

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.

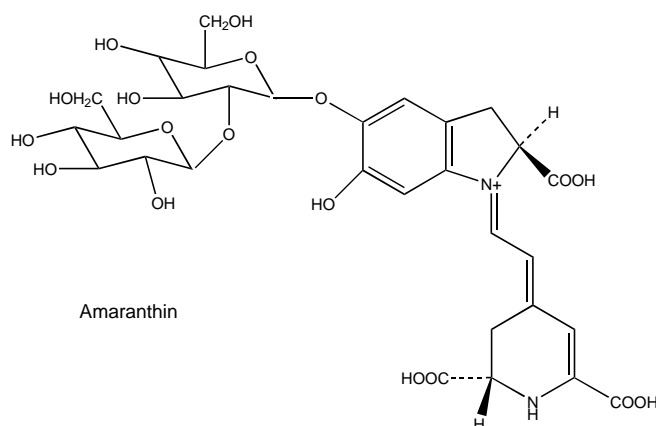
Many colours are used naturally in the food industry and these have E-numbers assigned to them. A list appears in Appendix III.

The colours obtained from natural plants

Products that give pink to red.

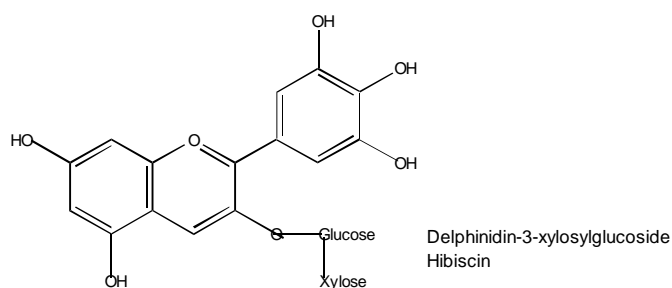
Amaranthin

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).



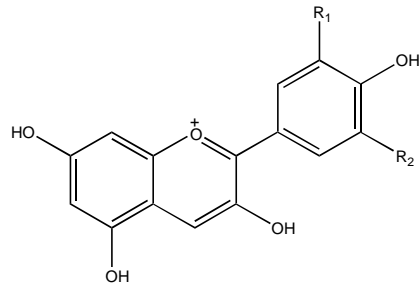
Anthocyanidins

A typical example can be obtained from *Hibiscus sabdifera*, 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.

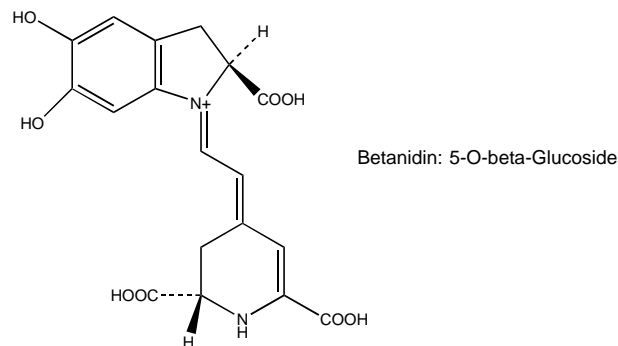


Anthocyanin	R₁	R₂
Pelargonidin	H	H
Cyanidin	OH	H
Delphinidin	OH	OH
Peonidin	OCH ₃	H
Petunidin	OCH ₃	OH
Malvidin	OCH ₃	OCH ₃

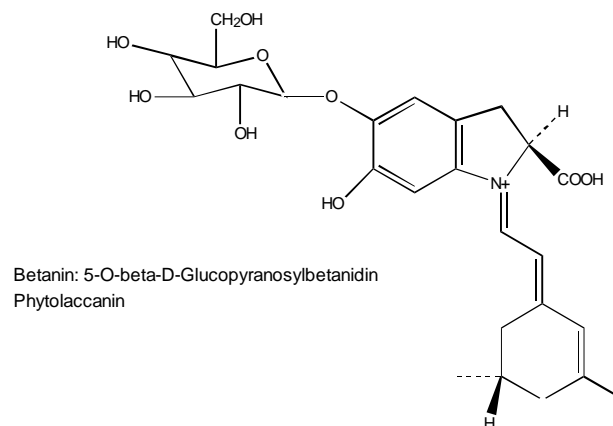
Cyanidin is found specifically in Purple Corn.

