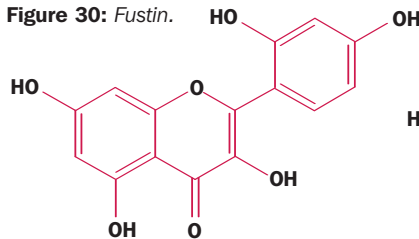


Figure 31: Genistein.

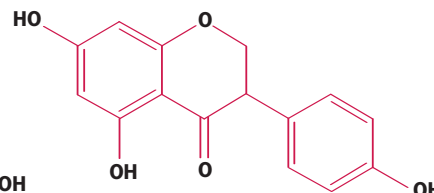
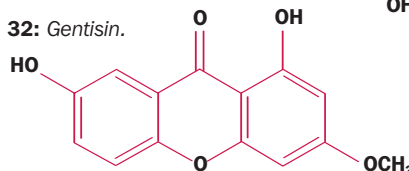


Figure 32: Gentisin.



### Datiscetin

This flavonoid has a yellow colour and is found in Bastard Hemp (*Datisca cannabina*).

### Delphinidin

Delphinidin is an anthocyanidin that gives colours from red wine to brown.

### Deoxyisosantalol, Deoxysantalol

The heartwood (camwood) and roots of *Baphia nitida* yield a red dye called Deoxyisosantalol that was used until recently to dye raffia and cotton textiles.

The powdered heartwood is used as a red body paint and the paste is used as a cosmetic for the skin. As a body paint it is considered to have magic powers.

The leaves or leaf juice are applied against parasitic skin diseases. The leaves and bark are considered haemostatic and anti-inflammatory, and are used for healing sores and wounds. The powdered heartwood is made into an ointment with shea butter which is applied against stiff and swollen joints, sprains and rheumatic complaints.

### Flavoxanthin

Flavoxanthin is a xanthophyll, providing a natural yellow colour. Xanthophylls are mixtures of hydroxy derivatives of alpha-, beta- and gamma-carotenes, their natural epoxides and fatty acid esters.

### Fumigatin

Fumigatin is isolated from *Aspergillus fumigatus* (a brown fungal toxin with antibiotic properties).

### Fustin

Fustin is closely related to morin and these two flavones are found in the wood from *Chlorophora tinctoria* and *Morinda citrifolia* (Indian Mulberry) whose pigments are mixtures of yellow to orange flavones similar in structure to fustin and morin. It is called maclurin which has long been used as a yellowish-brown or khaki dye.

### Genistein

Genistein is one of several known isoflavones. Isoflavones, such as genistein and daidzein, are found in a number of plants, with soybeans and soy products like tofu. Genistein functions as an antioxidant and many isoflavones have been shown to interact with oestrogen receptors and cause an effect in the body similar to those caused by the hormone oestrogen. It is a protein tyrosinase kinase inhibitor. Both the oestrogenic effect and the inhibition of kinases positively influence skin collagen content which is good for anti-ageing products. In adipose tissue it produces a lipolytic activity and is so useful in the treatment of cellulite.

### Genista tinctoria, Dyer's Greenweed

Genistein is a yellow dye contained as the glucoside genistin in Dyer's Greenweed, *Genista tinctoria*. An infusion is used against rheumatism, arthritis, dropsy and chronic skin disorders. In the past the flowers were used for dyeing fabrics.

### Gentisin

Gentisin is a yellow flavone found in the roots of *Genista tinctoria*, Dyer's Greenweed. PC

### Acknowledgement

I would like to thank Union Swiss in South Africa for its valued sponsorship of the oil soluble colour research.

### Reference

- 1 *International Journal of Cosmetic Science* 24, 5, 287-302, (2002). Natural ingredients for colouring and styling.

### Details at a glance

On the following four pages are comprehensive details of natural colours mentioned in the text. The second part of the article, together with another extensive table, will be published in the September edition of *Personal Care Europe*.



