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Development and Utilization of Food Bio-Colours: A Review

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ABSTRACT

A food that is taken, has some important characteristics, depending on which, it gets attractive. One of which is its' colour. To colour the food we may use any type of colour.Natural colours (or bio-colours) that are made from living organisms, Nature-identical colours pigments made by man, also found in nature, Artificial coloursthatare purely made by men.Among all these above mentioned, types of food colouring pigments, we are here focusing on the natural or bio-colours.The word bio-colour has two parts, 'bio' meaning natural and 'colour' meaning the thing used for colouring purpose.These bio-colours can be colours, additives. The bio-colours have many functional properties other than pigmentations, as therapeutic agent, as food preservatives, as quality control markers. The present review article would also elaborately explain about some bio-colours along with their pigmentations and uses other than colouring, as therapeutic agents, as food preservative, as quality control measures.

Key words: Food bio-colour, artificial colour, pigments, functional characteristics

1. INTRODUCTION

Colour is the first impression of a food. Colour is an important quality of food. A food gets attractive by its colour. The colours make a food appealing for the customers or consumer.It also defines the quality and nutrient content of food. There are basically two types of food colours, bio-colours or natural colours and synthetic colours.Bio-colours are the ones that we receive from biological sources or natural ones. The natural colours or pigment are mostly extracted from fruits, vegetables, seeds, roots and micro-organisms.There are two types of bio-colours, water soluble pigments or flavonoid and water insoluble pigments.Using synthetic colours are sometimes harmful. Therefore there is a shift being taken from synthetic to bio-colours.

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"Table 1." Basic classification of bio-colour

Sl No.	Categories	Description	Examples
1.	Natural colours Or Bio colours	made from living organisms	Beetroot extract, Annatto, Luetin

2.	Nature-identical colours	Man-made pigments that are also found in nature	Betacarotene ,Canthaxanthin
3.	Artificial colours	Purely man-made colours	Alura red, Brilliant blue, etc.

(Solymosi K, et al., 2015)

Recently there have been changes in the legislational which caused a significant reduction in number of synthetic colours used in foods. It has been seen that there is a growth of use of bio-colours from 4.9% in 2003 to 10.6 billion in 2008, but synthetic colours are still at growth, at a lower rate of 5-10% .(Downham A)Natural colours are the best over artificial colours as the artificial ones cause Attention Deficit Hyperactivity Disorder (ADHD), problems in behaviour, depression, food allergies, headaches and migraines.(Bora and et al., 2019)

"Table 2."Types and uses of natural colours:

Natural colourants	Colour	Uses
Carmine	Bluish red	Used as soft drinks, sugar and flavour confectionary, pickles, etc
Sandal wood	Orange-orange red	Used as fish processing, alcoholic drinks, sea food dressings, meat product
Chlorophyll	Olive green	Soups, fruit products, jams
Beet powder	Bluish red	Frozen ice creams & flavoured milk
Turmeric	Bright yellow	Yogurt, frozen products, pickles
Riboflavin	Yellow	Cereal products, sherbet, ice cream
Safflower	Yellow	Soft drinks, alcoholic drinks
Anthocyanin	Blue-reddish shades	Soft drinks, alcoholic drinks, pickles
Annatto	Orange shades	Used as dairy, fat products, desserts
Beta-carotene	Yellow-orange	Used as butter, fats, oils, soft drinks, fruit juices, ice creams, etc
Canthoxanthin	Orange red-red	Used as soups, meat & fish dishes
Paprika	Orange-red	Meat products, snacks, soups, salad
Saffron	Yellow	Provides colour to baked goods, rice dishes, meat dishes, soups
Leutin	Yellow	ice creams,dairy products, sugar, flour

(Parmar and et al., 2015)

2. Classification of food bio-colorants, their source and uses,

Bio-colours can be classified into three main classes(Singhand et al., 2015)

2.1. Natural colours: the basic natural pigments are; chlorophyll, the carotenoids and the flavonoids with their principal subclass, the anthocyanin.

