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# A COMPREHENSIVE INSIGHT TO NATURAL FOOD COLOURANTS

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## ABSTRACT

Not just the taste; colour, flavour and odour, plays a crucial role in perception of food. The objective of adding colour to foods is to make them appealing, augment the loss of colour during food processing etc which makes the food and pharma industries to concentrate more on the appealing colours of the food articles or medicines; they manufacture. Here they have to be careful in adding synthetic/ artificial colours for their hazardous effect on the health. Nowadays consumers are aware of the ill effects and toxic nature of synthetic colours and also about the benefits of natural colourants. Manufacturing of safe, viable, long lasting, cost effective colourants is a challenge and is the need of the hour too. Current over review article covers in detail about basic information of various sources, analysis, limitations and future prospects of natural colourants.

**KEYWORDS:** Food colour, Synthetic colours, Natural dyes.

## INTRODUCTION

Colour affects almost every aspects one does in life. i.e., for purchasing items for one's home, his/her clothing, or their food etc, decisions are most of the times on colour basis. Colourants are used in color painting, ink, cosmetics, food, plastic, fabrics, wood, metals, walls and furnitures.

Nowadays food colourants are also gaining popularity and importance. Food colouring or colour additive is any dye, pigment or substances that imparts colour when it is added to food

or drink. It comes in different forms ie liquids, powders, gels and pastes etc[2].Colour makes the food and medicine very attractive and appealing.

Adding colour to food has been used as a marketing strategy in food industries since long time. Food colouring is used both in commercial food production as well as in domestic cooking. It is also used in a variety of non-food applications including cosmetics, pharmaceuticals and medical devices.[2]

**Colour is added to food for the following reasons.[5,6]**

i. To replace and restore colour lost during processing
ii. To enhance colour that is already present
iii. To minimize batch variations in processing
iv. To colour the uncoloured food.
v. To glorify the natural colours

Food colours can be grouped into three categories: A) natural colours, B) nature-identical colours, C) synthetic colours.

The first synthetic colour (mauvine) was developed by Sir William Henry Perkin way back in 1856.[3,4] Synthetic colours were easier to produce, inexpensive, and superior in colouring properties when compared to colours of natural origin, but pose a threat for severe health ailments, such as cancer, asthma, allergic reactions, hyperactivity, and thyroidism etc.

Consumer perception that "**natural is best**", sociological awareness, safety concern and technological advances in food processing has contributed significantly to the increased in utilization of natural colorants.

Natural dyes are safe, devoid of above mentioned side effects and are not altering the qualities of the food that is consumed. The present article aims to detail about various sources, analysis, limitations and future prospects of natural colourants.

## METHODOLOGY

A natural food colour is defined as any dye or pigment which when added to food products enhances therapeutic efficacy and medicinal properties in it.

Nowadays food colourants (chemical name or common name) are represented by E number on the food labels: which actually are the code number preceded by the letter E, denoting food additives numbered in accordance with EU directives. Natural food colours are obtained naturally from:- seeds, vegetables, fruits, algae, flowers, insects etc .So it is also known as organic food colours or biocolours.

Natural identical colours are man-made pigments which are also found in nature. Examples are carotene, canthaxanthin and riboflavin. They are preferred because of their high stability, cost effectiveness, colouring value.

Artificial colours are man made colours which are obtained through chemical reactions and has high stability to light, $O_2$ and pH. They are cost effective and has low chances of microbial contamination. Some of the permitted food colours in India are Brilliant blue FCF, Sunset yellow FCF, Allura red, Fast green FCF, Indigotine etc.[7] The most common side effects associated with these synthetic food colours are Attention deficit hyperactivity disorder (ADHD) like behavioural problems, depression, food allergies, headache, hormonal imbalances etc.[8,9]

**Table no. 1: Artificial colour v/s Natural colour.**

| Colour | Synthetic Colours | Colour code | Natural Colours | Illustration |
|---|---|---|---|---|
| Violet | Allura red (E129) +Brilliant blue (E 133) | | Grapes (Draksha ) |  |
| Indigo & Blue | Indigotine blue (E132) | | Butterfly pea (Aparajita) |  |

| | | | | |
|---|---|---|---|---|
| Green | Fast green FCF (E 143) | | Spinach (Palakya) |  |
| Yellow | Sunset yellow (E110) | | Turmeric (Haridra) |  |
| Orange | Sunset yellow +Allura red | | Marigold (Jandu) |  |
| Red | Allura red (E 129) | | Annatto (Sindoori) |  |