## COLOUR COSMETICS

Code	CI number	Common name	Name	Chemical class	Colour	Plant name	Source
	75330	Natural Red 6,8,9,10,11,12	Alizarin	Anthraquinone	Red	<i>Rubia tinctorum</i>	Madder, chay
	75330	Natural Red 6,8,9,10,11,12	Alizarin, ruberythric acid	Anthraquinone	Red	<i>Rubia tinctorum</i>	Madder colour
	75330	Natural Red 6,8,9,10,11,12	Alizarin, rubiadin	Anthraquinone	Red	<i>Rubia tinctorum</i>	Madder root
	75520	Natural Red 20	Alkanet	Naphthoquinones	Red	<i>Alkanna tinctoria</i>	Alkanna root
	75530	Natural Red 20	Alkanet	Naphthoquinones	Red	<i>Alkanna tinctoria</i>	Alkanna root, orchanet, Spanish bugloss
	75530	Natural Red 20	Alkanin or anchusin	Naphthoquinones	Red	<i>Anchusa tinctoria</i>	
	75520	Natural Red 20	Alkannan	Naphthoquinones	Red	<i>Anchusa tinctoria</i>	
E160a	40800	Food Orange 5	Alpha-carotene, beta-carotene, gamma-carotene	Carotenoid	Orange		
E160a	40800	Food Orange 5	Apha-carotene, beta-carotene, gamma-carotene		Orange		Extract of natural carotene
E173			Aluminium	Element	Silver		
E150c			Ammonia caramel				
E160b	75120	Natural Orange 4	Annatto, bixin, norbixin	Xanthophyll pigment	Yellow orange	<i>Bixa orellana</i>	Seeds, lipstick tree, urucum
E160b	75120	Natural Orange 4	Annatto, bixin, norbixin	Carotenoids	Yellow orange	<i>Bixa orellana</i>	Annatto extract
E163			Anthocyanins				Extract of anthocyanins
E163			Anthocyanins	Anthocyanins	Red, blue or violet	Various	Many sources
E163			Anthocyanins	Anthocyanins	Deep magenta	<i>Vitis vinifera</i>	Grape skin
E163			Anthocyanins	Anthocyanins	Red	<i>Perilla frutescens</i>	Perilla colour
E163			Anthocyanins	Anthocyanins	Purple	<i>Brassica oleracea</i>	Red cabbage colour
E163			Anthocyanins	Anthocyanins	Mauve	<i>Brassica oleracea</i>	Red cabbage colour
E163			Anthocyanins	Aanthocyanins	Red	<i>Raphanus sativus</i>	Red radish colour
E163			Anthocyanins	Anthocyanins	Purple	<i>Ipomoea batatas</i>	Purple sweet potato colour
E163			Anthocyanins	Anthocyanins	Deep magenta	<i>Vitis vinifera</i>	Grape skin colour
	75590	Natural Yellow 1,2	Apigenin	Flavonoid dyes	Yellow	<i>Matricaria recutita</i>	Greek chamomile, weld
			Arbutin	Naphthoquinones	Red	<i>Shepherdia canadensis</i>	Canada buffaloberry
			Astacin		Red	<i>Homanus</i>	Crab, lobster shells
E161j			Astaxanthin	Xanthophyll pigment	Red	<i>Haematococcus pluvialis</i>	Microalgae
			Azulene	Naphthalene	Dark blue	<i>Vanillosmopsis erythropappa</i>	Candeia tree
E162			Beetroot red, betanin	Betalains, betacyanins	Purple-red	<i>Beta vulgaris</i>	Beetroot
E162			Betanin, beetroot red	Betalains, betacyanins	Red	<i>Beta vulgaris</i>	Beet red
			Berberine	Isoquinoline alkaloid	Yellow	<i>Berberis vulgaris</i>	Barberry
E160e	40820	Food Orange 6	Beta-apo-8'-carotenal (C 30)		Orange		
			Brazilin		Yellow	<i>Caesalpinia sappan</i>	Heartwood
	75280	Natural Red 24	Brazilin		Red	<i>Caesalpinia sappan</i>	Heartwood
E120	75470	Natural Red 4	Carminic acid or cochineal	Anthraquinone	Red	<i>Coccus cacti</i>	Opuntia cactus beetle
	75560	Natural Red 22	Camwood, deoxyisosantalin		Red	<i>Baphia nitida</i>	Heartwood (camwood) and roots
E161g	40850	Food Orange 8	Canthaxanthin	Xanthophyll pigment	Orange	<i>Chlorella zofingiensis</i>	Edible mushrooms, green algae
E160c			Capsanthin	Carotenoid	Red-orange	<i>Capsicum annuum</i>	Paprika
E159		Natural Brown 10	Caramel	Melanoidin pigment	Golden red/brown		Burnt sugar
E153		Pigment Black 7	Carbon black, vegetable carbon		Black		
E153		Pigment Black 7	Carbon black, vegetable carbon	Others	Black		Vegetable carbon black
E120	75470	Natural Red 4	Carmine	Anthraquinone	Red	<i>Coccus cacti</i>	Opuntia cactus beetle
		Natural Red 26	Carthamin, carthamine	Flavonoid	Red	<i>Carthamus tinctorius</i>	Safflor, Dyer's Saffron

