An Elsevier Indexed Journal ISSN-2230-7346

Journal of Global Trends in Pharmaceutical Sciences

NATURAL COLORS: A REVIEW

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ARTICLE INFO

Key Words

Natural colors, anthocyanins, toxicity, caretonoids, chlorophyll, betacyanins.

ABSTRACT

Consumer demand for natural colors is augmented as a result of awareness regarding toxicity of artificial colors. Many artificial colorants like Tartrazine, Quinoline Yellow, Carmoisine are banned as a result of they because allergy like symptoms and carcinogens. Plant based mostly natural colorants like lipide soluble caretonoids and water soluble anthocyanins and betacyanins are the alternatives to interchange artificial colorants. The utilization of plant pigments depends on several factors like pH, temperature, structure and concentration of the pigment, intensity level, presence of metallic ions, enzymes, oxygen, sugars and their degradation product, flexibility throughout process, long lasting result, profitableness. To beat these drawbacks, the new technologies like metal complexation, microencapsulation, intermolecular and intramolecular copigmentation are developed to fulfill the needs of current food process.

INTRODUCTION

Food colors are added to numerous foods commodities to reinforce their look. Artificial food colors are extensively employed in foodstuffs so as to boost their aesthetic value. Although the use of these colorants dates back to 5000 BC, their use in processed, packed and fun foods, has been increasing since 19th century, synthetic food colors can be used in number of domestic food commodities. The foremost reason for use of synthetic food colors is that they are available as different color blends. Blends can provide different shades to the food items which magnetize the children[1]. Synthetic colors are formed from cheap petroleum sources and show superior fastness properties. It is estimated that nearly 10,00000 tones of synthetic colors were used per annum. In the last 20 years synthetic colorants have been increasingly recognized as undesirable and harmful by consumers. Hence, most countries restricted the use of synthetic colors[2]. This need has come from legislative action and consumer focus against synthetic food colors[3]. Some food colors have been heighten or even antagonistic as compared to the original colors. The usage of large amount of synthetic colors causes pollution, disturbs the ecological balance and causes health danger to human beings. Many synthetic colorants have been restricted as they cause allergy like signs and symptoms or are carcinogens. Natural colors are originated from naturally occurring sources such as plants, insects, animals and minerals[4]. The starting material for the production of natural colors is mostly vegetable matter such as seeds, leaves, roots, barks and flowers. Amongest the all natural colors, plant based pigments have wide range of medicinal value[5]. Nature gives a number of compounds appropriate for food coloring, such as the water soluble anthocyanins, betalains, and carminic acid, as well as the oil soluble carotenoids and chlorophylls. However, replacing synthetic colors with natural colorants is challenge because the color and stability of plant pigments are dependent on many factors like structure and concentration of the pigment, light intensity, presence of, metallic ions, pH, temperature, enzymes, oxygen, ascorbic acid, sugars[6], flexibility during processing, long lasting effect, profitability. Synthetic colorants are more beneficial from all this point of view[7]. Because of the shortcomings of existing natural food colorants, the need for natural colorants is repeatedly heighten by the food industry. Therefore, part of plant pigment research is looking new sources of pigments[8]. Biocolorants are acceptable food colorants in a wide color spectrum, and a source of healthy components in variety of food products. These healthy properties are mainly due to antioxidant activity, and the opportunity to prepare functional food based on natural pigments is potential. Some natural pigments are already used as therapeutic products. Some of these are: Carotenoids, flavanoids betalains and porphyrins, which all are functional and significant molecules in the nature[9]. In addition to their color yielding characteristics, some of these plants also possess medicinal properties. The natural colorants are more adventitious as they are ecofriendly, safe for body contact, harmonized with nature, obtained from renewable sources and also their method of preparation involves a less or minimum possibility of chemical reactions[10]. Also they are gentle, soft and subtle, and create a restful effect. Most of them are water-soluble (anthocyanins), which accelerates their incorporation into aqueous food systems. These qualities make natural food colorants fascinating[11]. Generally natural colors do not cause any health hazards; Furthermore, they are biodisposable[10]. Food colour manufacturers therefore seeking to develop new technologies to meet customer demands and they are very proactive in offering technical and application support for the substitution of synthetic colors with natural colors. Micro emulsions have been developed with enhanced stability to heat, light and oxidation. Patented encapsulation techniques have been developed to fulfill the requirements of modern food processing as improved stability to pH and oxidation, light, reduced color migration, augmentation of natural color shades and increased color intensity and brightness. Hydrocolloid complexation, inter and intermolecular complexation, cyclodextrin inclusion have all been used to enhance stability[4].

