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Topic of the Research: The Natural Way of Food Colouring

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Abstract
Color is a measure of quality and nutrient content of foods. The objective of adding color to foods is to make them appealing, check the loss of color during processing, to improve the quality and also to influence the consumer to buy a product. At augment present, the demand for natural dyes is increasing worldwide due to the increased awareness on therapeutic and medicinal properties and their benefits among public and also because of the recognized profound toxicity of synthetic colors. Natural dyes are those derived from naturally occurring sources such as plants, insects, animals and minerals. Among all the natural dyes, plant-based pigments have medicinal values so are mostly preferred. Today the food industry and color suppliers are however constantly motivated to work towards the improvement of the technical and physical properties of the color preparations. Development of cost-effective, viable technology for the preparation of a food color and its application in foods is a challenge and the need of the day. This review article covers recent developments in technological advances of food colors with respect to natural color application and stability in foods compared to synthetic colors and the detail basic chemical information about of the major pigments.

Keyword: Food Additive, Natural Food Colour, Medicinal Properties, Pigments

Introduction

The first to feast is the eyes. This is an old axiom with very significant meaning and depicts how colors is life have importance. People's perception is usually influenced by the appearance of the food and this dictates the flavor. So it is important to note that the color of food or beverage often dominates over other set of information regarding the flavor from various studies it has been observed that color of a food or beverage can play profound sole in flavor perception [1] Different foods are associated with different colors by people. When this perception used it on has a detrimental effect on the psychology of how that food taste. So color strongly influences the hospitality industry as color attracts people. Color is an important quality attribute of foods. The objective of adding color to foods is to make them appealing, adjust the loss of color during pricing to improve the quality and also influence the come to buy a product. Color is added to food for the following replace and restore color lost sharing processing, is to enhance color that is already present, to minimize batch variations in processing and to color the uncolored food. Food colors can be grouped divided

into four categories a natural colors, nature-identical colors, synthetic colors and inorganic colors [2,3]

History of color: The earliest written record of the use of natural dyes dates back to 2600 BC in China and addition of colorants to foods is reported in Europe during the Bronze Age It is also sported that around 1500 BC in Egyptian cases candy makers used to add natural extracts and wine to improve the appearance. The first synthetic color ovine) was developed by Sir William Henry Perkin way hack in 1856. The beginning of the 19th century was remarked for the bulk of production and every of synthetic colors from the petroleum derived products like aniline, therefore they were called 'coal tar colors because the starting materials were obtained from coal. [4]

Objectives

- To know the natural alternatives of artificial food colours.
- To know the impact of colour additives in food.
- To understand the pigment of natural food colours.

Review of Literature

Color and Perception: Marketing strategy of food by major manufacturers are greatly influenced by color. Color affects almost everything one does in life is the statement given by Downham and Collins i.e., from purchasing items for one's home, his/her clothing, or their food, decisions are made while giving color the at most importance. Their hypothesis is that all individuals are sensitive to the color of food. Appetites are also influenced and stimulated by color; color may sometimes discourage eating certain foods and diminish the desire for that food. Colors also suggest the flavors that are anticipated when eating or drinking. Bright orange colored drinks imply the flavor of orange. Similarly, a bright red colored drink may hint at strawberry or cherry or beetroot flavor. Dull colors of orange or red drinks may indicate a lesser quality of nutrients and so are not as appealing. From past 20 to 30 years many food industries are being processed to create visually appealing food that tastes good that can be used by common man. This briefs out the importance of color to food choices [5,6].

Market trends: The demand for food color in global market in 2000 was 2400 MT which increased to 3000 MT by the year 2005 and further to increase to 8000 MT by the year 2010 and is expected to increase to 15000 MT by the year 2015. The investment in natural food color market across the globe has touched to US $ 1 billion and is continuously growing as there is demand for natural food colors against synthetic food colors. Because of consumer's choice for 'natural' food processing industry and have contributed to the increase in natural color market significantly [7,8].

Booster for Natural colors: i. As there is increasing awareness about the harmful effects of usage of synthetic colors and the chemicals obviously demand for natural food colors in the international market abruptly increases. ii. As Japan and all European countries have banned trading of synthetic color made products. iii. As encouragement for using Natural food colors in novel products like infant toys and crayons, organic textile printing, handmade paper etc has been implemented and followed in few developed countries. But colors from plant, animal and mineral sources also sometimes called as bio colors, which were used in earlier times, had their own drawbacks like heat, pH and light instability, and against oxidizing agents in food, which

made synthetic colors gain popularity in food industry. In contrast, chemically synthesized colors were easier to produce, inexpensive, and superior in coloring properties as they blend easily. As the use of synthetic colors in food increased, the safety concerns are also raised through numerous regulations across the world and in the USA, only seven synthetic colors are permitted. In India according to The Prevention of Food Adulteration Act of India the use of eight synthetic colors in specified food commodities at a uniform level of 100 mg kg-1 or mg l-1 is permitted [6,8].

Sources of Natural Dyestuffs: Plant sources include roots, berries, flowers, barks and leaves. Red color (dyer's root from Madder plant, Brazilwood, beetroot, cranberry, safflower and orchil), orange color (stigmas of saffron flower), yellow color from (Camomile and Milkwort flowers and Weld), green color (ripe Buckthron berries, ragweed) and blue color (Woad plant and Spirulina). The most important dyes extracted from animal sources are Natural Sepia (from the ink sac of the cuttlefish), Crimson (From the Kermes Louse) and Tyrian purple (from the Murex shellfisf) [3,9].