**Natural colourants from plants**

**1) Haridra (Curcuma longa)**

Turmeric (Curcuma longa) of Zingiberaceae family are being used as spice in South east Asian countries since very long time. It is used as the principal ingredient in almost all the dishes of India for its colour, flavor and taste other than for it's food and medicinal value. In Ayurveda, haridra is well used as single drug therapy and also in good number of compound preparations, because of its high medicinal value. It is best mentioned in *vrana.*[10] "Curcumin" is the plant pigment in haridra which helps to impart its yellow colour, which is

represented as a food colour with E-number E100 (i).[14] In food industry it is used to colour icecream, yoghurt, cheese, baked foods, confectionary, cooking oils, sauce, pickles etc. It is an active compound in cosmetic items like face creams, face wash, soaps etc. It is used mainly because of its skin colouring, antioxidant, anti ageing, antiseptic, antibacterial, anti fungal, anti inflammatory activity[12] etc. Apart from these it has got various pharmacological actions like hepatoprotective[13] anti histaminic, anticarcinogenic, anti microbial etc.

**2) Palakya (Spinacea oleracea)**

Spinacia oleracea (spinach) is a leafy green vegetable belonging to the family Chenopodiaceae and it is widely distributed and cultivated in India for culinary purpose. It considered as superfood as it is loaded with rich quantities of nutrients, fibers and minerals[16,17] and is very cheap and easy to prepare. It is beneficial to decrease oxidative stress,[18] improves eye health, improves blood glucose control in people with diabetes,[19] lowers the risk of cancer, and improves bone health. In traditional medicine, *swarasa or kwatha* of *palakya* is usually administered and found beneficial in case of prameha. It is even quoted as *mutrajanaka, rochaka, shothahara* and *dahashamaka dravya.*[15] Chlorophyll is the pigment that gives green colour to the plant with E-number E140. It is mainly used as colouring agent in beverages, sweets, chewing gums, soup concentrates, cheese spreads, preserves, vegetable pickles and even in toothpastes.

**3) Zandu (Tagetes erecta)**

Tagetes erecta (marigold) is an annual herb that has been commercialized worldwide as an ornamental plant and as a source of natural pigments from its yellow/orange flowers. The yellowish orange colour is due to the pigment called "lutein". It is used to colour baked goods, cereals, beverages, chewing gum, dairy product analogs, egg products, frozen dairy desserts, hard candy & soft candy, processed fruits &juices, infant and toddler foods etc and is represented as E161b. It's flowers are also indicated internally in *rakta arsha* and externally applied in case of *vrana*.[15] It is used for digestive tract problems including poor appetite, colic, intestinal worms, and dysentery and also used for coughs, colds, mumps, fluid retention. Lutein and zeaxanthin are the only dietary carotenoids that accumulate in the retina, particularly the macula region and protects against visual disorders and cognition diseases, such as age-related macular degeneration (AMD), age-related cataract (ARC), cognition diseases, ischemic/hypoxia induced retinopathy, light damage of the retina, retinitis pigmentosa, retinal detachment, uveitis and diabetic retinopathy etc.[20,26]

**4) Sindoori (Bixa orellana)**

The pericarp of achiote or lipstick tree is used as colourant in food industries, cosmeceuticals, and in textile industries. In the European Union, annatto has been given the E number E160b whereas in the United States, annatto extract is listed as a colour additive "exempt from certification" which is informally considered to be a natural coloring. The carotenoid pigments, ie bixin (80%) or norbixin (20%) is contributing red and yellow colour respectively. In food preparations, used to colour butter, margarine, mayonnaise, sausages, soup, juice, icecream, bakery products, macroni and cheese.[21] The aril covering the seed is widely used to treat burns and bleeding, dysentery, gonorrhoea, constipation and fever. The cosmetic industry increasingly uses it in cosmetics and skin care products such as lipsticks, shampoo, and sunscreen lotions due to it's natural red colour.

**5) Draksha (Vitis vinifera)**

Vitis vinifera, commonly known as grape vine is a tendril climbing vine, which is indigenous to southern Europe and Western Asia and is cultivated today in all temperature regions of the world. Anthocyanin is the pigment responsible for giving purple colour. *Ayurveda* envisages, "*Drakshae phalothama*" which means of all the fruits, grape is the best. It possess a broad spectrum of pharmacological and therapeutic effects such as antioxidative, anti-inflammatory, and antimicrobial activities, as well as having cardioprotective, hepatoprotective, and neuroprotective effects.[22] These berries are known as "*Vrishya*", which means they help in erectile dysfunction and premature ejaculation. It's juice is beneficial in case of *pandu, jwara, trishna* and *grahani.*[10] It has found application in water-based acid type beverages, jellies, candy, gelatin desserts, skin and hair care products, dry mixes, dark chocolate, cake mixes, ice cream, and compressed tablets. In textile industries, it is used to dye wool fabrics.