CHALLENGES FOR REPLACING SYNTHETIC COLORS WITH NATURAL COLOURS: Natural colors are having the advantage of being safe but they have demerits also such as

- Their seasonal production
- Variation in quality and purity from different sources
- Availability in limited blends
- Less yield in source material
- Difficulties in extraction from the sources
- Instability during storage and use
- High processing cost etc[12].
- Thermosensitivitry which has the most pivotal effect on the pigments stability during food processing and storage[6].
- Natural colorants are more sensitive to light, change in pH, and redox agents[2], Presence of oxygen, Sugars and their degradation components[3].

MARKET OF NATURAL COLORS: The principal markets of food grade natural colorants are at US, EU and Japan and rising market share in China, India and South Korea[1]. The market for natural food colors is appraised to increase by approximately 10% annually. Total imports of natural colors, flavours and thickeners by the EU amounted to Euro 2,055 million or 475 thousand tonnes in 2008. Developing countries like India and china may play a pivotal role in contributing natural colors either in processed forms or as raw materials to the EU markets[12]. The investment in natural food color market across the globe has touched to US $ 1 billion and is continuously emerging as there is demand for natural food colors against synthetic food colors[13]. As per the forecast of "Global Natural Food Colours – Market Analysis and Opportunity Assessment, 2014 – 2020". The report covered seven natural colouring pigments: anthocyanin, carotenoids (beta-carotene, annatto, lutein and lycopene), curcumin, paprika extract, spirulina extract, chlorophyll and others (betalains, carmine etc.). Carotenoids is estimated to be the highest segment with over 31% of the total market share in 2014 followed by anthocyanin with 22%. On the other side, paprika extract and curcumin together accounted for more than 20% of the market in the same year.

TOXICITY OF SYNTHETIC COLORS: Synthetic colors are having high acceptance as food colorants as they are more brighter, higher tinctorial strength, more uniform, well characterized, gives a wider range of shades, and are cheap than natural colors[14]. The synthetic food colors have been strictly regulated throughout the world; for example Food and Agricultural Organization (FAO) and World Health Organization (WHO)[15]. FDA and USDA have continued to oversee all category of substances that are Generally Recognized as Safe or GRAS substances in light of new scientific information if new evidence[16]. Many studies have exhibited the dangers of artificial colorants in food, which include the possibility of onset of attention deficit disorder (ADD), inhibition of the immune system, hyperactivity and allergic reactions. Also the use of non-permitted colors or overconsumption of permitted colors may also cause thyroid tumours, urticaria, dermatitis, asthma, nasal congestion, abdominal pain, nausea, eczema, liver and kidney damage and cancer. Synthetic food colorants namely, tartrazine, sunset yellow, allura red, quinoline yellow, ponceau 4R, allura red and azorubine, are commonly used in several food products. The permitted colors are also not completely safe[17].

PLANT NATURAL COLOURANTS: Natural drugs used as food colorants are good colorants in a wide color spectrum, and a source of healthy components in many food products. Among thousands of different naturally occurring pigments, only few of them are used as colorants in the food processing industry[9]. The natural colorants in natural plants have been the source of the traditional colorants of raw as well as the processed food. However, they can also be derived from microorganisms and animals, but few of them are available in adequate quantities for commercial use as food colorant. The natural colorants are varied in their structure and obtained from a variety of sources, the three fore most important are: tetrapyrrols, tetraterpenoids, and flavonoids. The most important member of the tetrapyrrols is chlorophyll, which is present in all higher plants. Carotenoids are tetraterpenoids that are as chlorophyll, as they are also involved in photosynthetic process. They give the yellow, orange and red colors to many fruits. Anthocyanins are class of flavonoids that provide the variety of shades of many fruits, particular red-orange colors in berries. Other classes of natural colorants are the anthraquinones (lac, kermes, carmine and madder) and betalains (beetroot) [22]. Natural colorants from plant sources are experiencing growing interest from both food manufacturers and consumers in the continuing substituting of synthetic color.

Chlorophyll: It is the green pigment present in all higher plants for photosynthesis. Chlorophylls are copious in all green plants and therefore they are consumed in considerable quantities by humans. It is lipid soluble[23]. It is extracted from edible plants, nettle, grass, or alfalfa, silkworm droppings and mulberry leaves[12]. Chlorophyll is a cyclic tetrapyrrole with coordinated magnesium in the center. In plants, there are two forms of chlorophyll (*a* and *b*) which only differ in the substitution of the tetrapyrrole ring[24]. The green color is due to the pigments chlorophyll a (blue–green) and chlorophyll b (yellow–green) that occur together in a ratio of about 3:1.22 [23]. It is used in jam, jelly, candy, ice cream,[25] soups, dairy products and sweets [5] and in several other products, but chlorophyll finds resticted use as a colorant because of the lability of the coordinated magnesium and the associated color change, Many food processing conditions such heating and changes in pH, light, acidity are major process conditions that provoked chlorophyll degradation[25]. Natural chlorophylls are not known to be toxic and reported to possess anticarcinogenic, antimutagenic, antioxidant, radioprotective and chemoprotective [23] effects have created an expectancy regarding potential health benefits[24]. The technological approach in chlorophyll pigment is that the magnesium atom in the structure is substituted by zinc or copper, which enhances its stability to light[25].