Color and Taste Perception: The importance of color on taste perception is vital when people decide whether to eat or not. People associate different foods with different colors. In nature Color = Nutrient density. According to Williams common color and food associations are noted in the table [23,9]

Table-1
Chemical Classification of Natural Colorants

Sl.No	Color	Chemical classification	Plant Sources
1	Orange-yellow	Flavone dyes, Isoquinoline dyes, Polyene dyes, Pyran dyes, Chromene dyes	Marigold, β-carotene, lycopene, gentism, turmeric, Saffron, Sanguinaria Canadensis
2	Brown	Napthochinone dyes	Camellia thea, Lawsonia inermis
3	Red	Chinone dyes, Anthrachinoe dyes Chromene dyes	Annatto, Beeta vulgaris, Paprica, grapes vitacea, Alkanna tinctoria
4	Purple- Blue	Benzopyrone dyes, Indigoid dyes Indole dyes	Centaurea cyanus, Indigoferat inctoria Vaccinium myrtillus, Indigoferat inctoria

Table-2
Common color and associated food

Sl.No	Color	Chromophore	Plant Sources	Nutrients
1	Purple-blue	Anthocyanins	Eggplant, blackberry, purple, cabbage, plum, blueberry, raisins, prunes, purple grapes, figs	Lutein, zeaxanthin, resveratrol, vitamin C, flavanoid, ellagic acid, quecertin
2	Green	Chlorophyll	Avocado, cucumber, spinach, kale, broccoli, snow pea, zucchini, artichoke, lettuce, kiwi	Lutein, zeaxanthin, vitamin C, calcium, folate, β-carotene
3	White-tan	Anthoxanthins	Cauliflower, mushrooms, parsnip, potato, ginger, onions, jicama, banana, garlic, onions	Ancillin, Potassium, Selenium
4	Yellow-orange	Carotenoids	Papaya, pineapple, apricot, pumkin, peach, peach, carrot, orange, corn	β-carotene, zeaxanthin, flavanoid, vitamin C, Potassium
5	Red	Lycopene or Anthocyanins	Cranberry, beet, watermelon, tomato, strawberry, pomegranate	Ellagic acid, quecertin, Hesperidin etc.

Chemistry of natural colorants derived from plants Purple to blue color

Centaurea cyanus (Cornflower, figure 3a) is used for coloring sugar, confectionaries and as one of the ingredient in tea. The petals of cornflower find use in salad, cornbread muffins and also used to garnish food items. It is used traditionally for the treatment of indigestion, regulation of kidney, gall bladder and liver. Its medicinal properties include regulation of menstrual disorder, in increasing immunity and also effective in washing out wounds. It is also used in the treatment of mouth ulcers, bleeding gums and for constipation. It has antioxidant, antibacterial and astringent properties hence can be used to cure irritated or inflamed skin. It is also used in hair products and cosmetics. The distilled water from its petals is used for weak eyes and conjunctivitis. A dark blue dye can be obtained from the petals of the flower that can be used to color fabric [10].

Indigofera tinctoria: Figure 3b is used to cure constipation, liver disease, heart palpitation and gout. Coloring matter (Indigotin) is usually present abundantly in flowers which give blue color mainly used to dye linen and hairs. Flavonoids, terpinoids, alkaloids, glycosides, Indigotine, Indiruben, rotenoids are the other related compounds abundantly present in the plant. These compounds were found to be responsible for many pharmacological activities such as antihyperglycemic activity, antioxidant, anti-inflammatory activity, antibacterial, anti hepato protective activity, antidiabetic activity and anticonvulsive agent [11].

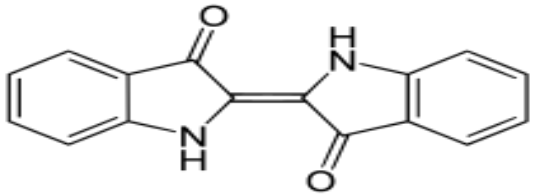


Figure-1 Structure Of Indigotin Pigment

Vaccinium myrtillus: Bilberry, figure 1c the fruit juice is red in color and this turns blue in basic medium. The extract can be used for treating bladder stones, biliary disorders, scurvy, coughs, and lung tuberculosis. More recently, bilberry fruit extracts have been used for the treatment of diarrhea, dysentery, and mouth and throat inflammations. Bilberry leaf decoctions have been used to lower blood sugar in diabetic patients [12].

Sambucus nigra: Blueberry, figure 3d are edible berries. Flowers are used for medicine, fruits as dyes for basketry, arrow shafts, flute, whistles, clapper sticks, and as folk medicine. The active alkaloids in elderberry plants are hydrocyanic acid and sambucine. Both alkaloids will cause nausea so care should be observed with this plant. Elderberries are high in vitamin C. The red berries of other species are toxic and should not be ingested [13].

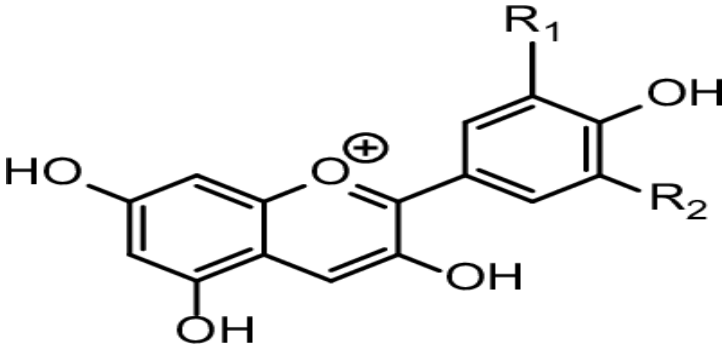


Figure-2 Structure Of Anthocyanin Pigment

Figure-3 Purple - blue pigments derived from [a] Centaurea cyanus, [b] Indigofera tinctoria, [c] Vaccinium myrtillus and [d] Sambucus nigra

Red color

Annatto (figure 9a): Seeds of annatto are used for coloring Gloucester cheese since the 16th century, following with Cheshire, Red Leicester cheese and cheddar made in Scotland. In Spanish it is called as local saffron. In the European Union, annatto has been given the E number E160b whereas in the United States, annatto extract is listed as a color additive "exempt from certification" which is informally considered to be a natural coloring. The yellow to orange color is due to the chemical compounds bixin and norbixin, which come under apocarotenoid. The fat soluble color in the crude extract is called bixin, which can then be saponified into water
soluble norbixin [15].

