

SOAPS, OILS, FATS AND WAXES

Natural Colours

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Introduction

There are an infinite number of colours in nature and who could not wonder at the bright vibrancy of spring as the dazzling daffodils show their trumpets to herald the coming of summer. Some plants have such spectacular colour that their beauty is legendary, the voluminous surge of colour from the bougainvillea, the velvet coloured softness of roses, the cool hue of a woodland carpet of bluebells or the majesty of a cactus in flower over the arid desert.

Legal status

Despite this potential storehouse of fabulous natural colours, the law is quite specific in those that may be used. However, sometimes a plant containing natural colour, is used for its beneficial properties, and this can carry the penalty of tinting the product in which it is used.

Natural colours

There are a vast number of colours that can be obtained from nature, many of them used today in the cottage textile industry, as would have been used in traditional yarns from the time that man first stopped wearing animal skins and started weaving cloth and spinning wool. The colour adopted by the fibre is heavily influenced by the other chemicals added to the dye batch (normally called mordants), which is influenced not only the pH, but also by added metal ions which strongly influence the end colour. The list of plants providing colour is so long that it would be impractical to give them all, however, a generous flavour is given in Appendix I. A clue that a plant yields colour often comes from the Latin name "*tinctoria*".

Notice that leaves, roots, flowers, barks, fruits and stems can be used, and surprisingly, it is not always the flowers that deliver the strongest colours. A list of typical chemical entities is given in Appendix II.

It has been said that Man often finds his most useful chemicals in plants and then copies them, the same cannot be said about natural colours. The plant produces natural colour for only one reason (in the most part) and that is to attract insects to them for the purpose of pollination. Once the act of fertilisation has been completed, the need for attraction is redundant and the flower dies so that the fruit can develop. The requirement for colours are therefore only transient and as a result the chemicals responsible for them are generally unstable.

Natural colours when freshly produced are delicious in their richness, and subtle in their tones from delicate pastels to regal purples. Nature does not produce colours that are garish or fluorescent.

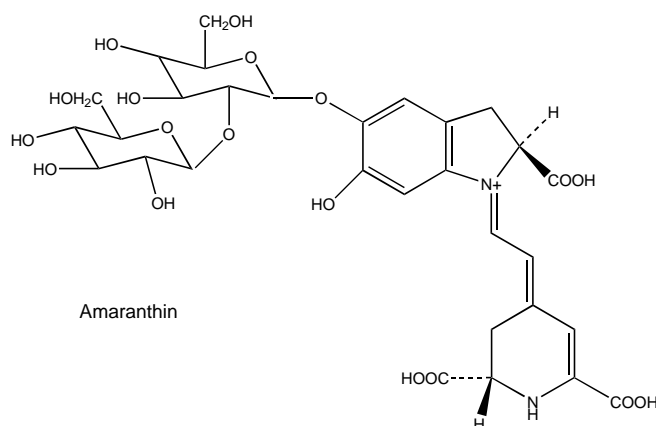
Many colours are used naturally in the food industry and these have E-numbers assigned to them. A list appears in Appendix III.

The colours obtained from natural plants

Products that give pink to red.

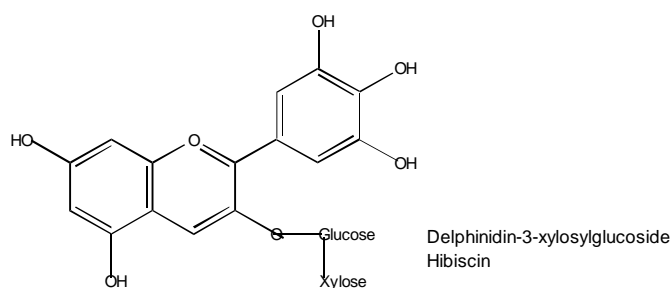
Amaranthin

This chemical is found in the leaves of *Amaranthus candatus* and *A. tricolor* in the inflorescences of *Celosia cristata* (Amaranthaceae) and in the leaves of *Atriplex hortense* and *Chenopodium amaranticolor* (Chenopodiaceae).



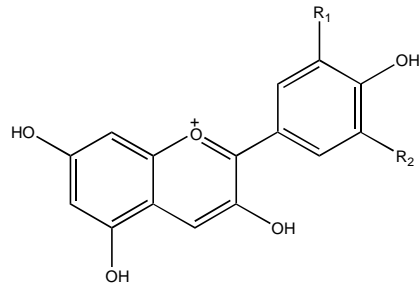
Anthocyanidins

A typical example can be obtained from *Hibiscus sabdifer*, which has bright red blossoms and yields an anthocyanidin known as delphinidin or cyanidin, it also has another colour chemical which is the glucoside hibiscin..



Anthocyanins

Cherries, plums, blackberries, black carrot, blueberries, cranberries, grapes, elderberry, mulberry, purple corn, rosehips, red cabbage, redcurrant.