	Solubility	Supplier	Trade name	Special comments
	Water soluble	Kiriya Chemical Co Ltd	Akane Red RM	A substance composed mainly of alizarin and ruberythric acid obtained from madder roots
	Water soluble	Alban Muller (agent IMCD)	Amicolor® Madder Red	
	Water soluble			
	Water soluble			
	Water soluble			
	Water soluble			
	Water soluble	Paroxite DD Williamson	Natural Carotene WD 10 AP Natural Carotene OSS 200	Rendered water soluble using maltodextrin, mod, starch. Sugar and MCT oil standardised in carrot oil
	Water dispersible	Overseal	Em-Seal Natural Carotene OF 3221	
	Oil/water dispersible			
	Oil soluble			
	Oil soluble	Kiriya Chemical Co Ltd	Annabejin A-08	A substance composed mainly of norbixin and bixin obtained from the seed coats of annatto
	Water soluble	Overseal	Overseal Blue OF 3100	
	Water soluble Almost oil soluble Oil soluble	Paroxite Univar Colour Overseal	Natural Blue Colour 3947 NET Anthocyanine OS MiChroma Blue OF 3200	- Triglyceride from middle chain fatty acids, elderberry juice concentrate, maltodextrin, citric acid Extract of anthocyanins sprayed on starch suspended in vegetable oil
	Water soluble	Overseal	Anthocyanin Extract OF 0039	
	Water soluble	Kiriya Chemical Co Ltd	Kiriyasu Shionin L	A substance composed mainly of terpenoids obtained from <i>Perilla</i> seeds or leaves
	Water soluble	Overseal	Overseal Magento OF 1000	Extract of anthocyanins with addition of invert sugar and potassium sorbate
	Water soluble	Kiriya Chemical Co Ltd	Kiriyasu Red RC-N	A substance composed mainly of anthocyanins obtained from <i>Brassica oleracea</i> L. var. capitata DC
	Water soluble	Kiriya Chemical Co Ltd	Kiriyasu Red RR-F	A substance composed mainly of anthocyanins obtained from <i>Raphanus sativus</i> L.
	Water soluble	Kiriya Chemical Co Ltd	Kiriyasu Red PSP	A substance composed mainly of cyanidine acylglucosides and peonidin acylglucosides obtained from the tuberous roots of sweet potatoes.
	Water soluble	Kiriya Chemical Co Ltd	Grape Colour BC-120	A substance composed mainly of anthocyanins obtained from the pericarps of American grapes or other grapes.
	Water soluble			
	Water soluble			
	Almost insoluble in water			
	Almost oil soluble			
	Sparingly water soluble			
	Water soluble	Paroxite	BeetRed WSP1	
	Water soluble	Paroxite	Beetroot Red P03	
	Water soluble	Univar Colour	Beetroot Powder 42047	
	Water soluble	Kiriya Chemical Co Ltd	Beet Pink SA	A substance composed mainly of betanin and isobetanin obtained from beetroots
	Water soluble	Sabinsa Corporation (agent Unifect)	Sappan Extract	Colour changes from yellow to red depending on pH
	Water soluble	Sabinsa Corporation (agent Unifect)	Sappan Extract	Colour changes from yellow to red depending on pH
	Water soluble	Univar Colour	Cochineal Powder 44000	
	Water soluble			
	Water dispersible			
	Water soluble	Overseal Univar Univar	Caramelised Sugar Syrup Caramel Liquid Caramel Powder	Controlled heating of sugar solution to produce burnt sugar or caramel
	Oil dispersible	Overseal	MiChroma Carbon Black OF 1569	Vegetable carbon black in sunflower oil
		Kiriya Chemical Co Ltd	Kiriyasu Black T	A substance composed mainly of carbon obtained by carbonising plants
	Water soluble	Overseal	Carmine Extract OF 0063	
	Water soluble (slightly)			