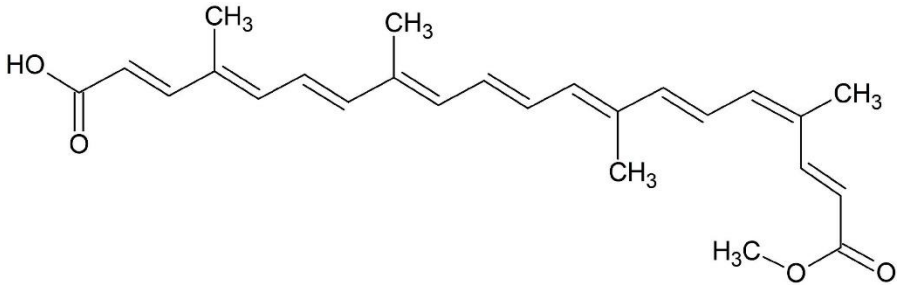


Figure-4 Structure Of Bixin Pigment

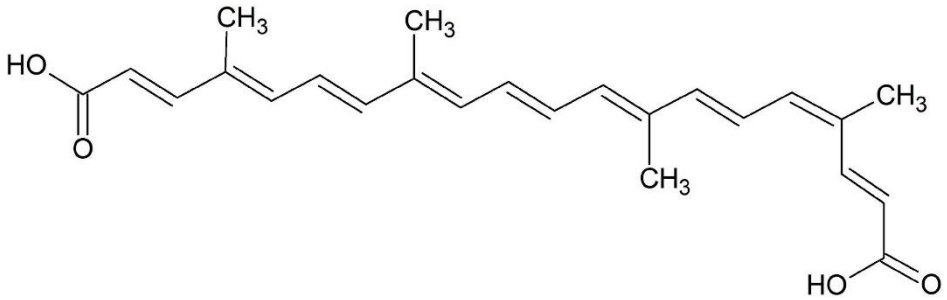


Figure-5 Structure Of Norbixin Pigment

Beeta vulgaris: Betanines or betalains are natural dyes extracted from different Beeta vulgaris. They are largely used as food colorants in food products like yogurts, ice cream and other products. Recent studies have shown that betanines have antioxidant, antimicrobial and antiviral activity besides betanine, another pigment which is extracted from beetroot is vulgaxanthine [16] (figure 2b).

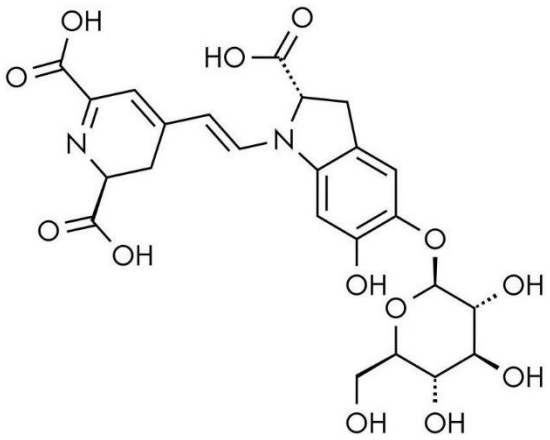


Figure-6 Structure Of Betanin Pigment

Grapes vitacea: The red dye obtained from the grape fruit was used in history by the Kiowa to paint skin and feathers. The red to purple color is due to the presence of anthocyanins. Other valuable nutrients present are glucose, fructose, potassium, calcium, tartaric acid, malic acid, tannins and anthocyanins. The medicinal benefits of grape are it is used in preventing diseases of the heart and blood vessels, varicose veins, hemorrhoids, "hardening of the arteries" (atherosclerosis), high blood pressure, swelling after injury or surgery, heart attack, and stroke. Grape seed is also useful in diabetes complications such as nerve and eye problems, improving wound healing, preventing tooth decay, preventing cancer, in an eye disease called age-related macular degeneration (AMD), poor night vision, liver disorders, and hay fever [14] (figure 9d).

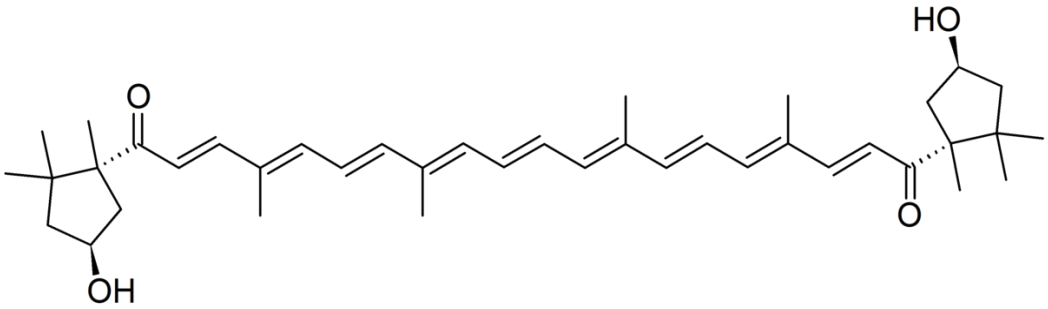


Figure-7 Structure Of Capsorubin Pigment

Alkanna tinctoria: Alkanna (figure 9e) is an astringent and a source of red pigment used in cosmetics. It was traditionally used topically for the treatment of skin wounds and diseases. Orally, alkanna root has been used for diarrhea and gastric ulcers. Alkanna root has demonstrated radical scavenging activity, suggesting potential antiaging effects. Alkanna root contains a mixture of red pigments found in the bark at levels of

up to 5% to 6%. These consist mainly of fat-soluble naphthazarin (5, 8-dihydroxy-1, 4-naphthaquinone) components, such as alkannin and related esters. The red pigments are soluble in fatty oils, which make them useful for the detection of oily materials in microscopic powders during histological examination [14].