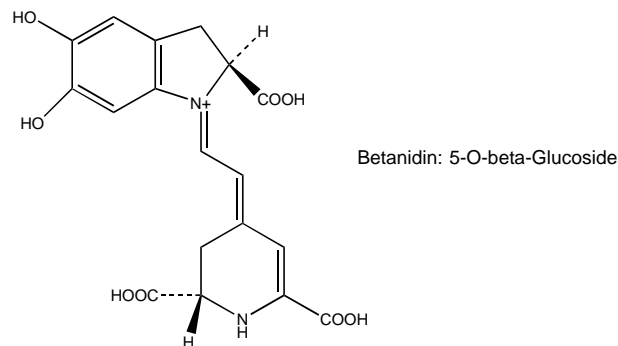


| Anthocyanin | R₁ | R₂ |
|--------------------|----------------------|----------------------|
| Pelargonidin | H | H |
| Cyanidin | OH | H |
| Delphinidin | OH | OH |
| Peonidin | OCH ₃ | H |
| Petunidin | OCH ₃ | OH |
| Malvidin | OCH ₃ | OCH ₃ |

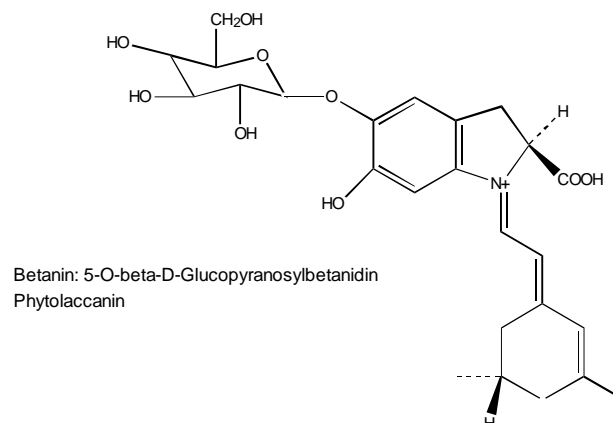
Cyanidin is found specifically in Purple Corn.

Betalaines

These are extracted from red beetroots (*Beta vulgaris*). It also occurs with isobetanidin in the flowers of *Mesembryanthemum edule* (Aizoaceae) and *Portulaca grandiflora* (Portulacaceae).



Another related compound is betanin or phytolaccanin



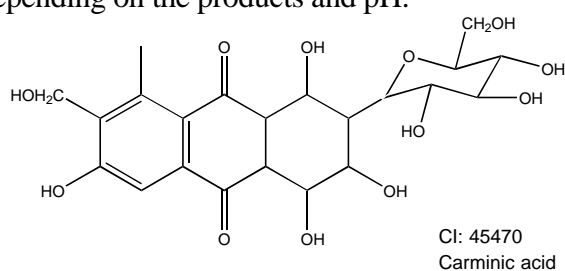
This colour occurs in the fruits of *Phytolacca americana* (Phytolaccaceae) and in *Portulacagrandiflora* (Portulacaceae). It is a purple pigment. Other places where it may be found are *Carpobrotus acinaciformis*, *Drosanthemum floribundum*, *Mesembryanthemum* spp. and *Opuntia bergeriana* and other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

Carmine

Aluminium complexes (lakes) can be prepared with varying ratios of alumina to give shades varying from pale yellow to violet with all shades of red in between.

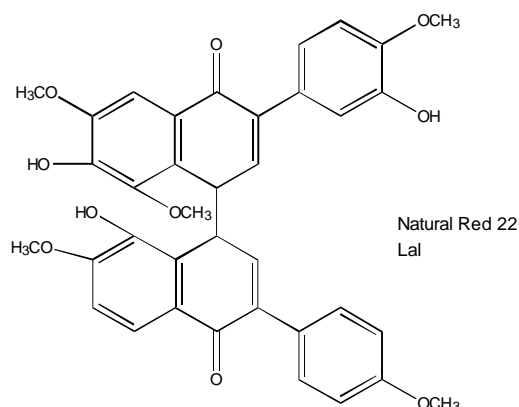
Carminic acid

This extract is associated with the protein material of the beetles and gives red, yellow and orange colours depending on the products and pH.

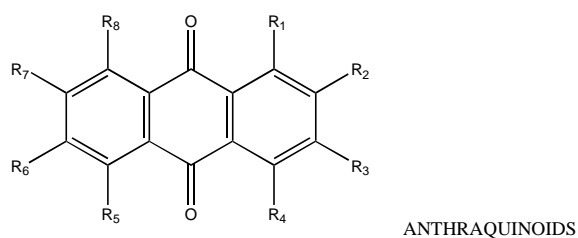


Lac

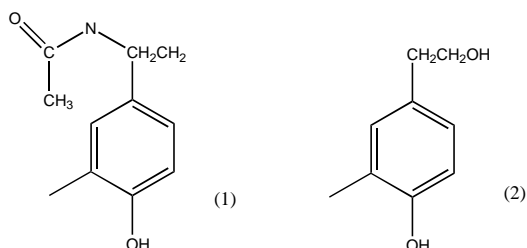
A material obtained from shellac is lac, which has a deep pink red colour.