## COLOUR COSMETICS

Code	CI number	Common name	Name	Chemical class	Colour	Plant name	Source
E150b			Caustic sulfite caramel				
	75580	Natural Yellow 12	Chamomile, apigenin	Flavonoid	Yellow	<i>Matricaria recutita</i>	Greek chamomile, weld
		Pigment Black 8	Charcoal		Black		
			Chimaphilin	Naphthoquinones	Yellow	<i>Chimaphila umbellata</i>	Wintergreen, pipsissewa, Prince's Pine
E140	75810	Natural Green 3	Chlorophylls and chlorophyllins: (i) chlorophylls (ii) chlorophyllins				
E140	75810	Natural Green 3	Chlorophylls and chlorophyllins: (i) chlorophylls (ii) chlorophyllins	Others			Chlorophylline
E140	75810	Natural Green 3	Chlorophylls and chlorophyllins: (i) chlorophylls (ii) chlorophyllins	Chlorophyll	Green	<i>Medicago sativa</i>	Leaves of alfalfa
E103			Chrysoine resorcinol				
	75400	Natural Yellow 23	Chrysophanic acid, chrysophanol	Anthraquinone	Yellow	<i>Rheum palmatum</i>	Turkey rhubarb
	75400	Natural Yellow 23	Chrysophanic acid, chrysophanol	Anthraquinone	Yellow	<i>Rumex crispus</i>	Yellow dock
E161i			Citranaxanthin	Carotenoid	Yellow		Produced synthetically
			$\beta$ -citaurin	Carotenoid	Orange	<i>Citrus sinensis</i> <i>Citrus tangerina</i>	Sweet orange peel, tangerine peel
	75570	Natural Yellow 10	Clover, pratol	Flavonoid	Yellow	<i>Trifolium pratense</i>	Red clover
E120	75470	Natural Red 4	Cochineal, carminic acid, carmines	Anthraquinone	Red	<i>Coccus cacti</i>	
E120	75470	Natural Red 4	Cochineal, carminic acid, carmines	Anthraquinone	Red	<i>Coccus cacti</i>	Cochineal extract
E141	75815		Copper complexes of chlorophylls and chlorophyllins (i) copper complexes of chlorophylls (ii) copper complexes of chlorophyllins	Chlorophyll	Bright green		
E141	75815		Copper complexes of chlorophylls and chlorophyllins (i) copper complexes of chlorophylls (ii) copper complexes of chlorophyllins	Chlorophyll	Bright green Bright green Bright green Olive green Olive green		– – – Spinach Stinging nettles
			Crocetin	Carotenoid dicarboxylic acid	Yellow	<i>Gardenia grandiflora</i>	Chinese crocin
	75100	Natural Yellow 6	Crocin	Carotenoid	Yellow	<i>Gardenia jasminoides</i>	Cape jasmine
	75100	Natural Yellow 6	Crocin	Carotenoid	Yellow	<i>Gardenia spp</i>	
	75100	Natural Yellow 6	Crocin	Carotenoid	Yellow	<i>Gardenia florida</i>	
E161c			Cryptoxanthin	Xanthophyll pigment	Yellow	<i>Physalis spp</i>	Cape gooseberry
E100	75300	Natural Yellow 3	Curcumin, turmeric	Curcuminoids (polyphenols)	Orange yellow	<i>Curcuma longa</i>	Rhizomes
	75630	Natural Yellow 12	Datisctin	Flavonoid	Yellow	<i>Datisca cannabina</i>	Bastard hemp
	75510	Natural Red 22,23	Deoxysantal	Naphthoquinones	Red	<i>Pterocarpus santalinus</i>	Sanderswood, barwood
	75440	Natural Green 2 Yellow 14	Emodin or frangula-emodin	Anthraquinone		<i>Rhamnus frangula</i>	Persian berries
E160f	40825	Food Orange 7	Ethyl ester of beta-apo-8'- carotenic acid (C 30)	Carotenoid	Orange		Often produced from apocarotenal (E160e)
	75620	Natural Brown I	Fisetin	Flavonoid	Brown	<i>Rhus cotinus</i>	Venetian sumac
		Natural Yellow 10	Flavine	Pteridines	Yellow		
E161a			Flavoxanthin	Xanthophyll pigment	Golden yellow	<i>Ranunculus spp</i>	Buttercup species
			Fucoxanthin	Carotenoid	Olive green, brown	<i>Fucus virsoides</i> <i>Zygnema pectinatum</i> <i>Undaria pinnatifida</i>	Fresh brown algae
	75600		Fulsugetin	Flavonoid		<i>Garcinia spicata</i>	Dyers
			Fumigatin	Benzoquinone	Maroon	<i>Aspergillus fumigatus</i>	Fungus derivative
			Fustin	Flavonoid	Yellow	<i>Rhus verniciflua</i> <i>Rhus cotinus</i> <i>Rhus succedanea</i>	Venice sumac Venetian sumac
			Genipin	Iridoid glycoside	Blue	<i>Genipa americana</i>	Fruit of Genipa
	75610		Genistein or prunetol	Flavonoid	Yellow	<i>Genista tinctoria</i>	Broom, Dyer's Greenweed