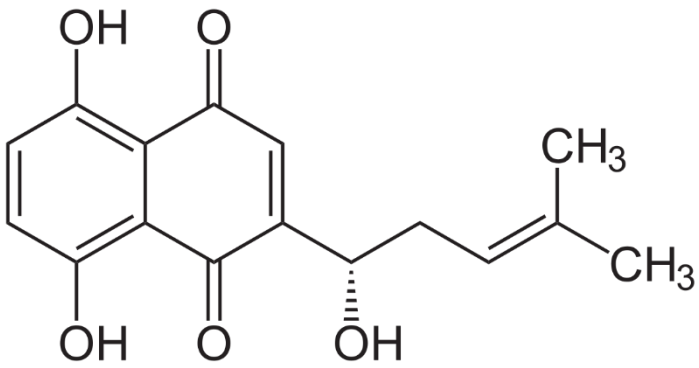


Figure-8 Structure Of Alkannin Pigment

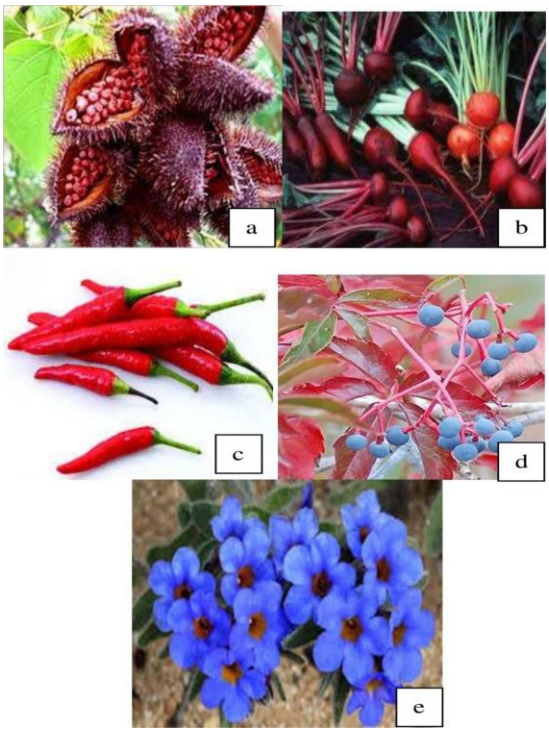


Figure-9 Red pigments derived from [a] Annatto, [b] Beeta vulgaris, [c] Paprica [d] Grapes vitacea and [e] Alkanna tinctoria

Brown color

Camellia thea (Tea, figure 11a): Black to brown color from extracted Camellia thea is used in the cosmetic industry as stated by a Japanese Chemical (Raw Material for Cosmetics) DAITO KASEI KOGYO company. Other benefits of tea include weight loss and obesity management, prevention of cancer, dental hygiene as it is rich in antioxidants [18,19].

Lawsonia inermis (Henna, figure 11b): The constituents of Lawsonia inermis include essential oils like 1,4 naphthoquinone and 5-10% tannins, gallic acid, flavonoids, lipids, sugars, triacontyl tridecanoate, mannitol, xanthones, coumarins (5-alkyloxy 7-hydroxycoumarin), 2-3% Lawsone (2-hydroxy-1,4-naphthoquinone). Among these Lawsone (2-hydroxy-1,4-naphthoquinone) is the coloring agent.The European Commission of Health & Consumer Protection Directorate-General in 2005 has not approved Henna as a food color. This was agreed by FDA (U.S Food and Drug Administration) in 2006 because of mild toxicity of Lawsone [18,20,21].

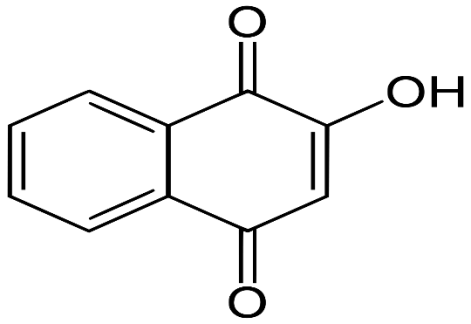


Figure-10 Structure Of Lawsone Pigment

Figure-11 Brown pigments derived from [a] Camellia thea and [b] Lawsonia inermis Yellow-orange

Curcuma longa (Turmeric, figure 15a): Is one of the most essential spice used all over the world. It is called "the golden spice of life". Since Harappan civilization the use of turmeric has been evidenced. It has been considered has the poor man's saffron because it offers a yellow coloring cost effectively. It is used as an alternative to saffron. Curcumin is the primary pigment of color. It is generally used in various food industries for coloring. Mainly used in dairy products, beverages, cereal, pickels, sausages, confectionaries, ice cream, bakery and savory products. Apart from coloring, it is also used in skin care and hair care cosmetic products as it is antibacterial in nature. It is also used in Ayurvedic medicine as analgesic, anti- inflammatory, antitumor, antiallergic, antioxidant, antiseptic, in treating anemia, diabetis, indigestion, gallstones, food poisoning, poor blood circulation [14].