Other chemicals that are found include Laccic acid A and Laccic acid B



| | R ₁ | R ₂ | R ₃ | R ₄ | R ₅ | R ₆ | R ₇ | R ₈ |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Laccaic acid A | OH | (1) | OH | OH | H | OH | COOH | |
| Laccaic acid B | OH | (2) | OH | OH | H | OH | COOH | COOH |



Lawsone

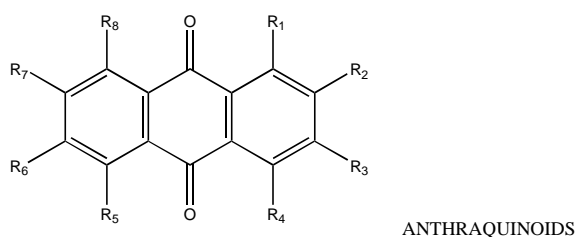
A colour used frequently in hair care is from Henna or *Lawsonia alba* and is present in the leaves. It is the chemical lawsone that is responsible for the red colour. This colour has been used for nearly five thousand years and was used by the ancient Egyptians for dyeing their hair and nails.

Lycopene

An extract from tomatoes, this gives a red to orange colour. It has a similar structure to the other carotenes.

Madder

There are two red chemical entities derived from the roots and tubers, which are known as alizarin and purpurin.

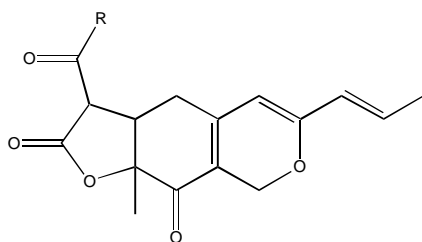


| | R ₁ | R ₂ | R ₃ | R ₄ | R ₅ | R ₆ | R ₇ | R ₈ |
|----------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Alizarin | | OH | PH | H | H | H | H | H |
| Purpurin | OH | OH | H | OH | H | H | H | H |

Monascus derivatives

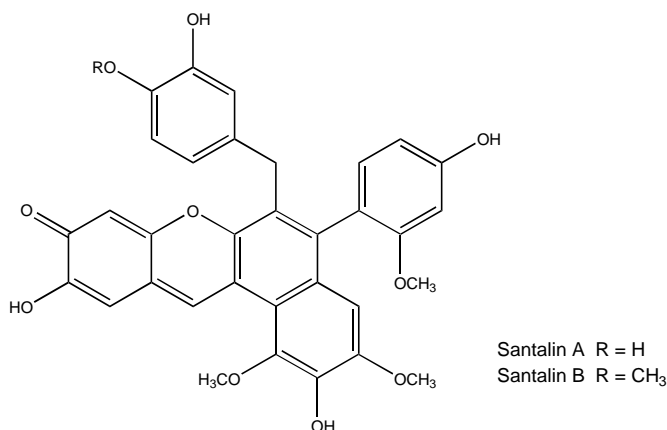
The use of *Monascus* microorganisms is also a rich source of natural colour and produces chemical species that give a red colour. These include monascin, ankaflavin,

rubropunctatin and monascorubrin, which have the following molecular skeleton. This is traditionally grown on rice in the Orient and is said to have an antibacterial effect.



Santalin

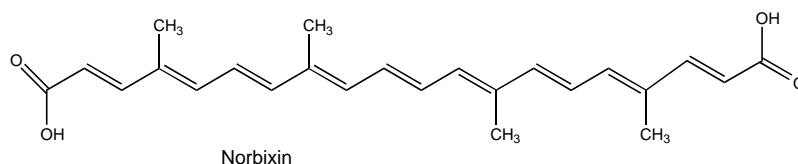
The red obtained from *Pterocarpus santalinum* or red sandalwood is a complex molecule known as santalin. There are a number of forms of this basic structure, which all give rise to quite intense red colours. The stability of this red is quite good compared to the others. It has been traditionally used for many centuries.



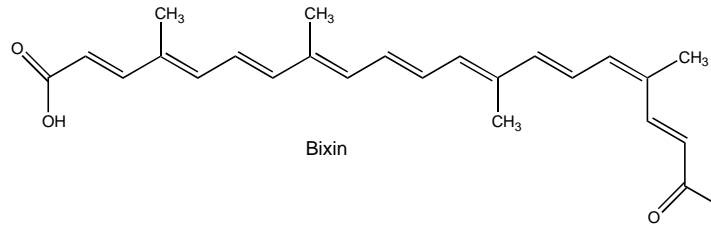
Products that give yellow to orange colour shades.

Annatto

Annatto or norbixin is extracted from the *Bixa orellana* tree; it gives a yellow to deep orange colour.

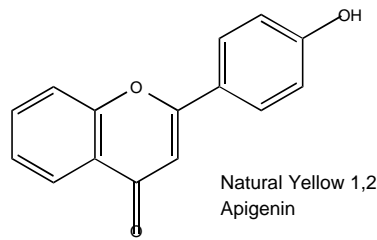


Another chemical found in the plant that is responsible for some of the colour is bixin.



