

Nature's Rainbow

Natural food colourants for a healthy diet

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CLOURS play an essential role in influencing the initial consumer acceptance of a food product. Apart from making foods attractive, the significance of colours from the perspectives of food safety and nutritional quality is also important. There are two types of food colourants, which are mainly used in processed food items — synthetic and natural.

Synthetic colours are highly stable, cheap, and readily available, but their use harms human health and the environment. Some of these synthetic food colourants,

such as tartrazine (E 102), allura Red (E 129), carmoisine (E 122), sunset yellow (E 110), brilliant blue (E 133), fast green (E 143), Erythrosine (E 127), green S (E 142) are permitted as food additives by the European Food Safety Authority (EFSA). However, besides these permitted colours, many harmful industrial colours, such as rhodamine B, are being used illegally on a large scale in food items to make them more appealing to consumers, especially children.

Because of the immediate and long-term harmful effects of synthetic colours, consumer interest has recently shifted

Important natural colours, along with sources and E numbers

Name	Source	Colours	*E number
Anthocyanin	Fruits, Flowers & Vegetables	Red, Purple, Blue	E 613
Betalain	Beetroots	Pink, Red	E 162
Chlorophyll	Leaves	Green	E 141
Carotenoids	Carrots	Orange	E 160
Curcumin	Turmeric	Yellow	E 100
Carminic acid	Cochineal insect	Red	E 120
Lac dye	Lac insect	Red	-

*E numbers are the codes for substances used as food additives

towards natural food colourants, which are safe and endowed with additional functional properties, such as antioxidants and diverse health benefits. Also, the extraction of natural colours is more sustainable and environment friendly compared to the manufacturing processes of synthetic colours.

There are various sources of natural colours that include, fruits, flowers, vegetables, seeds, insects, and microorganisms.

The natural colours can be further classified as — Plant-derived Natural Colorants, Natural Colourants Obtained from Insects, and Natural Colourants Obtained from Microbes.

Plant-derived Natural Colourants

Plant pigments with unique physico-chemical properties are produced through various biochemical pathways. These pigments play a significant role in protecting plants from harmful ultraviolet rays, absorption of light, and attracting pollinators. The major pigments found in plants are:



Anthocyanins: are water-soluble pigments belonging to the flavonoid family. They give attractive red, purple, violet and blue colours in many flowers, fruits, and vegetables. Anthocyanins show unique properties with the change in pH; their colour changes to red in acidic conditions and blue in alkaline conditions. They are mainly used in beverages, jams, and confectionery.

Betalains: are water-soluble nitrogen-containing heterocyclic pigments, which can further be categorised into betacyanins



(red-violet) and betaxanthins (yellow-orange). Their major sources include red beetroot, dragon fruit, red amaranth, opuntia, bougainvillea, etc. Extracted pigments lose stability in light, heat, and oxygen. However, they are structurally stable between pH 3-7, making them particularly suitable for frozen products with a low shelf life, such as ice cream and yoghurt.





fruits and vegetables. They can be further categorised into carotenes and xanthophylls. Major sources include tomatoes, carrots, pumpkins, papaya, melons, bell peppers, marigolds, etc. Carotenoids are used in meat products (sausages), vegetable oils, and butter.

Apocarotenoids: these pigments are derived from carotenoids and are responsible for the colouration of many plant parts. One of the major apocarotenoids is bixin, which is found in the seeds of achiote (*Bixa orellana*) and extracted commercially to form annatto, a natural food colourant used in different cuisines and cheese, yoghurt, deserts, etc. Crocetin is another apocarotenoid found in the stamens of saffron. Commercially, it is extracted from the fruits of gardenia.

Curcumin: is extracted from the rhizomes of turmeric. It is also a fat-soluble natural pigment used for centuries in Ayurveda and traditional Chinese medicine. It is used in various food items such as dairy and bakery products, beverages, pickles, confectionery, ice cream, meat and fish products, etc.

Chlorophyll: is one of nature's most widely distributed natural pigments that is a major component in light absorption. It is a fat-soluble natural pigment. It is used in various applications, including confectionery, baked foods, dairy products, and beverages.

Carotenoids: are fat-soluble natural pigments responsible for the orange, yellow, and red colouration of many

Natural Colourants Obtained from Insects

In addition to plants, insects are also rich sources of natural pigments. The major natural pigments obtained from insects and their applications in food items are as follows:

Lac Dye (Laccaic Acid): known as "Lakh Dye", is one of the oldest insect dyes. It is secreted by lac insects (*Kerria lacca*) to protect themselves from harmful ultraviolet radiation. This



Lac Insect



Cochinial Insect

Insect derived natural colours



dye is obtained during Seedlac (Chouri Lakh) preparation by washing Sticklac (Chili Lakh). Lac Dye is used as a natural food colourant, cosmetic colourant, and fabric dye.

Carminic acid: is a derivative of carminic acid obtained from the cochineal insect, namely *Dactylopius coccus*. These insects mainly thrive in cactus plants found in the American continent. Around 20% of their body weight consists of carminic acid. Carmine finds its major food applications in processed meats (sausages), red-coloured beverages, cakes, pastries, yoghurts, and alcoholic beverages.

Natural Colourants Obtained from Microbes

Microorganisms like bacteria, fungi, and microalgae, including marine algae, also produce various natural pigments commercially extracted and used as food colourants. As a source of natural pigments, microorganisms are better than plants because they grow rapidly in inexpensive media, are easy to culture, and their production is not dependent on weather conditions. Specific microbial cultures are exploited to harvest natural pigments from various groups, including carotenoids, melanin, quinines, etc. Pigments obtained from various microbial sources are used in food items such as yoghurt, milk, carbonated beverages, sweets, and ice cream. Major microbial pigments and their applications in food are as follows:

Phycobiliproteins: are water-soluble proteins obtained from cyanobacteria and some algae. The major pigments that belong to this group are phycocyanin (blue pigment) and

phycoerythrin (red pigment). These pigments uniquely show fluorescent properties. As these proteins denatured at high temperatures, their applications are limited to foods prepared at low temperatures.

Monascus pigments: some species of the fungus genus *Monascus* are commercially exploited to extract yellow, orange, and red pigments belonging to the chemical group of azaphilone, namely ankaflavin and monascin (yellow), monascorubin and rubropunctatin (orange), monascorubramine and rubropunctamine (red). These pigments are commonly used as food colourants for biscuits, ice creams, etc.

Challenges with Natural Food Colourants

There are many benefits of natural food colourants, but their use in food systems comes with some challenges as well, which are as follows:

- **Colour Stability and limited Colour Range:** natural colours tend to be less stable, which can result in their fading or changing over time.

This makes it challenging to ensure consistent colour in products. In addition, natural colourants do not provide an extensive range of colour spectrums, unlike synthetic colourants, limiting their use in some food products.

- **Sources:** seasonal availability and price fluctuations can affect obtaining natural colourants from specific fruits or vegetables.
- **Processing and Cost:** Extraction and processing of natural colourants can be complex and require specialised equipment, which can increase the cost of food products.

The potential impact of synthetic food colourants on human health and the environmental issues associated with their production and disposal are serious concerns. Despite the harmful effects of synthetic colourants, they are used in various food items. Therefore, there is a need to raise awareness among consumers about the potential risks of synthetic food colourants and to make them aware of the benefits of natural colourants. Additionally, challenges related to natural colourants, such as colour stability and limited production on a large scale, hinder their use, which necessitates more research in this direction.

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