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



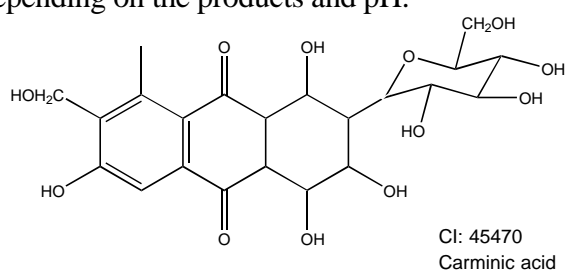
This colour occurs in the fruits of *Phytolacca americana* (Phytolaccaceae) and in *Portulacagrandiflora* (Portulacaceae). It is a purple pigment. Other places where it may be found are *Carpobrotus acinaciformis*, *Drosanthemum floribundum*, *Mesembryanthemum* spp. and *Opuntia bergeriana* and other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

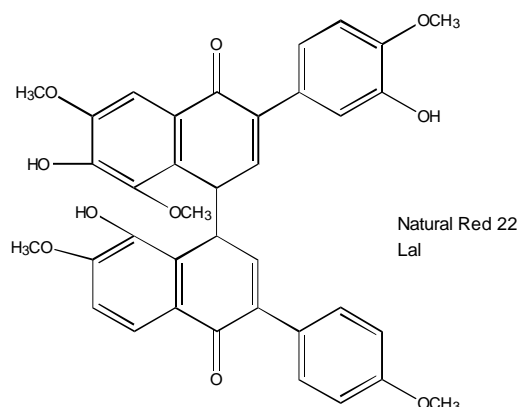
Carminic acid

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

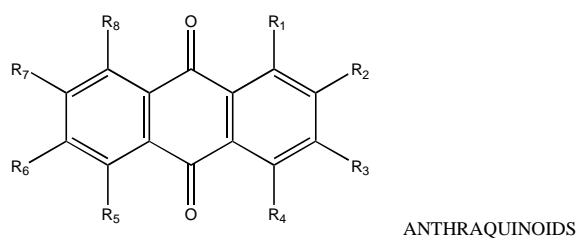


Lac

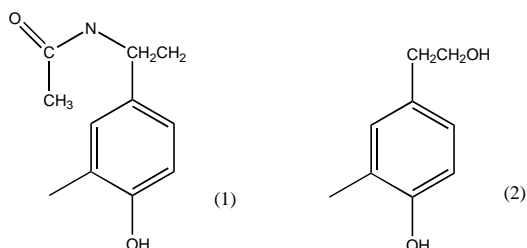
A material obtained from shellac is lac, which has a deep pink red colour.



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

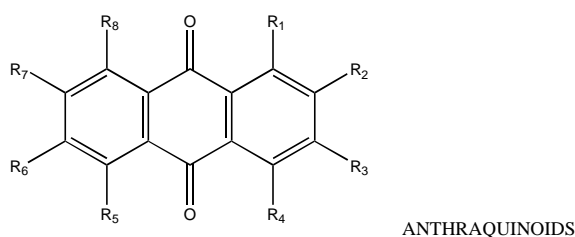
A colour used frequently in hair care is from Henna or *Lawsonia alba* and is present in the leaves. It is the chemical lawsone that is responsible for the red colour. This colour has been used for nearly five thousand years and was used by the ancient Egyptians for dyeing their hair and nails.

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.