Apigenin

This flavonoid, which occurs widely in plants gives a dull, golden yellow and is usually obtained from German Chamomile or *Matricaria recutita*.

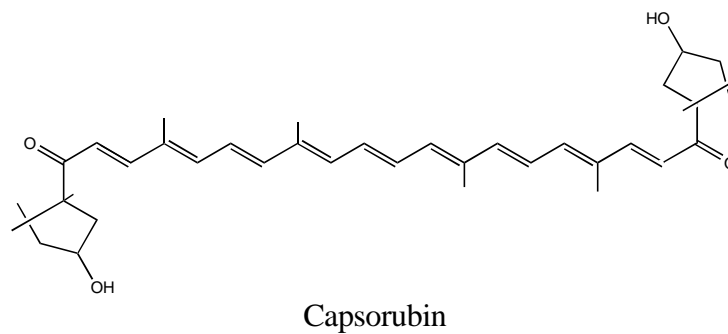
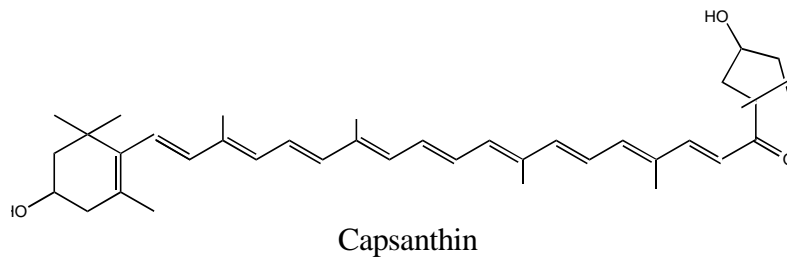


Canthaxanthin

This is a carotenoid that naturally occurs in fungi but is more usually produced by "nature identical" synthesis. Colour can be yellow to an almost orange red.

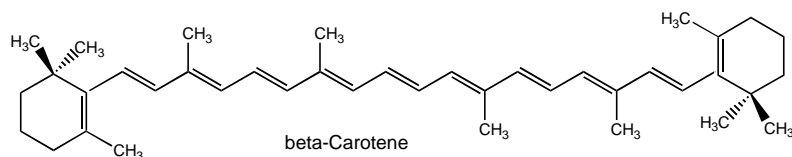
Capsanthin and Capsorubin

Capsanthin and the related capsorubin are most commonly found in paprika or *Capsicum annuum*.



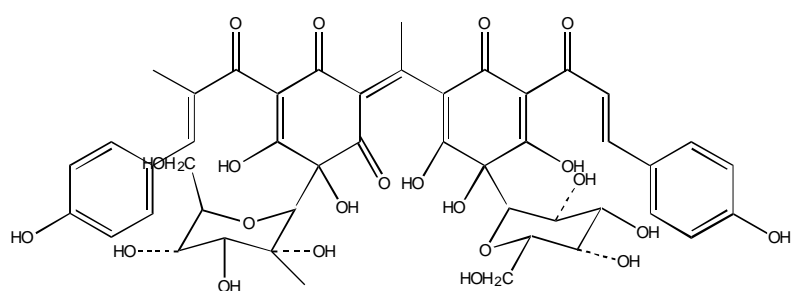
Carotenes

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



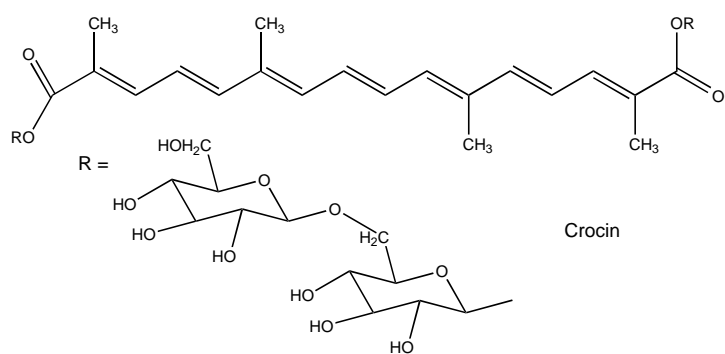
Carthamin

The flowers of *Carthamus tinctoria* or safflor (Bastard saffron) yield a pigment carthamin, which is a yellow-orange colour.

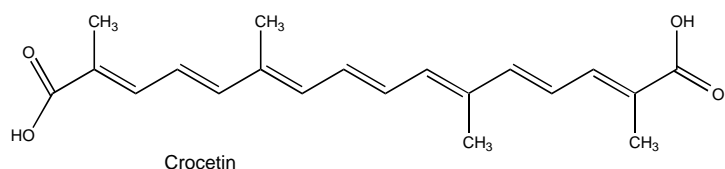


Crocin

A bright yellow colour that has been in use for over a thousand years. Extracted from the fruit of *Gardenia jasminoides*.