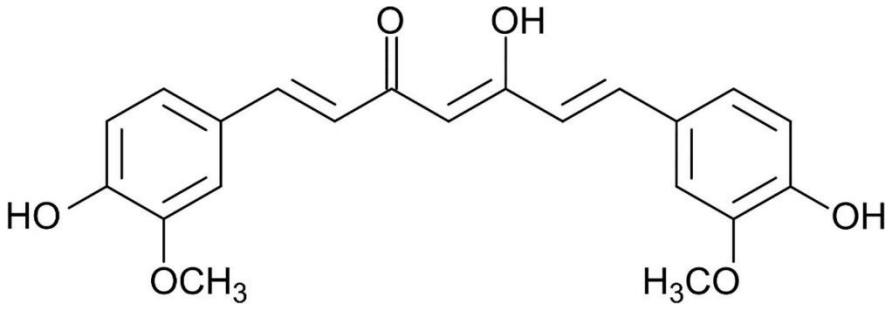


Figure-12 Structure Curcumin Pigment

Sanguinaria Canadensis (Blood root, figure 15b): Bloodroot has been used historically by some Native American tribes as a medicinal agent to stimulate the digestive system and induce vomiting. It has also been used as an antimicrobial agent. Recently, the main active constituent of bloodroot; Sanguinarine, has been added to dentifrices (used to clean teeth) to reduce plaque and treat gingivitis and periodontal disease as reported in 2003 from the U.S. Food and Drug Administration (FDA) Dental Plaque Subcommittee of the Nonprescription Drugs Advisory Committee. They also concluded "that sanguinaria extract at 0.03-0.075% concentration is safe. It is also used to empty the bowels, to treat croup, hoarseness (laryngitis), sore throat (pharyngitis), poor circulation in the surface blood vessels, nasal polyps, achy joints and muscles (rheumatism), warts, and fever [18,22].

Tagetes erecta (Mexican Marigold, figure 15c): Lutein from Tagetes erecta L. is a purified extract obtained from marigold oleoresin. Lutein is extracted from the petals of marigold flowers with organic solvents which impart yellow to orange color. It is used as a food coloring agent and nutrient supplement (food additive) in a wide range of baked goods, beverages, breakfast cereals, chewing gum, dairy product analogs, egg products, fats and oils, sauces, infant and toddler foods, in levels ranging from 2 to 330 mg/kg. It is also used as antiseptic [23].

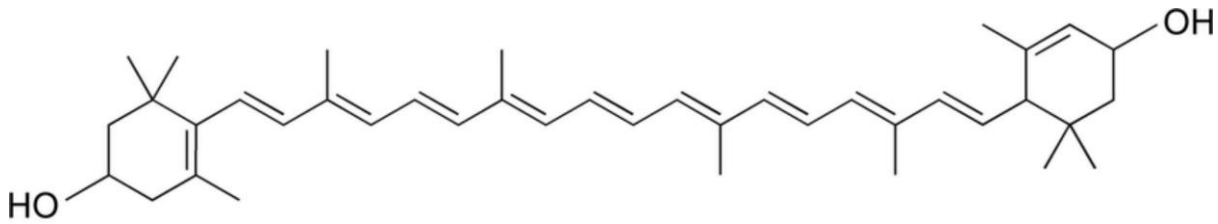


Figure-13 Structure Of Lutein Pigment

Crocus sativus (Saffron, Figure 15d) - The essential oil of saffron contains several terpenes pinene,bcineole) and carbonyl compounds. Its most abundant constituents are afranal(2,6,6-trimethyl-1,3-cyclohexadiene-1-carboxaldehyde),2-Hydroxy-4,4,6-trimethyl-2,5-c yclohexadien-1-one,picrocrocin(4-(D-glucopyranosyloxy)-2,6,6-timethyl-1cyclohexene-1-carbo xaldehyde) and cartotenoid type pigments. Although saffron contains some conventional carotenoids (-carotene, lycopene and zeaxanthin), its pronounced staining capability is mostly caused by crocetin esters; crocetin is a dicarboxylic acid with a carotenoid-like C18 backbone which is formed from carotenoid precursors

("diterpene carotenoid") [17]. Saffron also finds use in medicine, as a food spice and in industry as a textile dye and in perfumery.

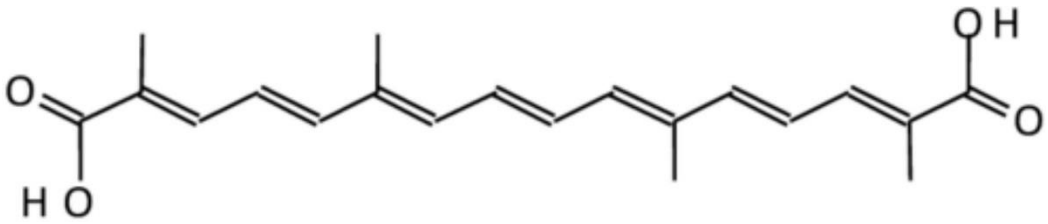


Figure-14 Structure Of Crocetin Pigment

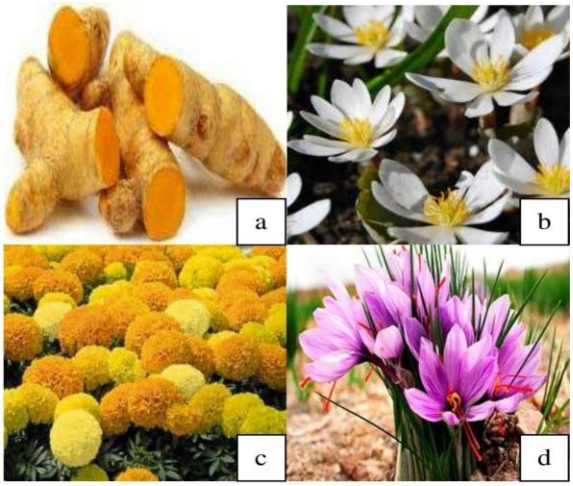


Figure-15 Yellow pigments derived from [a] Turmeric, [b] Sanguinaria Canadensis, [c] Tagetes erecta and [d] Saffron

Green color: Chlorophyll is a green pigment found in most plants, algae, and cyanobacteria. The name is derived from the Greek words (chloros "green") and (phyllon "leaf"). Chlorophyll was first isolated by Joseph Bienaimé Caventou and Pierre Joseph Pelletier in 1817 [21,3].

