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Plant Pigments as Colorants in Foodstuff: A Review Article

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Abstract: ***Plant derived-colorsare important in human life because they are safe and eco-friendly in nature. Colouredcomplexes that are applied to fibre, paper, food, cosmetics, hair, etc. to give colors. These canbe extracted from the roots, fruits, bark, leaves, flowers, etc. Synthetic colorants have been quizzedin the past years for their safekeeping, leading to a decline in the number of permitted colorants.Hence, interest in natural colorants has suggestively amplified as a significance to both legislative action and consumer awareness for the use of synthetic extracts in the foods. This review article deals with the information on the dye-yielding plants.***

Keywords: ***Dye-yielding plants, Synthetic extracts, natural color, Pigment Extraction.***

I. INTRODUCTION

Dyes are coloured complexes that are applied to fibre, paper, food, cosmetics, hair, etc. to givecolors, these can be extracted from the roots, fruits, bark, leaves, flowers, etc. with the help of various extraction processes. Plant derived-colours are important in human life because theyare safe and eco-friendly in nature. The call for natural dyes has been increased today worldwide due to alertness about their valuable properties. Proper documentation, cultivation and conservation should be done for these natural dye-yielding plants [1].

A. Natural Dyes vs Synthetic Dyes

Appearance of food triggers neurons and this plays a crucial role in its consumption. Natural colors are harmless as well as own some medicinal qualities. On the other hand, synthetic colorsare formed from coal and petroleum, which could be harmful [2]. Synthetic colours are man- made which are not originated from nature, these are often azo-dyes, artificial color additives have demonstrated negative health issues after consumption, unlike natural colors which are pigments by living organisms. Usually, are made by modification of materials from living organisms like plants [3]. Various researches were led in different cities of Iran confirmed the illegal use of these materials in traditional food products, as they tested for many samples and finally 40% of thetotal samples were found to be non-consumable based on the ethics of the Ministry of Health and National Standard of Iran [4]. Interest in natural colorants has suggestively amplified as a significance to both legislative action and consumer awareness forthe use of synthetic extracts in the foods [5]. In March 2011, the United States (U.S.) Food and Drug Administration (FDA) Food AdvisoryCommittee held a hearing on artificial food colors (AFCs). The committee decision (8-6 vote) was not to recommend, banning AFCs or requiring a warning label [6]. As civilization becomes attentive towards the toxicity caused by synthetic dyes for both the environment and humans. Plant-derived dyes propose a promising alternative that is slowly motivating global market [7].

B. Significance of Natural Pigments

Anthocyanins contain various group of intensely coloured pigments. These are responsible forthe attractive colors from many fruits, vegetables, flowers, leaves, roots, etc. They are water soluble and have been used without any side effect. Besides this interest, anthocyanins have deepened for their likely health benefits.

Which include enhancement of sight acuteness, antioxidant capacity, treatment of various blood circulation disorders resulting from capillary fragility, Vaso-protective and anti-inflammatory properties, inhibition of platelet aggregation, maintenance of normal vascular permeability, controlling diabetes, anti-neoplastic and chemoprotective agents, radiation-protective agents and possibly others.

Due to these qualities' anthocyanins are found to be one of the best alternatives for synthetic dyes [5]. Natural colorant in food seems to have multidimensional potential. For example, carotene may be used in food as a vital vitamin source and betalains as source of essential amino acid and anthocyanins as quality control for food stuffs. Flavonoids are the colorants with high pharmacological abilities [3]. Recently, tannins with the determined structures were found to have antiviral, antibacterial and antitumor activity in extensive biological tests. Like, certain tannins can selectively inhibit HIV replication [8].