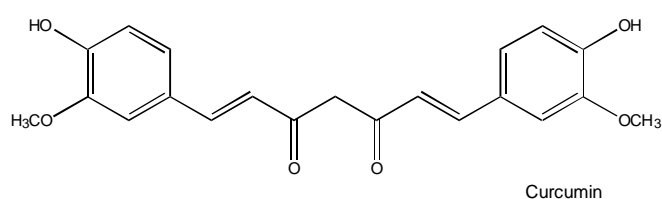


Another colour found in the plant is crocetin, where the most common source is found in *Crocus sativus* (styles) and better known as saffron. In other *Crocus* spp. the colour is often found in the petals. This material has been used for over two thousand years as a food colour.



Curcumin

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.



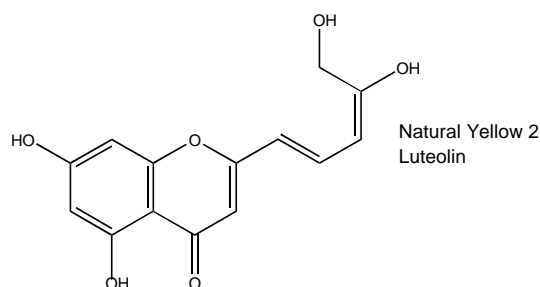
Lutein

An extract from *Tagetes erecta* (the Aztec Marigold). This is a xanthophyll which occurs naturally in all green leaves, green vegetables, eggs and some flowers. Exhibits egg to lemon yellow colours.

Luteolin

The colour luteolin is found in Dyer's Rocket (also known as Weld) or *Reseda luteola*. It is one of the oldest yellow dye plants and is found in many parts of Central Europe. The leaves and seeds are used, which contain more dye than the stems. An infusion of the plant has been used for treating wounds.

This dye is also present in Dyer's Broom, Dyer's Greenweed or *Genista tinctoria*, where the colour is a more green-yellow. An infusion of the plant has been used for chronic skin disorders. It has anti-inflammatory and antibacterial properties. The 7-glucoside and 7-glucuronide is found in the petals of *Antirrhinum majus* (Scrophulariaceae). The 7-galactoside and 7-rutinoside occur in *Capsella bursa-pastoris* (Cruciferae) and the 3'-glucoside in *Dracocephalum thymiflorum* (Labiatae).

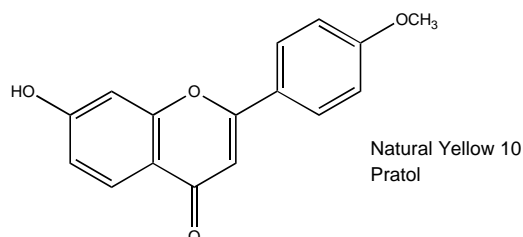


Paprika

The major colouring pigments of paprika are capsanthin and capsorubin. These are extracted from the red paper (*Capsicum annum*). The colour can vary from a golden yellow to a red/orange.

Pratol

From clover or *Trifolium pratense* one can obtain a natural colourant called pratol, which is a dull, golden yellow. There are a number of flavonoids that can be used from plant sources. Clover has been traditionally used for eczematous skin conditions, especially where the skin is pruritic. It is also useful for boils and pimples.



Products that give orange to brown shades.

Caramel

E150 caramel is produced by heating food grade carbohydrates in the presence of selected accelerators.

Caramelised sugar or burnt sugar is formed by heating sugars without a catalyst.

Cocoa

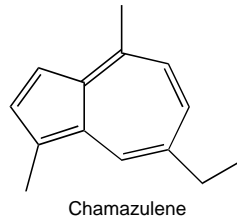
Extracted from cocoa beans and used in both food and drink products.

Products that give green and blue colours

Azulene

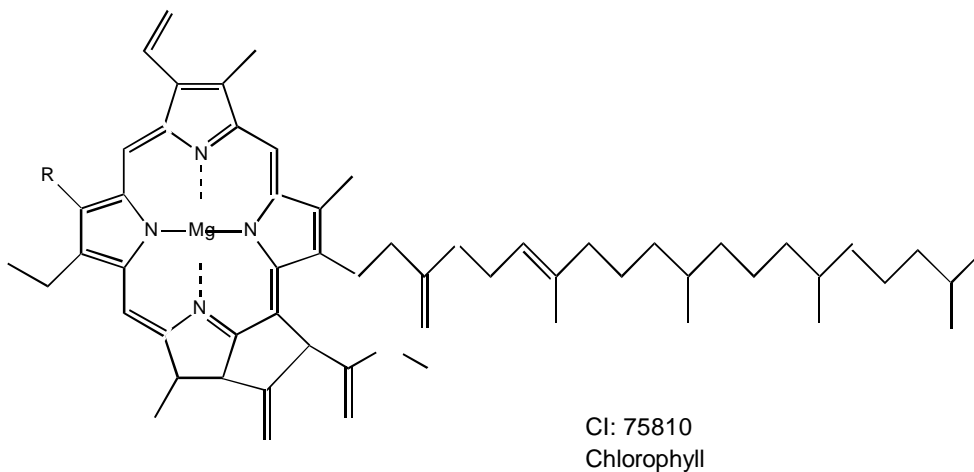
Probably the most famous of all the blue dyes that comes from German Chamomile or *Matricaria recutita*, Roman Chamomile or *Anthemis nobilis*, Yarrow or *Achillea millefolium* and Wormwood or *Artemisia absinthum*. This oil is responsible for the brilliant dark blue colour of the essential oils distilled from the fresh flowers.