Flavonoids: The flavonoids are a diversified group of polyphenolic compounds affording to the yellow color of many products. They are widely distributed in the plant kingdom and over 4000 structurally unique flavonoids have been discovered in plant sources**.** These are divided into six different major classes (flavonols, flavanones, flavones, isoflavones, flavonols and anthocyanidins) Flavonoids, especially flavones and flavonols are also mainly responsible for yellow color. The main active nutraceutical ingredients in plants are flavonoids. Phenolic compounds, they can act as potent antioxidants and metal chelators. They also noted to have anti-inflammatory, antiallergic, hepatoprotective, antithrombotic, antiviral, and anticarcinogenic activities,[26] As notified their strong antioxidant properties, there is a emerging interest in the science and health effects of polyphenolic compounds in human nutrition and their use in order to replace some of the artificial food colorants currently used in the food industry[27]. Quercetin is one of the highly important flavonoids. The chief sources of quercetin are: apples, onions, *Sambucus nigra*, the main source of quercetin is from quercitron, isolated from the inner bark of an oak, plants of Cruciferae family and *Quercus tinctoria* [26]. It is also found in horse chestnuts, onion skins, tea and sumac, and Citrullus Colocynthis[12]. Luteolin is one of the principle compounds of yellow color, which evokes the most vibrant and light fast. The dye and weld or dyer‘s rocket (*Reseda luteola*) was cultivated for extraction of luteolin in northern Europe. Its major use was the dyeing of gold braid. The perennial plant saw-wort, *Serratula tinctoria.*[26] Anthocyanins are the class of highly coloured flavonoids.

Anthocyanins:

Anthocyanins are the immense group of water soluble pigments in the plant and belong to the class of flavonoids. Anthocyanins are responsible for most of the red, blue, and purple colors of fruits, vegetables, flowers, and other plant tissues or products. There structure composed of polymethoxylated or polyhydroxylated glycosides or acylglycosides of anthocyanidins which are oxygenated derivatives of 2-phenylbenzopyrylium or flavylium salts[28]. More than 540 anthocyanin pigments have been found in nature, with most of the structural differentiation coming from glycosidic substitution at the 3 and 5 positions and possible and acylation of sugar residues with organic acids. The chief anthocyanidin are pelargonidin (orange-red), cyanidin(red purple) and delphinidin (blue-purple), which variate among themselves by number and position of hydroxyl groups on the benzene ring. Through methylation of anthocyanidins mentioned, will result different color pigments: pentunidin(purple) , peonidin(red), and malvidin (deep purple)[29]. Several plants reported to contains anthocyanins are mulberry, Garden Huckleberry (*Solanum scabrum*), Red radish (*Raphanus sativus),* onion (*Allium cepa), Oxalis triangularis*, elderberries (*Sambucus nigra*), Red radish (*Raphanus sativus),* onion (*Allium cepa),* red cabbage (*Brassica oleracea*), roselle (*Hibiscus sabdariffa*), blood orange (*Citrus sinensis*), black chokeberry (*Aronia melanocarpa*), sweet potato (*Ipomoea batatas*), *Rubia tinctorum* etc. Anthocyanin are used as a colorant for non beverage foods, including gelatin desserts, fruit fillings and certain confectionaries[30]. They are also used to color canned fruit, fruit syrups, yogurt, and other products[25], jams, biscuits, candies[5]. Anthocyanin pigments are relatively unstable except in low pH environments. Degradation of an anthocyanin's color in foods occurs mainly during processing of foods. With this in mind, the major factors affecting the color produced and pigment stability are the individual anthocyanin structure as well as the environment that surrounds them includes, pH, temperature, oxygen, ascorbic acid, light, enzymes, sugars, sulfur dioxide. A main problem is the pH influence on their behaviour[31]. It has been evidenced that increased glycosidic substitution, and in particular, acylation of sugar residues with organic acids, reduced water activity will increase stability and anthocyanin pigments in dried forms can exhibit pronounmced stability [12]**.** The more stable acylated anthocyanins are found in high amounts in vegetables such as: red cabbage, black carrot, red radish, red potatoes or red corn. These pigments are less sensible to pH changes and an increased heat and light stability. For this reason, acylated anthocya nins are satisfactory to be applied not only for food with low pH but also for neutral and slightly alkaline products such as dairy products, powdered and read y-to-eat desserts[32]**.** Acylated anthocyanins were proved to be more stable than others[33]. In current years, various studies intensified wide range of biological activities of anthocyanins including anti-inflammatory, antimicrobial, antioxidant, anti-carcinogenic activities, improvement of vision, induction of apoptosis, and neu-roprotective effects. In addition, anthocyanins display a variety of effects on blood vessels and platelets that may lowers the risk of coronary heart disease. Anthocyanins are powerful antioxidant surpassing to classical antioxidants such as butylated hydroxytoulene (BHT), butylated hydroxyanisole (BHA), and α-toco-pherol[28]. Anthocyanins also plays role in anti-diabetic properties such as lipid lowering, insu- lin secretion and vasoprotective effects[34]. Most foods contain a variety of anthocyanins and related compounds. Currently, researchers have shown the ability of anthocyanins to become increasingly stable in food, drug and cosmetic matrices by intermolecular and intramolecular co-pigmentation with phenolic compounds. Anthocyanins moleculews form complexes with themselves and other organic compounds such as other proteins, tannins flavonoids, , and polysaccharides and this process is known as copigmentation. In these complexes, the anthocyanin color may be changed by shifts of the absorption maxima and also the maximum absorption may be increased. Copigmentation usually increases anthocyanin stability during food processing and storage[24]. Other methods are metal complexation and by microencapsulation[2].