II. MATERIALS AND METHODOLOGY

Table no. I
Plant and their edible pigments

Sr no.	Plant	Part	Pigment	colour	Extraction method	Reference
1.	*Capsicumannuum*	Fruit	Carotenoids	Red	Solvent extraction	[3]
2.	*Vitis*	Fruit	Carotenoids	Pinkishred	Solvent extraction	[3]
3.	*Crocus sativus*	Stigma	Carotenoids	Yellow	Solvent extraction	[3]
4.	*Beta vulgaris*	Bulb	Betalains	Red	Maceration	[9]
5.	*Amaranthus sp.*	Leaves	Betalains	Red	Maceration	[9]
6.	*Opuntia sp.*	Fruit	Betalains	Red	Ethanal extraction	[9]
7.	*Hylocereus*	Fruit	Betalains	Red	Ethanol extraction	[9]
8.	*Daucus carota*	Root	Carotenoid	Orangered	Solvent extraction	[10]
9.	*Elaeis guineensis*	Fruit mesocarp	Carotene	Yellow	Solvent extraction	[10]
10.	*Lycopersicon esculentum*	Fruit	Lycopene	Orange	Solvent extraction	[10]
11.	*Tagetes erecta*	Flower	Lutein	Yellowish green	Solvent extraction	[10]
12.	*Curcuma longa*	Rhizome	Curcumin	Yellow	Solvent extraction	[10]
13.	*Bixa orellana*	Seeds	Bixin	Reddish orange	Solvent extraction	[10]
14.	*Capsicumannuum*	Fruit pods	Capsanthin	Reddish orange	Solvent extraction	[10]
15.	*Crocus sativus*	Dried stigma	Crocin	Yellow	Solvent extraction	[10]
16.	*Beta vulgaris*	Bulb	Betalains	Purple red	Solvent extraction	[10]
17.	*Gardeniaangusta*	Fruits	carotenoid crocin	Yellow	Solvent extraction	[10]
18.	*Punica granatum L.*	Pericarp	Tannin	Yellow	Solvent extraction	[8]
19.	*Castanea*	Nut	Tannin	Brown	Solvent extraction	[8]
20.	Quercus	Stem	Tannin	Yellowish brown	Solvent extraction	[8]
21.	*Caesalpiniacoriaria*	pods	Tannin	Yellowish brown	Solvent extraction	[8]
22.	*Rhus*	Inflorescence	Tannin	Red	Solvent extraction	[8]
23.	*Terminaliachebula*	Nuts	Tannin	Yellowish brown	Solvent extraction	[8]
24.	*Buddleja officinalis*	Flower		Yellow	Traditional method	[7]
25.	*Dioscorea cirrhosa Lour.*	Tuber		Brownishred	Traditional method	[7]

26.	*Diospyros kaki Thunb.*	Bark		Russet	Traditional method	[7]
27.	*Reynoutria japonica Houtt.*	Root		Red	Traditional method	[7]
28.	*Ardisia crenataRoxb.*	Root		Red	Traditional method	[7]
29.	*Adinandra milletii Benth. etHook. f. ex Hance*	Leaves		Black	Traditional method	[7]
30.	*Buddleja lindleyana*	Flower		Yellow	Traditional method	[7]
31.	*Vaccinium bracteatumThunb*	Bark		Brownish Red	Traditional method	[7]
32.	*Zanthoxylum simulans Hance*	Leaves		Black	Traditional method	[7]
33.	*Carthamustinctorius*	Root		Red	Traditional method	[7]
34.	*Curcuma longa*	Flower	Uranidin	Yellow	Traditional method	[7]
35.	*Sassafras tzumu*	Rhizome	curcumin	Yellow	Traditional method	[7]

A. Pigments

Betalains are water-soluble nitrogen-containing pigments. They are formed from the amino acidtyrosine [9], found mostly in fruits and flowers from species belonging to order Caryophyllales[16] .Betalains are divided into two subclasses: betacyanins (red–violet) and betaxanthins (yellow to orange) [17] Carotenoids are lipid-soluble, yellow–orange–red pigments originate in all higher plants. Plant, algae, fungal, and synthetic carotenoids are allowed as colorants [10]. They are synthesized photosynthetically in plants.[18] Tannins are polyphenolic secondary metabolites of higher plants [8]. They are water-soluble[19]. Anthocyanins are glycosides, they have sugars attached to the anthocyanidin. In structure of anthocyanins, many anthocyanidins have been famed, and the most common are cyanidin, delphinidin, pelargonidin, peonidin, malvidin and petunidin [11]. Curcumin is greenish yellow, like lutein [10]. Curcumin has diferuloylmethane which is the primary constituent responsible for its vibrant yellow colour [20].

B. Pigment Extraction methods

1) *Aqueous Extraction:* In aqueous extraction, the material is first broken into small pieces or powdered. It is then soaked with water in earthen, wooden, or metal vessels for a long time usually overnight to loosen the cell structure and then boiled to get the dye solution, which is filtered to remove non dye plant residues. The process of boiling and filtering is repeated to remove as much dye as possible [12].
2) *Alkali or Acid Extraction:* In acid and alkali extraction the dyes are extracted under dilute acidic or alkaline conditions. The addition of the acid or alkali facilitates the hydrolysis of glycosides resulting in better extraction and higher yield of color [13].
3) *Microwave and Ultrasonic Assisted Extraction:* In microwave and ultrasonic assisted extraction, extraction efficiency is increased by the use of ultrasound or microwaves, thus reducing the quantity of required solvent, time, and temperature of extraction [14].
4) *Fermentation:* Fermentation is method of extraction which uses the enzymes produced by the microorganisms present in the atmosphere for assisting the extraction process. Indigo extraction is the most common example for this type of extraction [15].
5) *Solvent Extraction:* In Solvent extraction, natural coloring materials depending upon their nature can also be extracted by using organic solvents such as acetone, petroleum ether, chloroform, ethanol, methanol, or a mixture of solvents such as mixture of ethanol and methanol, mixture of water with alcohol etc. [12].

Betalain-containing substances are normally macerated. Pigments can be water-extracted, though, in several cases, the use of methanol or ethanol solutions is mandatory to complete the extraction [9]. Lipid-soluble pigments like chlorophyll and carotenoids are generally extracted with organic solvents, with other material such as triglycerides, sterols, wax, and other lipid- soluble compounds. Water-soluble pigments such as anthocyanins are in general extracted with water or lower alcohols. Curcumin is insoluble in water and only a little soluble in vegetable oil. [10].