The azulenes are generally accepted as being anti-inflammatory and healing in their action.



Chlorophyll

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



Copper chlorophyll

Derived from the 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. Naturally oil soluble.

Copper chlorophyllin

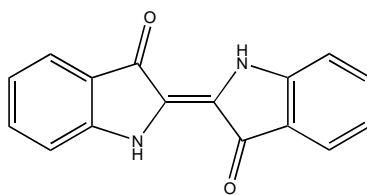
This is produced as the copper chlorophyll but a saponification process renders this form water soluble. The colour is a bright green to green/blue.

(Blue) Gardenia

An extract obtained from the gardenia fruits, modified by reacting with an amino acid. A dull navy blue, to a rich azure blue colour.

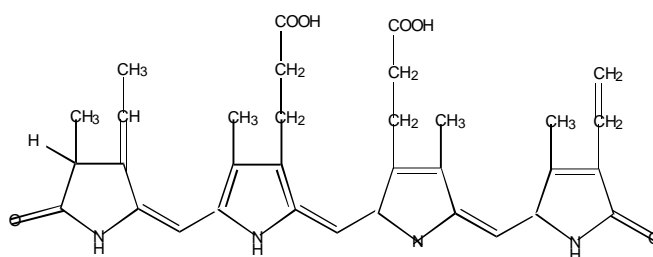
Indigo

Extracted from the fermented leaves of the plant *Indigo fera*. This produces a blue to mauve colour called indigotin (an indigoid structure).



Phycocyanobilin

An extract from a blue algae, often from spirulina. A colour shade similar to the blue gardenia. The chemical species responsible for this colour is one of the phycocyanobilin molecules, one of the structures of which is shown below.



A rich blue colour obtained from the fermented leaves of the plant *Isatis* spp (probably better known to most as woad). Used for many years for dyeing fabrics. Has been used in conjunction with herbs for colouring use. This has identical structure to the indigotin found in indigo (above). There are similar structures called indirubinoids, specifically 6,6'-dibromoindirubin, which can be obtained from whelks (*Murex trunculus*, *Murex brandaris* and *Thais haemastoma*), normally common to the Mediterranean region. This colour is a regal purple.

Zi Cao

Zi Cao (Mandarin or Chinese name) or *Lithospermum erythrorhizon*.

The main derivatives in the roots are acetyl shikonin, shikonin, alkanin and other shikonin derivatives. Shikonin and alkanin are naphthaquinone dyes, with an intensive red colour. The water soluble extract has remarkable properties. It can be used as a natural colour having an anti-inflammatory and calming effect too.

Depending on pH value and solvent system extracts of *Lithospermum* occur in various colours: below a value of pH 7 the extract is intense red, in the neutral range it is purple and in weak alkalic medium it is bluish-purple. Where the pH value exceeds 10 it is deep blue.