Carotenoids: Carotenoids are lipid-soluble, yellow–orange–red pigments distributed in all higher plants and some animals [25]. It is located in the chloroplasts and chromoplasts of plants and have many functions in plants, including light harvesting and photoprotection. In nature, more than 600 types of carotenoid have been identified **[36]**. It is biosynthesized by bacteria, algae, fungi, and plants, and not by animals, which must obtain them from their food. Not only plants, for example, vegetables, fruits, cereals, etc[37]. The most vital carotenoids are carotenes which include (alpha carotene, beta-carotene, betacryptoxanthin, lutein, and lycopene) and xanthophylls including violaxanthin, neoxanthin, zeaxanthin andcanthxanthin. In addition to, esterification of carotenoids with fatty acids can also occur during fruit ripening, which may affect the color brightness[36]. In these molecules the color is due to the presence of long conjugated double bonds. Annatto and saffron are examples of this class[37]. This group of compounds includes carotenes, which are hydrocarbons. Beta-carotene is one of the few carotenoids that are prepared synthetically for application as a food colorant. Its bright orange color is effective in a very low concentrations (1-10 parts per million). It is having use in bakery goods, cheese, ice cream, margarine, salad dressings, and other foods. Lycopene is another important carotenoid that is the red colorant in tomatoes[25]. The antioxidant properties repair oxidative DNA damage and a high intake of carotenoids is correlated to lowers the risk of certain diseases, such as coronary heart disease and different types of cancer[38] . In food products, carotenoids are highly sensitive to heat so processes involving heat treatments should be kept at minimum both for temperature and time, and storage in frozen temperatures is advised for maximum carotenoid stability[39].

ß-Carotene: It is orange-yellow in color, oil soluble but can be made into a water dispersible emulsion. Plant carotenes may be derived from edible plants, carrots, vegetable oils, grass, alfalfa, and nettle. Carrot (*Daucus carota*) is a good source of ß-carotene. But most ß-carotene for commercial use is now derived from algae. Oil palm, orange, apricot, mango, and peach and pepper contributed significantly in increasing ß-cryptoxanthin and ß-carotene concentrations of foods[23] supplements. It gives intense orange color in a very low concentrations (1-10 parts per million). It may be used in bakery goods, cheese, ice cream, margarine, salad dressings, and other foods[25]. Besides being used as colorants, carotenes are also used for nutritional purposes as provitamin A agents as in margarine where they also provide color or as dietary[23]. Isomerization of trans double bonds to cis isomers occurs readily due to many conditions such as heat, organic solvents, acid, and light. Isomerization to cis isomers does not affect the spectral properties of the carotenoid compound but the possible provitamin A activity is decreased or lost[40].