The traditional method for extraction of colour from plants starts with filling the dye barrel with clean water from river or well to a level that is below the top of the barrel by 12–15 cm. Next, one has to pour 4 kg of dried plant dye material and 1 kg of rice wine. Now stir the pigment material and allow them to ferment in the barrel for 10–12 days. Stir the surface to check the dye is ready which will be shown by the desired color. The dye is then sieved and used. Different shininess can be obtained by applying various materials such as wine and ash [7].

C. Traditional processing of dying food

Dying of food plants includes first drying the dye plant in sun and then mingling the plant with cold water. The plant material is filtered and the subsequent extract is mixed to uncooked fooditems such as glutinous rice [7].

III. CONCLUSION

Natural plant dyes are appealing for the present trend of sustainability in food industry. It is difficult to implement plant dyes for a large production since of their comparative low yield, and expensive labour costs. But still, the call for natural dyes has been increased worldwide due to alertness about their valuable properties. Properdocumentation, cultivation and conservation should be done for these natural dye-yielding plants.

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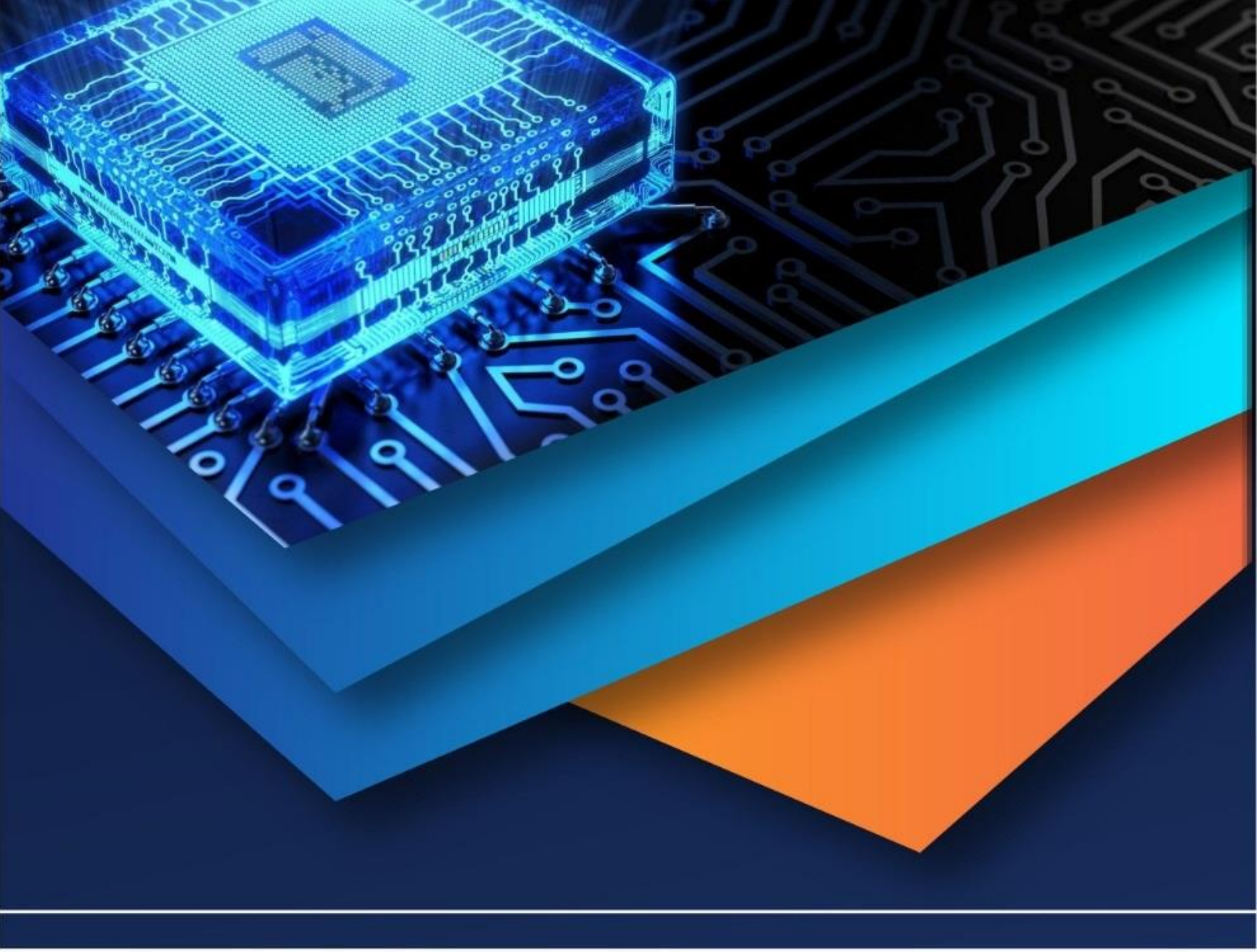

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