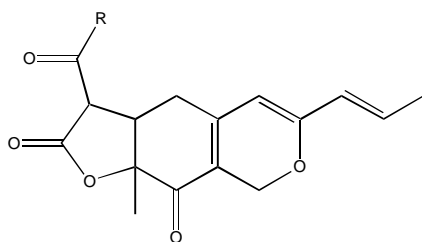


	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈
Alizarin		OH	PH	H	H	H	H	H
Purpurin	OH	OH	H	OH	H	H	H	H

Monascus derivatives

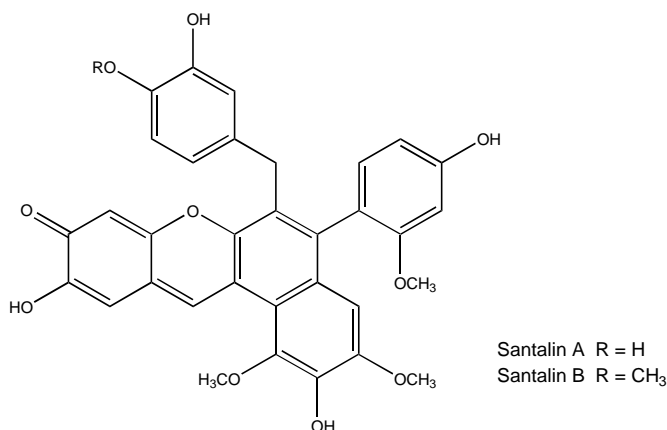
The use of *Monascus* microorganisms is also a rich source of natural colour and produces chemical species that give a red colour. These include monascin, ankaflavin,

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

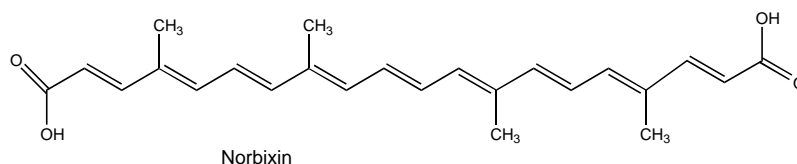
The red obtained from *Pterocarpus santalinum* or red sandalwood is a complex molecule known as santalin. There are a number of forms of this basic structure, which all give rise to quite intense red colours. The stability of this red is quite good compared to the others. It has been traditionally used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



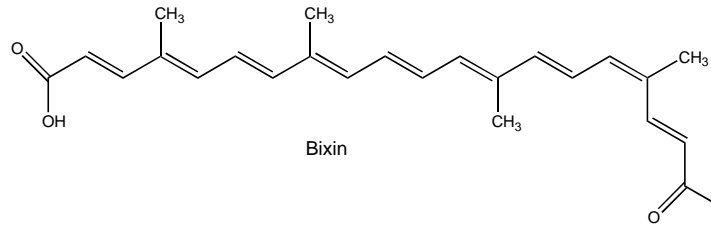
Products that give yellow to orange colour shades.

Annatto

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

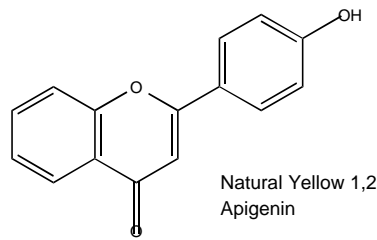


Another chemical found in the plant that is responsible for some of the colour is bixin.



Apigenin

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

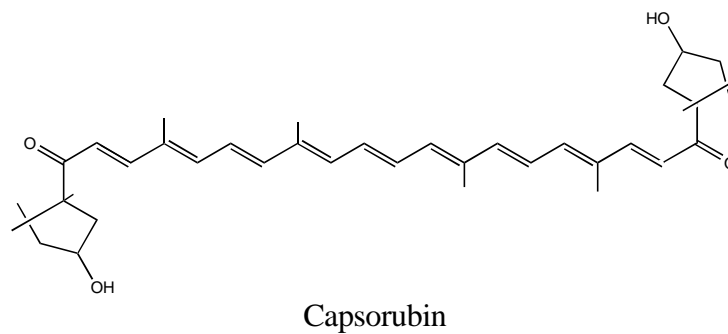
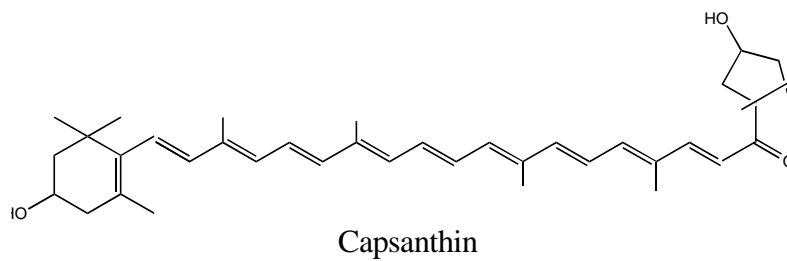


Canthaxanthin

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.