	Solubility	Supplier	Trade name	Special comments
	Water soluble			
	Water soluble			
		Kiriya Chemical Co Ltd	Kiriyasu Green CWS	A substance composed mainly of chlorophyll obtained from <i>Spinacia oleracea</i> L.
	Water soluble	Alban Muller (agent IMCD)	Amicolor® Alfalfa Green	
	Water soluble			
	Water soluble			
	Insoluble in water, slightly oil soluble			
	Water soluble			
	Water soluble	Univar Colour	Carmine Powder 44002	
	Water soluble	Kiriya Chemical Co Ltd	Carmin Red K	A substance composed mainly of carminic acid obtained from cochineal insects
	Water soluble	Paroxite	Copper Chlorophyllin WS 95AP	Polysorbate 80, potassium hydroxide, sodium copper chlorophyllin
	Water soluble	Givaudan (agent Adina)	Super Green	Copper chlorophyllin
	Water soluble	Univar Colour	Chlorophyllin AS Liquid	–
	Oil soluble	Overseal	Copper Chlorophyll Extract OF 0709	Sunflower oil
	Oil soluble	DD Williamson	Copper Chlorophyll OS 140	Standardised in vegetable oil
	Oil soluble	Sensient LCW (agent Adina)	Natpure Col Green LC 718L	Standardised in vegetable oil, ascorbyl palmitate, alpha-tocopherol
	Oil soluble	Univar Colour	Spinach Extract OS 20	Triglyceryl fatty acid esters, complete extract spinach, alpha-tocopherol
	Oil soluble	Univar Colour	Stinging Nettle Extract OS 10	Triglyceryl fatty acid esters (middle chained), complete extract stinging nettle, alpha-tocopherol
	Oil soluble	Univar Colour	Chlorophyll OS Liquid 42058	–
	Water soluble			
	Water soluble	Hayashibara	Ujo GYSP (Gardenia Yellow Dyed Silk)	Sold as a laked powder on silk
	Water soluble	Kiriya Chemical Co Ltd	Kirishin-L Conc	A substance composed mainly of crocin and crocetin obtained from gardenia fruits
	Water soluble	Univar Colour	Gardenia Florida Extract	
	Oil soluble			
	Water soluble	Givaudan (agent Adina)	Turmeric Yellow	Curcumin
	Water soluble	Univar Colour	Curcumin Powder 42066	90% dyestuff
	Water soluble			
	Sparingly water soluble			
	Water soluble			
	Water soluble	Alban Muller (agent IMCD)	Amicolor® Genipa Blue	
	Water soluble			