**6) Aparajita (Clitorea ternatea)**

Clitorea ternatea also known as butterfly pea is abundantly found in South India. It is a perennial vine of fabaceae family with royal blue colour flower. Anthocyanin is the pigment giving its deep blue colour, because of which is gaining popularity as natural colourant. It is used to colour teas, rice preparations, cakes and desserts. It is also used to colour fabrics in textile industries.[11,27] According to *Ayurveda*, plant is having *medhya, kantya, netrya, kushtaghna, shothahara, vranahara* and *shulahara karmas*.[10]

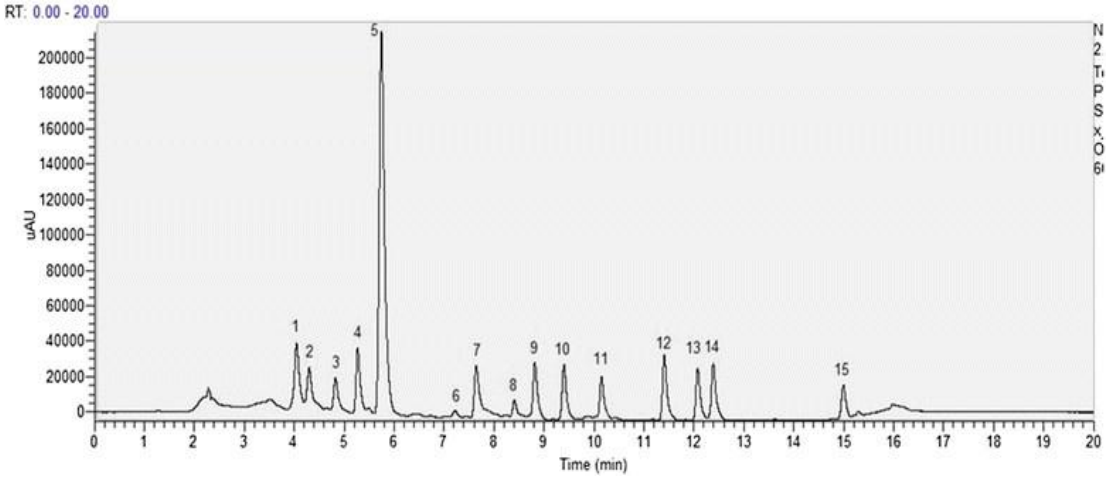
**Extraction and Analysis of food colours**

Consumers among worldwide demands for natural food colours; therefore numerous optimized extraction techniques were developed in past years to extract natural pigments from animal and plant sources.

Extraction methods can be classified into two:- Conventional and Advanced , based on the technology used in the procedure.

- **Conventional:-** The conventional techniques that are followed are maceration, soxhlet extraction, solvent extraction, aqueous extraction[1].
- **Advanced:-** It includes enzyme assisted extraction, microwave-assisted extraction, supercritical fluid extraction , gamma irradiation, sonication, pressurised liquid extraction [1] etc.
- **Analysis of food colours:-** It can be done by sensorial organs like visual and smell perception as well as instrumentally by the use of monochromatic colorimeter, tristimulus colorimeter, spectrophotometer, HPTLC and HPLC.