Chemical structure- Chlorophyll is a green pigment, which is structurally similar to and produced through the same metabolic pathway as other porphyrin pigments such as heme. At the center of the ring a magnesium ion is present. The chlorin ring is connected to different side chains, usually a long phytol chain. There are different forms; the most widely distributed form in terrestrial plants is chlorophyll a. The general structure of chlorophyll a was elucidated by Hans Fischer in 1940, and in 1960, Robert Burns Woodward published a total synthesis of the molecule. In 1967, the last remaining stereochemical elucidation was completed by Ian Fleming, and in 1990 Woodward and co- authors published an updated synthesis. Chlorophylls, a group of fat soluble natural pigments, are obtained by solvent extraction of grass material, lucerne and nettle. The principal coloring matters are the phaeophytins and magnesium chlorophylls, which are highly unstable to light. 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 Chlorophyll is converted to chlorophyllins in presence of alkali, which

renders it water soluble. The technological advance in chlorophyll pigment is that the magnesium atom in the structure is replaced by zinc or copper, which improves its stability to light [21,3].

Chemistry of natural colorants derived from

animals Dactylopius coccus (Cochineal, figure 18a): is native insect of South America and Mexico. It is a parasite which lives on cacti of genus Opuntia feeding on moisture and nutrients. The dye stuff extracted from this insect and its eggs is Carminic acid (Carmine), which is red in color. Carmine is used as a food dye in juices, ice cream, yogurt, and candy, and as a dye in cosmetic products such as eye shadow and lipstick. But as a food dye it has been known to cause severe allergic reactions and anaphylactic shock in some people [25].

Sepia officinalis L (Female Cuttlefish, Figure 18b): it has rich concentrates of orange-red pigment in the accessory nidamental glands. The pigment is called Sepiaxnthine. The dye is called Sepia ink. The sepia pigment is used in capsule printing ink which has been patented in European Patent Application EP1361258. It is used in Spanish cuisine breaded and deep-fried cuttlefish is a popular dish in Andalusia. In Portugal Chocos com tinta is served as deep-fried strips 'cuttlefish in black ink'. Black pasta is often made using cuttlefish ink. The ink is a mixture containing melanin, protein, carbohydrate and lipid. It is reported that protein constitutes approximately 10.08% of squid ink from Sepialla maindroni. Additionally, the dark natural material contains nine fatty acids (approximately 1.34%) of which 43.4% are unsaturated fatty acid and 56.6% is saturated fatty acid plus sixteen amino acids of which aspartic acid is the richest [26].

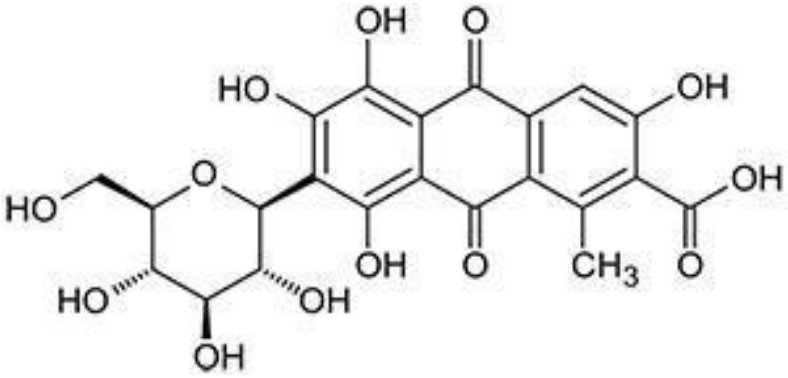


Figure-16 Structure of Carminic Pigment

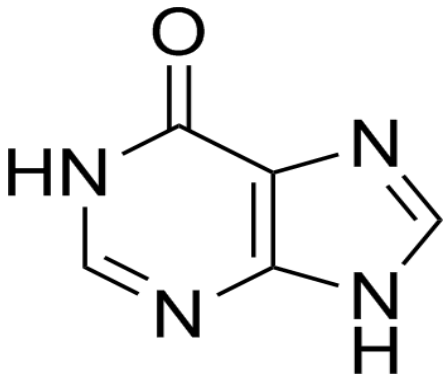


Figure-17 Structure of Sepiaxnthine Pigment

Cephalopod is another member of the molluscan class **Cephalopoda**, Figure 18c: Cephalopod ink is generally obtainable from fishmongers or gourmet food suppliers and in cooking, it is used as a food coloring and flavoring, in pasta and sauces [27].

Monascus purpureus (figure 18d) - Monascus purpureus are fungus. The red pigments produced by this fungus were traditionally used in oriental countries, because of its potential application as food additives. The use of this color additive is not yet regulated in the European Union, United States and Brazil, Philippines, Taiwan among other regions. Oriental countries such as Japan make extensive use of these pigments since decades - as water soluble pigments in candies (Watanabe, 1997), or red pigment for red rice wine. It is also used as cholesterol-lowering agent [28, 29].