2.1.1. Chlorophyll:chlorophyll is the most widely distributed natural pigment and occurs in the leaves and other parts of most plants.(Humpheryand et al., 2006) It is the green pigment present in chloroplasts which provides the energy necessary for photosynthesis in plants. Chlorophyll has the intense green colour because it stronglyabsorbed in the red and blue regions of the electromagnetic spectrum, and because of these absorbenciesthe light it reflects and transmits, appears green. Chlorophylls are used for the rich green colours in pastas and confections. Chlorophyll has a chemical structure, quite similar to a chemical structure found within red blood cells of human.Chlorophylls are highly sensitive to heat, light, oxygen, acids and enzymes, leading to their degradation and change in colour. They are stable in alkaline pH between 7-9. It is unstable in acidic pH.(V jadhav et al., 2020) Chlorophyll is one such pigment which is a potential cancer preventive agent. Biological activities that are attributed to chlorophyll derivatives and are consistent with cancer prevention include, antioxidant and antimutagenic activities.(Ieventinanc et al., 2011)

2.1.2. Carotenoids: the pigments are fat soluable pigments responsible for red, orange and yellow colours. Most carotenoids are hydrocarbons that contain 40 carbon atoms along with it two terminal rings. Other than their use as colorants they are also used in food fortification as it has health benefits, such as, strengthening the immune system, reducing the risk of degenerative diseases, antioxidant properties and antiobesity/hypolipidemic activities.(Mezzomo et al., 2016-2015)Carotenes help provide the orange colour to the carrot, for which this class of chemicals is named and for the colours of many other fruits, vegetables (for example, sweet potatoes, tomatoes,

orange, and melon). But not all of the yellow colours in dry foliage are due to carotenes. They also (in lower concentrations) provide the yellow colour to milk-fat and butter.Two classes of carotenoids are found in nature, β-carotene, consists of linear hydrocarbons.The oxygenated derivatives of carotenes such as, lutein, violaxanthin, neoxanthin and zeaxanthin, known as xanthophylls.(Mezzomo et al., 2016-2015)

2.1.3. Flavonoids: They are a group of natural substances with variable phenolic structures that are found in nature like in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine .(Panche et al., 2011)These natural products also have a lot of beneficial effects on health.

2.1.4. Anthocyanins:They are colored water-soluble pigments, and they belong to phenolic group. The colours like red, purple and blue in fruits and vegetables are due to this pigment. In acidic condition the pigment occurs as red, whereas it occurs as blue in alkaline condition.(EngKhoo et al.)Food plants rich in anthocyanins include the blueberry, raspberry, black rice, and black soybean, among many others like red or blue or purple or black.Anthocyanins provide colour to some of the autumn leaves.Anthocyanins are approved for use as food colorants. The Food SafetyAuthority of India concluded that anthocyanins from various fruits and vegetables have been insufficiently characterized by safety and toxicology studies to approve their use as food additives. Extending from a safe history of using red grape skin extract and black current extracts to coloured foods, it is concluded that these extract sources were exceptions to the ruling and were sufficiently shown to be safe.(EngKhoo et al.) We use anthocyanins as they are stable at low pH and high temperature. And we also prefer them for its' unique property, saturated absorption, and acylation, which lowers their apparent absorption. They may also provide health promotion in terms of obesity prevention, cardiovascular health, anti-inflammatory and anti-cancer effects. (Singh et al., 2015)

2.1.5. Caramel: caramel is defined as a colouring agent and an antioxidant, which is used in several food products. It is a complex blend of fat globules in different size groupings which are surrounded by a high-concentration sugar solution in which milk solids are dispersed or dissolved.(Sengar et al., 2012)It is manufactured by heating a mixture of glucose syrup, milk, and vegetable fat at a temperature ranging between 118 and 130 degree C.(W. Minifite et al., 1989) It is classified into 4 classes ,Caramel Colour I (plain or spirit caramel), Caramel Colour II (caustic sulphite caramel), Caramel Colour III (ammonia or beer caramel, baker's and confectioner's caramel), Caramel Colour IV (sulphite-ammonia, soft drink caramel).[Washington DC et al., 1992, Codex food chemicals, 1996, Caramels colours, 2011)It is polymeric in its character. Controlled heat treatment of carbohydrates produces caramel.