Lycopene: Being a starting material in the biosynthesis of carotene, it is distributed in plants containing carotene, usually at a very low concentration[23]. The best-known sources of lycopene are tomatoes, watermelon, guava, and pink grapefruit. The important source of lycopene is tomato which is obtained from fresh ripen fruits of plant *Solanum copersicum*[41]. Lycopene is a costly pigment and is very susceptible to oxidative degradation which is much more so than carotene, but highly stable under a wide range of temperature and pH, hence used as common food colorant. It is available in liquid form or as cold water dispersible powder. Though lycopene is distributed in tomatoes in large proportion, red pepper, *Taxus baccata* (yew), *Calendula officinalis* (marigold) , Kapia pepper, onion, *Rosa rubiginosa* (rosehip), and *Citrullus lanatus* (watermelon) also contains lycopene at low concentration[23].

Lutein: It is very common carotenoid. Marigold, (*Tagetes erecta*) flowers are by far the most important natural source for commercial lutein. Lutein is found esterified with saturated fatty acids like lauric, myristic, palmitic, and stearic acid. Lutein is more yellowish-green than oil palm carotenes.. Lutein, is also found in Zucchini (*Cucurbita pepo L. var. giromontia*), green vegetables like cabbage, parsley, spinach, etc. and some fruits. For Commercial application, the most interesting source is marigold (*Tagetes erecta*) in which lutein is primarily found esterified with saturated fatty acids (lauric, myristic, palmitic, and stearic acid[23]. Lutein is not acceptable as a food colorant in the USA except for chicken feed 12. It protects the eyes against the development of age-related Macular Degeneration (AMD), cataracts, and anticancer[37].

Xanthophylls: These are oxygenated carotenes. They are orange to yellow color present in yew tree, *Taxus baccata* is due to rhodoxanthin and Rubixanthin produces yellow colour in dog rose, *Rosa canina* . This concluded to function as protective antioxidants in the macular region of the human retin. These compounds also having activity against aging, mascular degeneration, and senile cataract[41].

Annatto: It is yellow to orange color caretonoids. It has been used for mainly for coloring dairy products especially cheese and is derived from the outer layer of seeds of the tropical tree *Bixa orell*[23]. The main colour present is cis- bixin, the monomethyl ester of the diapocarotenoic acid norbixin, which is observed as a resinous coating surrounding the seed itself. The seed consists of the carotenoid pigment over the present bixin, a C24 – apocarotenoid is a methyl ester which after removal of the methyl ester groups yields the dicarboxylic acid norbixin which forms the basis of the annatto colors[41]. The pH and solubility affect the color hue; the greater the solubility in oil, the brighter is the color. Water soluble, oil soluble, and oil/water dispersible forms of annatto are available. Bixin is used in solid pharmaceutical dosage forms. Norbixin is used to color dairy products[22]. It is also used to color beverages with neutral pH, e.g., flavored milk drinks, but not with low pH because of precipitation and it is slightly more reddish in application than β-carotene[23]. Annatto colors are also used in fish products, salad dressings, confectioneries, bakery products, ice-creams, beverages and snack foods. As it precipitates at low pH, it is also available as emulsion, an acid proof state[44]. Annatto is slightly more reddish in application than β –carotene[23]. Annatto is thought to anticancer due to their antiangiogenic effect[42].

Curcumin: Turmeric is bright yellow colorant can also be obtained from the ground powder of the rhizome of turmeric (*Curcuma longa*) plant. Turmeric contains 3–5% volatile oils and 2.5–6% yellow pigments, the curcuminoids, of which curcumin predominates. Solubility of turmeric compound depends on the processing medium. Turmeric oleoresin is water soluble; but oil extract can be added to fat based foods and at high pH, the extract turns orange[24]. Curcumin is very prone to photobleaching[12]. Curcumin mainly used in dairy products, beverages, cereals, pickels, sausages, confectionaries, ice cream, bakery and savory products[13]. The principal applications of turmeric colors are 0.05 % in pasta, 0.01 % in soft drinks and 0.05 % in salad sauces and jams[24]. Studies have shown that curcumin is not toxic to humans. Curcumin has antioxidant, anti-inflammatory, antiviral and antifungal actions. antiarthritic, antiamyloid, anti ischemic, and antiseptic activity[42].