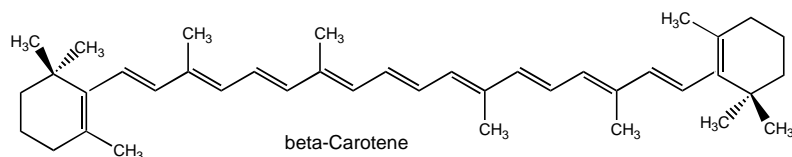
Capsanthin and Capsorubin

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



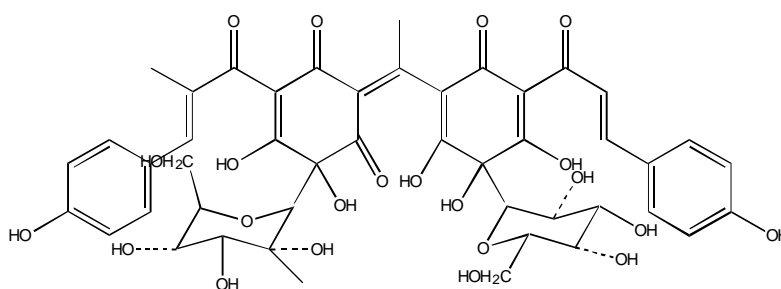
Carotenes

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.



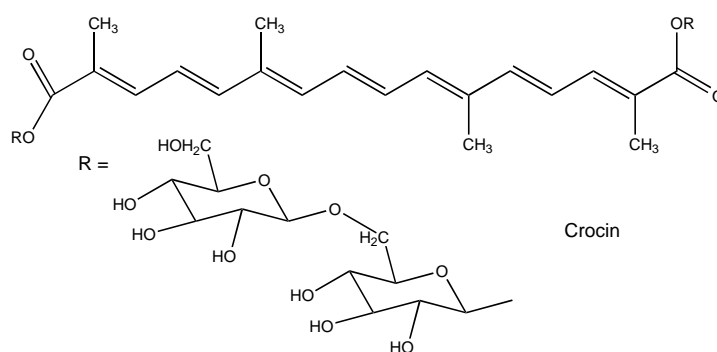
Carthamin

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

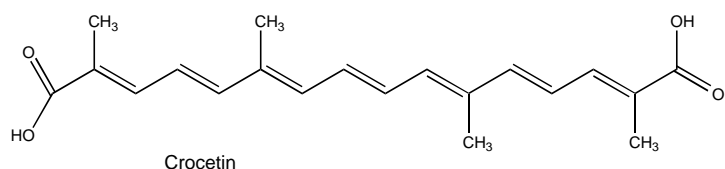


Crocin

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

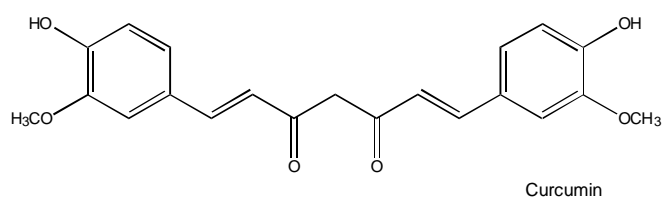


Another colour found in the plant is crocetin, where the most common source is found in *Crocus sativus* (styles) and better known as saffron. In other *Crocus* spp. the colour is often found in the petals. This material has been used for over two thousand years as a food colour.



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.