2.1.6. Carmine:Carmine is one of the few dyes that are currently certified by the Biological Stain Commission. There are three cochineal derivatives carmine, carminic acid and aminocarminic acid. It is relatively new in food trade as an acid-stable red colorant.(Dapson, 2005)Extraction of carminic acid occurs from several insect texa like, *Kermes vermilio*(kermes), *Porphyrophorapolonica*(Polish cochineal),*Porphyrophorahamelii*(Armenian cochineal),*Kerrialacca*(lac - often referred to by its old name: *Lacciferlacca*, etc.(Salmosiet al., 2015)

2.1.7. Beta-carotene: Beta-carotene mostly appears as orange colour. In human body, beta-carotene is broken down by beta-carotene dioxygenase in the mucosa of small intestine into two retinyl molecules, which is later reduced to vitamin A (retinol).(During et al., 2001)Beta-carotene can be found in yellow, orange, and red coloured fruits and vegetables.(Khoo et al., 2011)

2.1.8. Annatto:Annatto is a natural colouring agent which is obtained from the outer coats of the tropical shrub Bixaorellana (seeds). The principal colouring component of annatto is the oil-soluablediapo carotenoid bixin, which is methyl ester of dicarboxylic acid norbixin and soluable in aqueous alkali.(Scotter et al., 2009) Annatto is often used to add colours to dairy products such as butter, cheese, or puddings.(Sathiya Mala et al.)

2.2. Additives: Food additive colours are based on anthocyanins, derived from red grapes or beet.(Smith et al.,)

"Table3." Authorized bio-colourants with their European E-Codes

Colourants	E number	Design feature
Anthocyanin	E 163	Provides red to blue pigment that are found in mature fruits
Betanin	E 162	Majorly in red beet
Caramel colour	E 150	These are obtained by careful heating of food grade carbohydrates
Carminic acid	E 120	Provides extract of the female cochineal insect
Carotinoids	E 160	Extracted mainly from plants (like carrots, tomatoes)
Beta- carotene	E 160 a	Carrot
Bixin, norbixin, or annato extract	E 160 b	Extract from Bixaorellana (a seed)
Lycopene	E 160 d	Tomatoes, pink grapefruit, watermelons
Lutein	E 161 b	Marigold flowers
Canthaxanthin	E 161 g	Salmon, shrimp
Chlorophyll	E 140	Natural green pigment that participate in the photosynthesis process
Chlorophyllin	E 141	Provides natural green pigment
Curcumin	E 100	Provides major pigment of turmeric that are extracted from a plant rhizome (Curcuma longa)

(Mortensen A, 2006)

3. Application of bio-colours in pharmaceutical industry and in food industry

3.1. as therapeutic agents:Other than colouring food, bioactive properties are present in many natural dyes and are used as therapeutic agents and as diagnostic tools.(Vikram et al.)There are some of the dyes that are known for, curative effect, analgesics, antibacterial, antifungal, antileprotic, antiviral and anti-inflammatory.(Wilens TE, 002)

3.2. as food preservative:Some of the food are protected from microbial spoilage by possessing antagonistic activity to certain bacteria, fungi and viruses, by natural colorants. Some are also active against protozoa and insects.(Heer et al.)

3.3. as quality control markers:The quality of coloured food can be evaluated, by the level of anthocyanin, used as an indicator, for maintaining good manufacturing practices.(do-Vergas F et al., 2000)

4. Conclusion:

Colour is the main feature of food, to make it appealing. So colour is to be used in food. So bio-colours are the perfect ones to be used in food. This paper shows the preference of using food bio-colours.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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