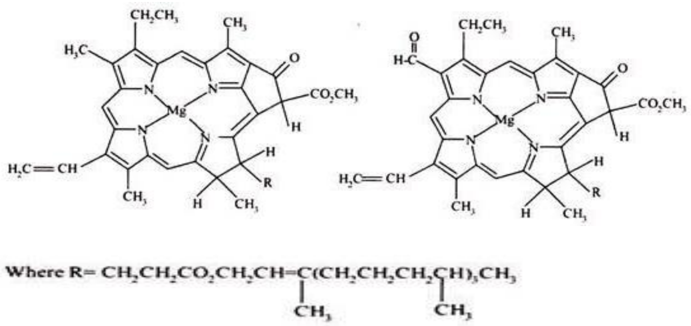
Paprika: Paprika is cheaper, more stable, and provides a similar color shade. The food colorants obtained from paprika (*Capsicum annum*) including red colour due to red carotenoids which are dominated by canthaxanthin and capsorubin and yellow colour imparted by xanthophylls includes ß-cryptoxanthin, zeaxanthin, antheraxanthin and ß-carotene. This combination also produces a bright orange to red orange colour in many food products. The oleoresin is oil soluble, when emulsified becomes water dispersible[23]**.** It is widely used in food industry and it has potent anticancer property[41]. The red carotenoid of paprika is permitted colouring agent for food pharmaceutical preparation cosmetics, beverages and juice sherbet, beverages, instant desserts, icecreams[22].

Betacyanins (betalains): Betalains are the red coloured N-heterocyclic water soluble plant pigments can be found in roots, fruits and flowers[43]. Betalains includes two groups of pigments: the red–purple betacyanidins and the yellow betaxanthins, both of which are water-soluble. Betacyanidins are conjugates of cyclo-DOPA and betalamic acid, and betaxanthins are conjugates of amino acids or amines and betalamic acid. As like anthocyanins, the betacyanidins (aglycones) are most often glycosylated, in which case they are called betacyanins. The few edible known sources of betalains are red and The stability of betalain pigments is depend on many factors including pH, temperature, oxygen, water activity, and light, similarly to other natural pigments. yellow beetroot (*Beta vulgaris*), grain or leafy amaranth (*Amaranthus sp*.) colored Swiss chard (*Beta vulgaris* L. ssp. cicla), and cactus fruits, such as those of *Opuntia* and *Hylocereus* genera[8]. Thermal degradation of betalains above temperatures of 50º c is probably the main problem that limits their use as food colorants[43]. It has also been found out that pH affects thermal degradation rates with maximum betanin thermal stability between pH 4–5 in anaerobic conditions and at pH 5–6 in aerobic conditions[44]. Photooxidation of betanin also dependent on the pH with degradation being greater at pH 3 than at pH 5. pH values between three and seven do not markedly affect the color of betacyanins Below pH 3, the color of betanin change towards violet and above pH 7 the colour change towards blue. In alkaline conditions (above pH 10), betanin degrades to yellow betalamic acid and colourless cyclodopa-5-O –glucoside[41]. They possess antioxidant, anti-inflammatory and anticancerous property so they can be better studied as the natural source of food colorant[8]. Moreover, anti-inflammatory effects of these pigments and their potential antioxidant or anticarcinogenic activities were also reported. The red pigment obtained from the red beet (*Beta vulgaris*) extract that are widely used as a food coloring agents[8]. The beet root extract contains red, yellow and also a bluish-red color pigments depending on their content produced by a compound known as betanin which is stable at higher pH range .It has wider application in many food commodity from beverages to candy and from dairy to cattle products [26] and also used in processed meat, ice cream, baked goods, candies, and yogurt .The red–purple betacyanins are the major part of pigments in beetroot, and of these a single one, betanin, comprises 75–95 %. Besides beetroot is a rich source of many potent nutrients including magnesium, sodium, potassium and vitamin C.[44]

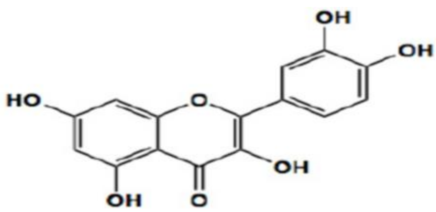
Quinones: The quinones (naphtoquinons, anthraquinons) are the type of natural coloring agents, which give red, reddish-brown and brown colors[4]. They are distributed in different plant organs and are generally present as the glycosides in young plants[2].