**HPLC standards of carotenoid pigments[28]**

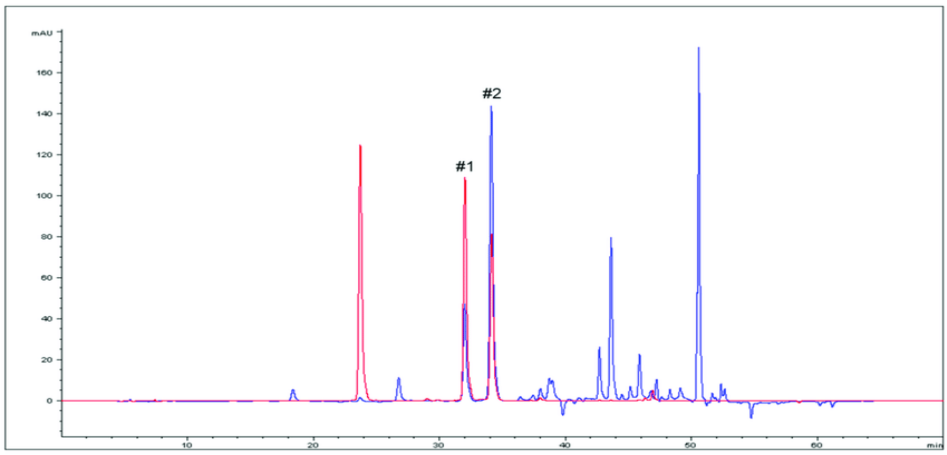



HPLC profile of carotenoid standards recorded in the range of 250.00-700.00 nm. The compounds are (1) violaxanthin; (2) neoxanthin; (3) anthraxanthin; (4) lutein; (5) zeaxanthin; (6) phytoene; (7) β-cryptoxanthin; (8) phytofluene; (9) α-carotene; (10) β-carotene; (11) ζ-carotene; (12) δ-carotene; (13) γ-carotene; (14) neurosporene; (15) lycopene.

**HPLC analysis of curcumin**[29]

HPLC chromatogram of curcumin from Curcuma longa extract by employing a gradient system of 0.1% formic acid in water and acetonitrile

**HPLC profile of anthocyanin**[30]




HPLC analysis. Overlapping of HPLC chromatograms obtained by anthocyanin standards (red curve) and pomace extract (blue curve), wavelength = 520 nm. #1 and #2indicate the fractions collected and further analyzed by MS.

## DISCUSSION

Synthetic or artificial colourants are derived from petroleum and coal products. Synthetic colourants like sunset yellow, indigotine blue, allura red, fast green FCF are widely available in markets and are cost effective. They are proved to be highly harmful, causing adverse drug reaction like nausea, vomiting, hyperactivity, asthma, allergies, neurotoxicity, DNA damage, tumorigenic effect etc. So it is safe to use natural colourants or synthetic natural identical colours, hence should avoid the artificial food colours.

Natural identical colours are better as they are having higher stability than natural origin colours. It has low chances of microbial contamination and also due to lesser side effects when compared to artificial colours they are preferred nowadays in industries for commercial purposes. But always natural is considered best, as far as safety concerns.
Eg. Lutein, Carotene, Zeaxanthin, Canthaxanthin etc.

Natural food colours are healthy, easily available and are considered to be safe, when compared to other two types. Eventhough natural food colourants are found to be non toxic, non allergic and biodegradable in nature, still it is facing challenges in some aspects like

tedious extraction procedure of the colouring compound from the raw material, low colouring value, cost ineffectiveness, instability to high temperature, pH and light, difficulty in collection of plants or scarcity of raw materials, lack of standardization and lack of precise technical knowledge of extracting and dyeing techniques. In order to stabilize and maintain the color, various techniques can be incorporated like microencapsulation, addition of anti-oxidants, emulsification etc.

Therefore careful studies are still needed to optimise different available technologies to enrich natural pigment contents and to increase pigment stability of natural food colourants. There should be appropriate tests for optimising the biological effects, safety as well as other properties of food colour. There is a need to improve standards or methodological tests for authenticity of colourants to detect adulteration.

## CONCLUSION

It is best to adopt and prepare the colourants from the aqueous extract of medicinal plants; by which the stability of natural colourants can be increased .It is ideal to use natural colourants from the resources available from medicinal plants for keeping the individual safe , healthy and disease free.

## REFERENCES

1. Rimsha Nawaz, Natural food grade dye extraction techniques, Research Journal of Chemical Sciences, 2019; 9(2): 24-27.
2. CFR Title 21 Part 70: Color Additive Regulations, *FDA, March 1977*, retrieved February, 2012; 15: *22.*
3. Walford, J. "Historical Development of Food Colouration". Developments in Food Colours. London: Applied Science Publishers, 1980; 1: 1–25.
4. Sharma, Vinita; McKone, Harold T.; Markow, Peter G. "A Global Perspective on the History, Use, and Identification of Synthetic Food Dyes". Journal of Chemical Education, 2011; 88: 24–28. doi: 10.1021/ed100545v.
5. "Food Ingredients & Colors". International Food Information Council. *June 2010*. Retrieved February, 2012*;* 15: *29.*
6. Barrows, Julie N.; Lipman, Arthur L.; Bailey, Catherine J. (December 17, 2009). "Color Additives: FDA's Regulatory Process and Historical Perspectives". *FDA* (Reprinted from Food Safety Magazine October/November 2003 issue). Retrieved, 2012*;* 2.