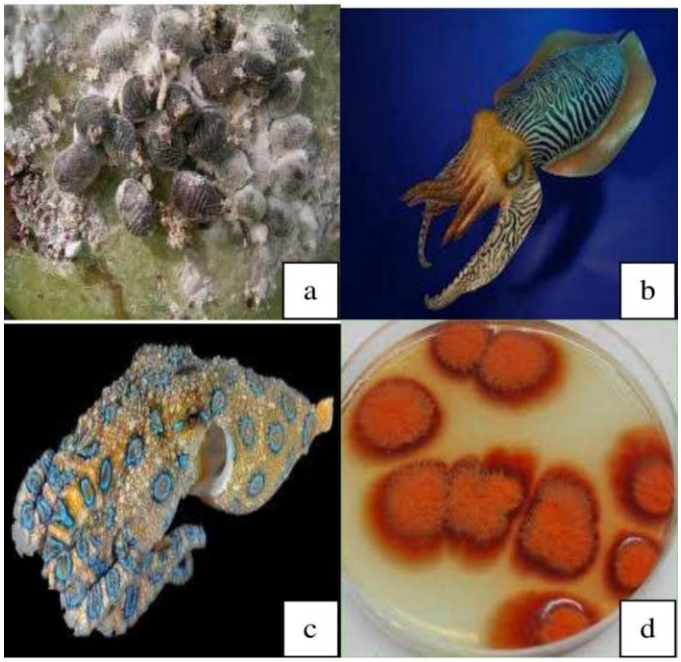


Figure-18 Pigments that are derived from animals [a] Dactylopius coccus (Cochineal), [b] Sepia Officinalis, [c] Cephalopod and [d] Monascus purpureus

Research Methodology

This was one of the most integral part of study. In order to carry out this research study the insights of the objectives were studied. The Natural Way of Food Colouring various other alternative substitutes were identified in the form of a questionnaire. This feedback from various targeted respondents was collected with the help of the survey questionnaire. It was circulated amongst mixed samples of various food industry students. This survey was specifically carried out to evaluate and fulfil the set objectives for the study

Type of Research: A descriptive and qualitative form of research was used to study the various other natural alternatives of food colorings. This also includes surveys and fact finding enquiries in different manner.

Methods of Data Collection

Primary data - was collected from the mixed sample of various students of food industry, Primary data was collected through survey in the following ways:

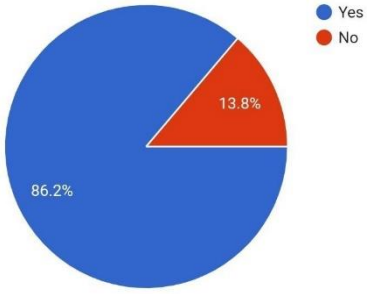
Questionnaires: Considering the Reviews, and the additional inputs, one questionnaire was prepared and distributed to various respondents.

Secondary Data - was collected from published/unpublished literature on nature way of food colorings and also the latest references available from the research publications, past records and other relevant sources available online.

Data Analysis Method: The type of data analysis method that is present in this report is the qualitative method, since there is no quantifiable data present.

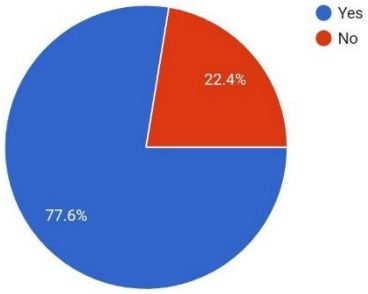
Data Analysis & Interpretation

1. **Are natural food colorings typically free from artificial additives and chemicals? Ans.**



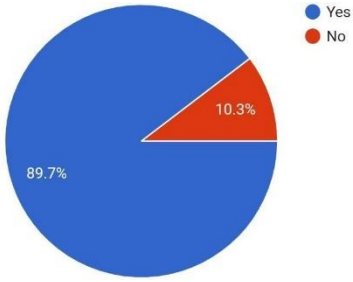
In the above pie chart, it can be seen that 86.2% of the people from the sample selected 'Yes' as the option while 13.8% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

2. **Can natural food colorings provide a wide range of vibrant and appealing hues? Ans.**



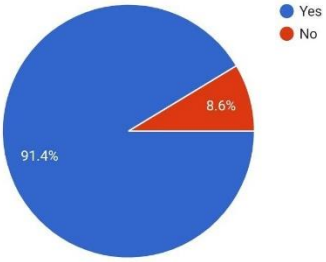
In the above pie chart, it can be seen that 77.6% of the people from the sample selected 'Yes' as the option while 22.4% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

3. **Does the use of color additives in food have an impact? Ans.**



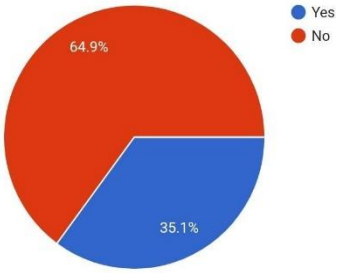
In the above pie chart, it can be seen that 89.7% of the people from the sample selected 'Yes' as the option while 10.3% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

4. Can color additives affect the appearance of food? Ans.



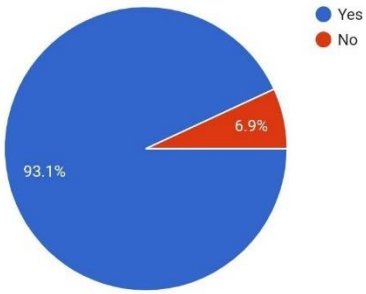
In the above pie chart, it can be seen that 91.4% of the people from the sample selected 'Yes' as the option while 8.6% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

5. Are color additives regulated for safety? Ans.



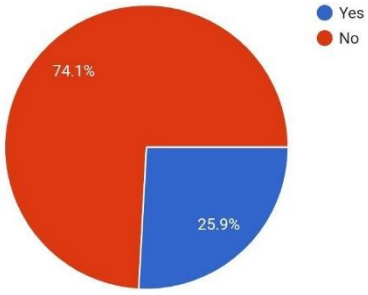
In the above pie chart, it can be seen that 64.9% of the people from the sample selected 'No' as the option while 35.1% selected 'Yes' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