Table I: Reported toxicity of synthetic food colorants

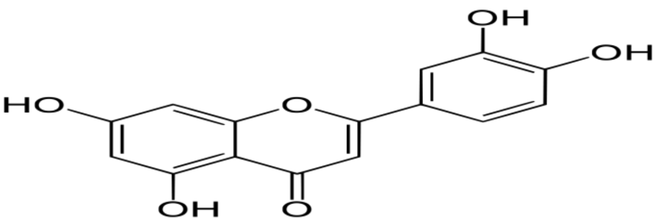
Additive Number	Name of Food colour	Reported Toxicity
102 & E102	Tartrazine	Hyperactivity, Carcinogenic[14], Urticaria, asthma, Purpura and eczema ,anaphylactic, bronchial asthma[18], genotoxic on liver and kidney[16], hyperactivity in children, mutagenic[15], anxiety, headaches, blurred vision, sleep disorders[20].
104 & E104	Quinoline Yellow	Asthma, hyperactivity, Carcinogenic[14], skin rashes[17].
107 & E107	Yellow 2G	Hyperactivity, Asthama, Carcinogenic[14].
110 & E110	Sunset Yellow	Gastric problem, allergy skin irritation17 many sings of behavior variation like hyperactivity, nervous motion and aggressiveness17, Genotoxic19, Mutagenic15, Asthama, Carcinogenic 14.
122 & E122	Carmoisine (Azorubine)	Mutagenic[19], skin rash similar to nettle induced, including swelling of the skin[20], Allergy, hyperactivity, carcinogenic[14].
123 & E123	Amaranth	Carcinogenic, birth defects, sterility and early foetal deaths[21], Mutagenic, carcinogenic, asthama[14].
124 & E124	Ponceau, Brilliant Scarlet	Hyperactivity, Asthama,Carcinogenic[14].
127 & E127	Erythrosine	Allergy, rashes[17], Hyperactivity, Carcinogenic[14].
E128	Red 2G	Mutagenic[19], Hyperactivity, Asthama,Carcinogenic[14].
129 & E129	Allura Red	Mutagenic[15], Hyperactivity, Asthama, Carcinogenic[14].
133 & E133	Brilliant Blue	Mutagenic[19], Hyperactivity, Asthama, Carcinogenic14.
142 & E142	Acid Brilliant Green, Green S, Food Green)	Hyperactivity, Asthama [14].
143	Fast Green	Many sings of behavior variation like hyperactivity, nervous motion and become aggressive[17], asthama [14]
150 & E150	Caramel	Hyperactivity[14].
155 & E155	Chocolate Brown HT, Brown HT	Genotoxic on liver and kidney[17], Hyperactivity, Asthama, Carcinogenic[14].



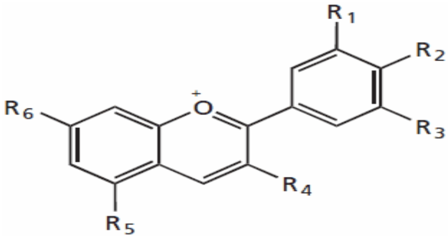
Chlorophyll - a chlorophyll - b



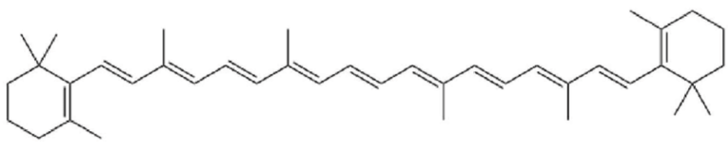
Quercetin



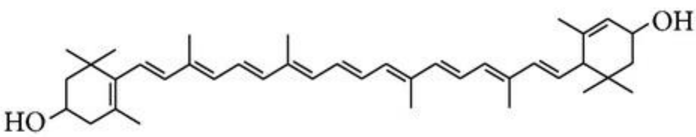
Luteolin

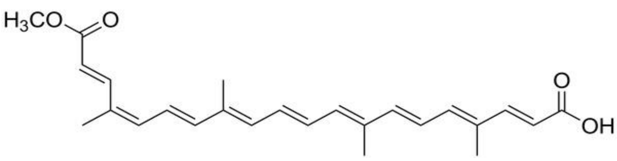


Anthocyanins	**R_1**	**R_2**	**R_3**	**R_4**	**R_5**
Pelargonidin-3-O-glucoside	H	OH	H	Glucoside	OH
Cyanidin-3-O-glucoside	OH	OH	H	Glucoside	OH
Delphinidin-3-O-glucoside	OH	OH	OH	Glucoside	OH
Peonidin-3-O-glucoside	OCH_3	OH	H	Glucoside	OH
Malvidin-3-O-glucoside	OCH_3	OH	OCH_3	Glucoside	OH
Malvidin-3,5-O-diglucoside	OCH_3	OH	OCH_3	Glucoside	Glucoside
Cyanidin-3-O-rutinoside	OH	OH	H	Rutinoside	OH