APPENDIX I

A selection of plants that can provide natural colour

| | | |
|--------------------|--------------------------------|--------------------|
| Agrimony stalks | <i>Agrimonia eupatoria</i> | yellow |
| Agrimony leaves | <i>Agrimonia eupatoria</i> | yellow |
| Alkanet root | <i>Alkanna tinctoria</i> | grey |
| Annatto seed | <i>Bixa orella</i> | orange |
| Annatto | E-160b | dark orange |
| Anthocyanins | E-163 d,e,f | blue-red |
| Barberry bark | <i>Berberis vulgaris</i> | yellows |
| Bayberry leaves | <i>Myrica pensylvanica</i> | grey-black |
| Bearberry leaves | <i>Arctostaphylos uva-ursi</i> | grey-black |
| Bearberry berries | <i>Arctostaphylos uva-ursi</i> | blue |
| Bearberry | <i>Arctostaphylos uva ursi</i> | khaki |
| Birch leaves | <i>Betula</i> sp | yellows |
| Black Oak bark | <i>Quercus velutina</i> | yellow |
| Black Walnut hull | <i>Juglans regia</i> | tan-brown |
| Black Walnut leaf | <i>Juglans regia</i> | khaki/tan |
| Blackberry shoots | <i>Rubus</i> spp. | grey-black |
| Bloodroot root | <i>Sanguinaria canadensis</i> | orange |
| Blueberry fruit | <i>Vaccinium</i> spp. | blue/lavender |
| Brazilwood | <i>Caesalpinia</i> sp | reds |
| Buckthorn bark | <i>Rhamnus frangula</i> | rusts |
| Buckwheat stalks | <i>Fagopyrum esculentum</i> | blue |
| Buffalo fruit | <i>Shepherdia argene</i> | pink |
| Buffalo berry | <i>Shepherdia argene</i> | pink |
| Butternut rootbark | <i>Juglans cinerea</i> | browns |
| Camomile flower | <i>Anthemis tinctoria</i> | yellow |
| Canthaxanthin | E-161g | red (quite bright) |
| Caramel | E-150 | umber brown |
| Carmine | E-120 | red |
| Cedar (red) root | <i>Juniperus virginiana</i> | lavender purple |
| Chamomile | <i>Matricaria recutita</i> | yellows |
| Chlorophyll | E-140 | bright green |
| Chlorophyllin | E-140 | yellow-green |
| Cochineal | <i>Dactylopius coccus</i> | pinks/reds |
| Cochineal | dried insect | pink |
| Coffee beans | <i>Coffea arabica</i> | green/tan-brown |
| Copper chlorophyll | E-141 | dull green |
| Coreopsis flower | <i>Coreopsis tinctoria</i> | yellow/orange |
| Curcumin | E-100 | orange |
| Cutch | <i>Acacia catechu</i> | browns |
| Dahlia | <i>Dahlia</i> spp | orange |
| Dock root | <i>Rumex obtusifolius</i> | yellow |
| Dyer's Broom flora | <i>Genista tinctoria</i> | yellow |
| Dyer's Broom | <i>Genista tinctoria</i> | yellows |
| Elderberries | <i>Sambucus nigra</i> | browns |
| Elderberry fruits | <i>Sambucus nigra</i> | blue/lavender |
| Eucalyptus leaves | <i>Eucalyptus</i> sp | khaki/tan |
| Fustic | <i>Chlorophora tinctoria</i> | yellow/golds |

| | | |
|-------------------------|---|----------------------|
| Goldenrod | <i>Solidago</i> spp | yellow |
| Grape juice | E-163 d,e,f | grey-blue |
| Grape fruits | <i>Vitis</i> spp | blue/lavender/purple |
| Heather flowers | <i>Calluna vulgaris</i> | golds/rusts |
| Henna powder | <i>Lawsonia inermis</i> | rusts/tans |
| Hibiscus | <i>Hibiscus rosa-sinensis</i> | red |
| Indigo | <i>Indigofera</i> sp | blues |
| Indigo balls | <i>Lonchocarpus cyanescens</i> | blues |
| Indigo leaves | <i>Indigofera tinctoria</i> | blue |
| Juniper berries | <i>Juniperus communis</i> | tans |
| Kola nuts | <i>Cola nitida</i> | browns |
| Lady's Bedstraw | <i>Galium verum</i> roots | pink |
| Lady's Bedstraw | <i>Galium verum</i> tops | yellow |
| Lily-of-the-valley | <i>Convallaria majalis</i> leaves | green/yellow |
| Logwood | <i>Haematoxylon campechianum</i> | purples |
| Madder | <i>Rubia tinctorium</i> | red/corals |
| Madder root | <i>Rubia tinctorium</i> | pink |
| Marigold | <i>Calendula officinalis</i> | fawns/creams |
| Marigold flower | <i>Tagetes</i> spp | yellow |
| Mulberry fruit | <i>Morus</i> spp | blue/lavender/purple |
| Natural carotene | E-160a | orange |
| Onion | <i>Allium cepa</i> | orange/yellow |
| Orchil lichens | | pink/lavender/purple |
| Paprika oleoresin | E-160c | orange-red |
| Persian berries | <i>Rhamnus</i> sp | yellows/gold |
| Pokeweed fruit | <i>Phytolacca decandra</i> | pink/orange/lavender |
| Purple Corn | <i>Mais morado</i> | dark pink |
| Rhubarb root | <i>Rheum</i> sp | yellows/golds |
| Riboflavine | E-101 | yellow-orange |
| Riboflavine-5-phosphate | E-101a | orange |
| β-carotene | E-160a | orange |
| Safflower flowers | <i>Carthamus tinctorius</i> | pink/orange/yellow |
| Safflower | <i>Carthamus tinctorius</i> | yellow/pinks |
| Sandalwood | <i>Santalum album</i> | fawns |
| Sanderswood | <i>Pterocarpus santalinus</i> | rusts |
| Scotch Broom | <i>Cytisus scoparius</i> flowering tops | yellow |
| Spinach green | <i>Spinacia oleracea</i> | bright green (very) |
| St. John's Wort | <i>Hypericum perforatum</i> flowers | yellow/pink |
| Sticklac | <i>Laccifer lacca</i> Kerr | reds/pinks |
| Sumac flower tops | <i>Rhus glabra</i> | yellow |
| Tea leaves | <i>Thea sinensis</i> | tan-brown |
| Tomato | <i>Solanum lycopersicum</i> | slightly blue-red |
| Turmeric | <i>Curcuma longa</i> | yellows/golds |
| Walnut hulls | <i>Juglans regia</i> | browns |
| Weld | <i>Reseda luteola</i> | yellows |
| White Birch | <i>Betula alba</i> | yellow/tan-brown |
| Wild Cherry bark | <i>Prunus serotina</i> | pinky tans |
| Xanthophylls | E-161b | orange |
| Zinnia flowers | <i>Zinnia elegans</i> | yellow |