7. Food Safety and Standard Act, 2006, Rules 2011, Regulations 2011 (14th ed.). Delhi: International Law Book Company, India. 2015; 483.
8. FDA. Background Document for the Food Advisory Committee: Certified Color Additives in Food and Possible Association with Attention Deficit Hyperactivity Disorder in Children, 2011; 30-31.
9. Millichap JG, Yee MM (February). "The diet factor in attention-deficit/hyperactivity disorder". Pediatrics, 2012129 (2): 330–337. *doi*:*10.1542/peds.2011-2199*. *PMID 22232312*. *S2CID 14925322*
10. Dr Prakash L Hegde, Dr Harini A, A textbook of Dravyaguna Vijnana, Chaukhambha publications, New Delhi, Edition: Reprint, 2018.
11. Nurul Amira Binti Ahmad Yusof, Investigation on Natural Blue Colorant of Clitoria Ternatea Tea 1. Fabaceae (Bunga Telang): The Effects of Stabilizers to Extracts, January, 2015.
12. Aggarwal, B. B., Sung, B. Pharmacological basis for the role of curcumin in chronic diseases: an age-old spice with modern targets. Trends Pharmacol. Sci, 2009; 30: 85–94. doi: 10.1016/j.tips.2008.11.002.
13. Rahmani, S., Asgary, S., Askari, G., Keshvari, M., Hatamipour, M., Feizi, A., et al. Treatment of Non-alcoholic Fatty Liver Disease with Curcumin: A Randomized Placebo-controlled Trial. *Phytother. Res*, 2016; 30: 1540–1548. doi: 10.1002/ptr.5659
14. Delgado-Vargas, F. and Paredes-López, O. (Eds): Natural colorants for food and nutraceutical uses. CRC Press, 2003.
15. Bhavamishra. Bhavaprakasha Nighantu - Hindi Commentary by K.C. Chunekar. 1sted. Varanasi: Published by Chaukhumbha Bharathi Academy, 2002.
16. Osteoporosis Diet & Nutrition: Foods for Bone Health" National Osteoporosis Foundation. 2015-12-21. Retrieved, 2019; 11: 18.
17. Storage time and temperature effects nutrients in spinach". Retrieved, 2008; 07: 05.
18. Sang -Heui Ko, Jae -Hee Park et. al, Antioxidant Effects of Spinach (*Spinacia oleracea* L.) Supplementation in Hyperlipidemic Rats, Preventive nutrition and food science, 2014; 19(1): 19–26.
19. V. Gomathi, Antidiabetic activity of leaves of Spinacia oleracea Linn. in Alloxan induced diabetic rats, Journal of Chemical and Pharmaceutical Research, 2010; 2(4): 266-274.
20. Sandeep Kumar Rajvanshi and Deepa H Dwivedi, Phytochemical screening studies of bioactive compounds of African marigold (Tagetes erecta L.), Journal of Pharmacognosy and Phytochemistry, 2017; 6(4): 524-527.

21. Daniela de Araujo Vilar et. al, Traditional Uses, Chemical Constituents, and Biological Activities of *Bixa orellana* L.: A Review, Scientific World Journal, 2014; 2014: 857292.
22. Marjan Nassiri et.al, Review of the pharmacological effects of Vitis vinifera (Grape) and its bioactive compound, Phytother Res, 2009; 23(9):1197-204.
23. Chaitanya Lakshmi G, Food Coloring: The Natural Way, Research Journal of Chemical S ciences, 2014; 4(2): 87-96.
24. Éva Németh, Colouring (Dye) Plants, Cultivated Plants, Primarily As Food Sources – Vol. II
25. Mohamad Faizal Mohamad, Daniel Joe Dailin, Sara E. Gomaa, Muktiningsih Nurjayadi, Hesham EI Enshasy, Natural Colorant for Food: A healthy alternative.
26. Jia, Y-P, Sun, L., Liang, Zhang, The Pharmacological effects of Lutein and Zeaxanthin on Visual disorders and Cognition Diseases., Molecules, 2017; 22(4): 610.
27. Sean Michael Campbell, Brian Pearson, Butterfly Pea (*Clitoria Ternatea*) Flower Extract (Bpfe) And Its Use As A Ph-Dependent Natural Colorant, jjdoi.org/10.32473/edis-ep573-2019
28. Prateek Gupta et.al, A rapid and sensitive method for determination of Carotenoids in plant tissues by HPLC, Plant methods, 2015; 11: 5.
29. Bing Hui chain et al, Inhibition of lung cancer cells A549 and H460 by curcuminoid extracts and nano emulsions prepared from Curcuma longa Linnaeus, August International Journal of Nanomedicine, 2015; 10: 5059.
30. Posadino Anna Maria et al, Protective Effect of Cyclically Pressurized Solid–Liquid Extraction Polyphenols from Cagnulari Grape Pomace on Oxidative Endothelial Cell Death, August, 2018; 23(9): 2105.