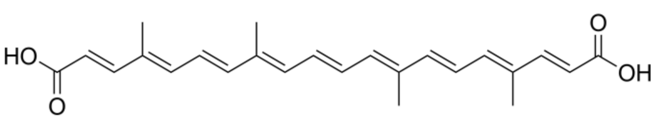


β-carotene

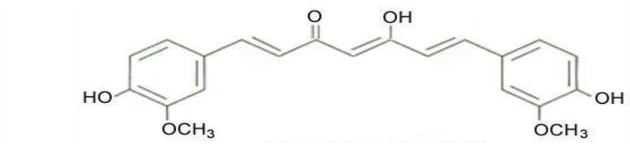




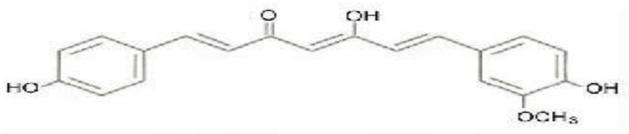
Bixin



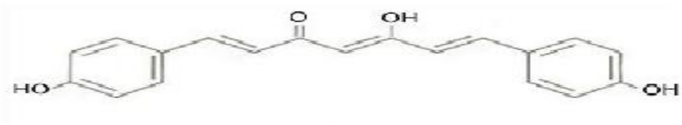
Norbixin



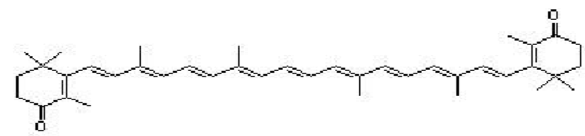
Curcumin



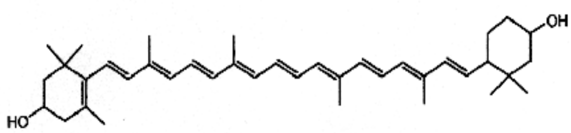
Demethoxycurcumin



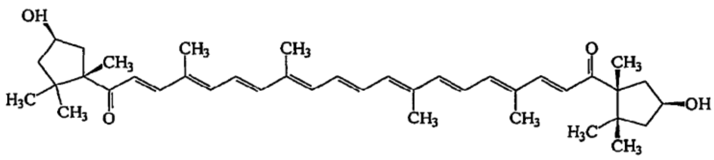
Bisdemethoxycurcumin



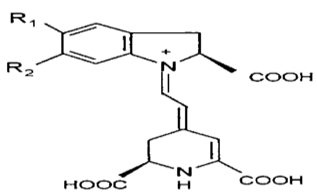
Cantaxanthin

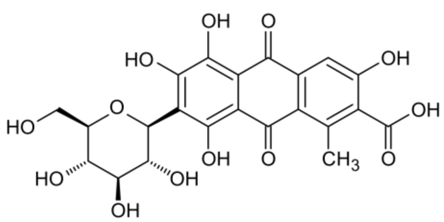


Zeaxanthin



Capsorubin





Carminic acid

Different anthraquinones are alizarin, mungistin, purpurin from Madder family; emodin from Persian berries. Carminic acid from cochineal, Indian mulberry (*Morinda citrifolia*), and Napthoquinones, e.g. juglone (walnut) and alkanin; hypericin (St. John's wort). Anthraquinones are the major group of quinones, best known for their use as mordant colors. The utilisation area is large, e.g. cosmetics, confectionery, and medicines. In current years, natural anthraquinones have been used as coloring agents for beverages, sweets and other foods[4]. Current major usages of cochineal and its derivates are in the drug, food, and cosmetics industries, and as biological stains. Carminic acid color shifts dramatically according to the pH, goes from magenta-red above pH 12 to violet at 11. 5, from dark to lighter violet at 11.0–9, from red to lighter red at 7.7–7.0, orange-red at 6.5, orange at 5.5 and then to light orange at pH below 4.5. Carminic acid have wide use in food applications such as soft and alcoholic drinks, bakery and dairy products, confectionery and pickles at dosage levels ranging from 0.1 to 0.5 %. Carminic acid and its derivatives are employed in extruded cereal products (0.02 %), pasta (0.05 %), nonalcoholic beverages (0.01 %), sauces, jams and fillings (0.05 %) [24].

CONCLUSION:

The usage of synthetic colors was done commercially for attractive colors and varying shades but it is harmful to human and environment. Although worldwide possesses large plant resources, only little has exploited so far. More detailed studies and scientific investigations are needed to assess the real potential and availability of natural dye yielding resources. Natural colors are not only having dyeing property but also having the wide range of medicinal properties. To conclude, there is need for proper methods, documentation and characterization of dye yielding plants for further development of pharmaceutical industry to formulate the natural plant pigments with high yield, betterment in stability and shelf life for safe use in food to replace synthetic food colorants.

ACKNOWLEDGEMENT:

Authors are thankful to Dr. S. S. Bhujbal, H.O.D, Dept. of Pharmacognosy, Dr. DYPIPSR, Pimpri, Pune, Maharashtra, for providing inspiration & motivational support.

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