APPENDIX II

| COLOUR SOURCE | LATIN NAME | MAJOR PIGMENT |
|--------------------------------------|-----------------------------|---------------------|
| Tumeric | <i>Curcuma longa</i> | Curcumin |
| Saffron | <i>Crocus sativus</i> | Crocin |
| Gardenia fruit | <i>Gardenia jasminoides</i> | Crocin |
| Marigold (Tagetes) | <i>Tagetes erecta</i> | Lutein |
| Alfalfa | <i>Medicago sativa</i> | Lutein |
| Carrots | <i>Daucus carota</i> | B-carotene |
| Algae | <i>Dunallella salina</i> | B-carotene |
| Annatto | <i>Bixa orellana</i> | Bixin |
| Annatto | <i>Bixa orellana</i> | Norbixin |
| Paprika | <i>Capsicum annum</i> | Capsanthin |
| Paprika | <i>Capsicum annum</i> | Capsorubin |
| Black Grapes | <i>Vitis vinifera</i> | Anthocyanin |
| Elderberries | <i>Sambucus nigra</i> | Anthocyanin |
| Hibiscus | <i>Hibiscus sabdariffa</i> | Anthocyanin |
| Beetroot | <i>Beta vulgaris</i> | Betanin |
| Cochineal insect | <i>Coccus cacti</i> | Cochineal carmine |
| Cochineal insect | <i>Coccus cacti</i> | Carminic acid |
| Grass | <i>Graminae</i> sp | Chlorophyll |
| Spinach | <i>Spinacia oleracia</i> | Chlorophyll |
| Alfalfa/lucerne | <i>Medicago sativa</i> | Chlorophyll |
| Vegetable material Carbonised (Peat) | | Carbon Black |
| Caramelised sugar | (sugar, sucrose) | Melanoidin pigments |
| Malt extract | <i>Hordeum distichum</i> | Melanoidin pigments |

APPENDIX III

| C.I. Number | Name | E No. | Common name |
|-------------|--------------------------------------|-------|----------------------|
| 14720 | Azorubine, carmoisine | E122 | |
| 16185 | Amaranth | E123 | |
| 40800 | beta-carotene | E160a | Food Orange 5 |
| 40820 | beta-apo-8'-carotenal | E160e | Food Orange 6 |
| 40825 | Ethyl ester of beta-apo-8'-carotenal | E160f | Food Orange 7 |
| 40850 | Canthaxanthin | E161g | Food Orange 8 |
| 73000 | Indigo | | Vat Blue 1 |
| 75100 | Saffron, crocetin | | |
| 75120 | Annatto, bixin, norbixin | E160b | Natural Orange 4 |
| 75125 | Lycopene | E160d | |
| 75130 | Mixed carotenes | E160a | Natural Yellow 26 |
| 75135 | Marigold | E161d | |
| 75140 | Saffron | | Natural Yellow 6 |
| 75300 | Curcumin, turmeric | E100 | Natural Yellow 3 |
| 75470 | Cochineal, carminic acid | E120 | Natural Red 4 |
| 75486 | Henna, lawsone | | |
| 75520 | Alkanet | | Natural Red 20 |
| 75530 | Alkanet | | Natural Red 20 |
| 75540 | Sandalwood, santalin | | Natural Red 22 |
| 75550 | Isosantalol | | Natural Red 22 |
| 75560 | Camwood, deoxyisantalol | | Natural Red 22 |
| 75570 | Clover, pratol | | Natural Yellow 10 |
| 75580 | Chamomile, apigenin | | Natural Yellow 12 |
| 75590 | Luteolin | | Natural Yellow 2 |
| 75660 | Osage orange, morin | | Natural Yellow 8, 11 |

| | | | |
|-------|---|-------|-------------------|
| 75780 | Indigo | | Natural Blue 1 |
| 75810 | Chlorophyll, chlorophyllins | E140 | Natural Green 3 |
| 75815 | Copper complex of chlorophyll, chlorophyllins | E141 | |
| - | Paprika, capsanthin, capsorubin | E160c | |
| - | Lutein | E161b | |
| - | Beetroot, betanin | E162 | |
| - | Anthocyanins | E163 | |
| - | Flavine | | Natural Yellow 10 |
| - | Caramel | E150 | Natural Brown 10 |
| - | Plain caramel | E150a | |
| - | Caustic sulphate caramel | E150b | |
| - | Ammonia sulphate caramel | E150c | |
| - | Sulphite ammonia caramel | E150d | |
| - | Vegetable carbon | E153 | Pigment Black 7 |
| - | Charcoal | | Pigment Black 8 |
| - | Persian berry | | Natural Yellow 13 |
| - | Riboflavin | E101 | |
| - | Riboflavin-5'-phosphate | E101 | |
| - | Monascus | | Natural Red 2 |