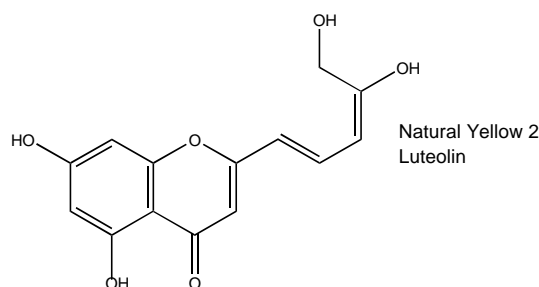
Lutein

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).

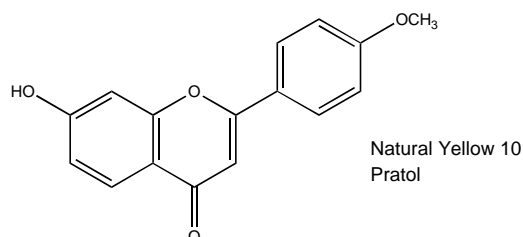


Paprika

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

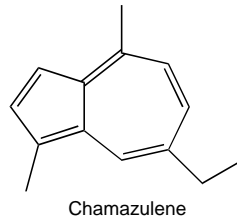
Extracted from cocoa beans and used in both food and drink products.

Products that give green and blue colours

Azulene

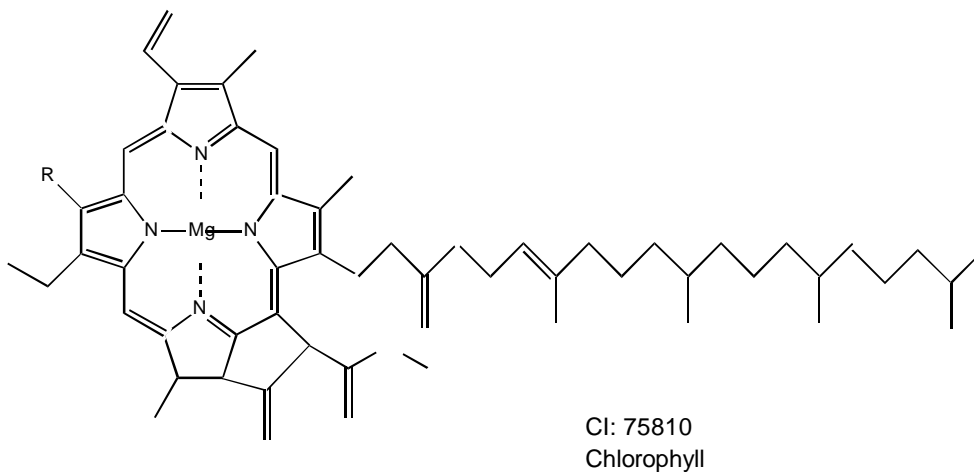
Probably the most famous of all the blue dyes that comes from German Chamomile or *Matricaria recutita*, Roman Chamomile or *Anthemis nobilis*, Yarrow or *Achillea millefolium* and Wormwood or *Artemisia absinthum*. This oil is responsible for the brilliant dark blue colour of the essential oils distilled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

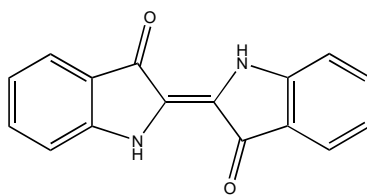
This is produced as the copper chlorophyll but a saponification process renders this form water soluble. The colour is a bright green to green/blue.

(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.

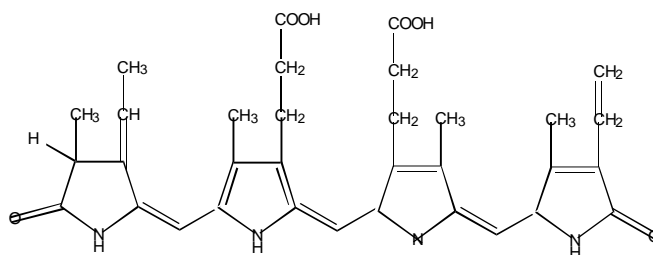
Indigo

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