6. Can color additives cause allergic reactions in some individuals? Ans.



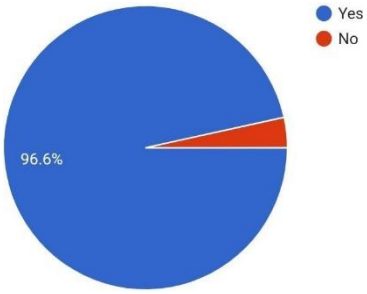
In the above pie chart, it can be seen that 93.1% of the people from the sample selected 'Yes' as the option while 6.9% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

7. Do color additives provide any nutritional value? Ans.



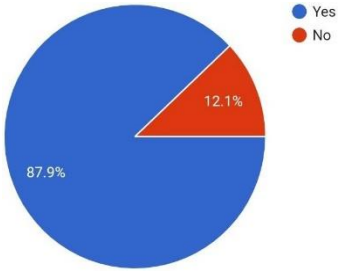
In the above pie chart, it can be seen that 74.1% of the people from the sample selected 'No' as the option while 25.9% selected 'Yes' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

8. Can fruits and vegetables be used as natural food colors? Ans.



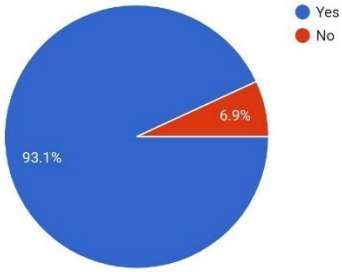
In the above pie chart, it can be seen that 96.6% of the people from the sample selected 'Yes' as the option while 3.4% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

9. Are spices like turmeric and paprika used as natural food colors? Ans.



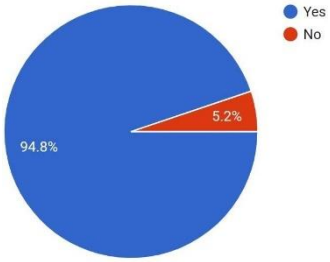
In the above pie chart, it can be seen that 87.9% of the people from the sample selected 'Yes' as the option while 12.1% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

10. Can beetroot and carrot juice be used as natural food colors? Ans.



In the above pie chart, it can be seen that 93.1% of the people from the sample selected 'Yes' as the option while 6.9% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

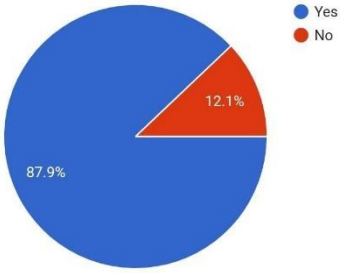
11. Are there natural food color options made from plants? Ans.



In the above pie chart, it can be seen that 94.8% of the people from the sample selected 'Yes' as the option

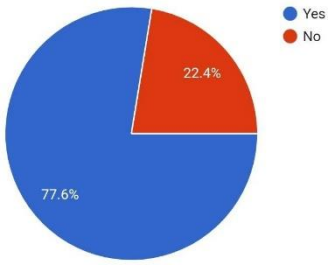
while 5.2% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

12. Are there various pigments used in natural food colors? Ans.



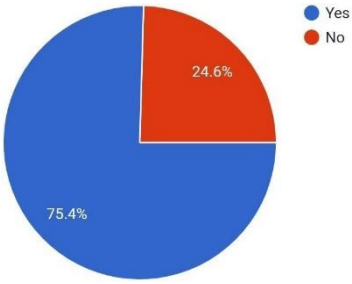
In the above pie chart, it can be seen that 87.9% of the people from the sample selected 'Yes' as the option while 12.1% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

13. Can chlorophyll be used as a natural food color pigment? Ans.



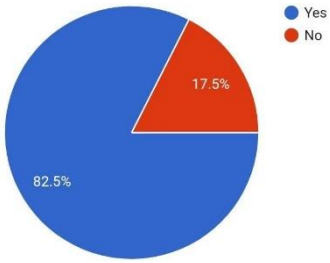
In the above pie chart, it can be seen that 77.6% of the people from the sample selected 'Yes' as the option while 22.4% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

14. Are anthocyanins responsible for red, purple, and blue colors in natural food colors? Ans.



In the above pie chart, it can be seen that 75.4% of the people from the sample selected 'Yes' as the option while 24.6% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

15. Do betalains contribute to the vibrant red and purple shades in natural food colors? Ans.



In the above pie chart, it can be seen that 82.5% of the people from the sample selected 'Yes' as the option while 17.5% selected 'No' respectively. Hence this supports the idea that The Natural Way of Food Colouring.

Observation and Findings

1. Natural food colorings are a popular choice for those seeking additives and chemical-free options.
2. The use of natural food colorings allows for a wide range of vibrant and visually appealing hues in various food products.
3. The impact of color additives in food is significant, as they play a crucial role in enhancing the overall appearance and attractiveness of the food.
4. Color additives have the ability to transform the visual appeal of food, making it more enticing and visually appealing to consumers.
5. Regulatory bodies ensure the safety of color additives, implementing standards to ensure their safe usage in food products.
6. Allergic reactions to color additives can occur in certain individuals, highlighting the importance of ingredient transparency and labeling.
7. While color additives may not provide direct nutritional value, they contribute to the overall sensory experience and enjoyment of food.
8. Fruits and vegetables offer a natural and wholesome source for creating vibrant and natural food colors.
9. Spices like turmeric and paprika are commonly used as natural food colorings, adding both color and flavor to various dishes.
10. Beetroot and carrot juice are natural alternatives for food coloring, providing rich and vibrant colors to different food products.
11. Plant-based sources offer a wide range of natural food color options, allowing for creativity and diversity in food presentation.
12. Natural food colors utilize various pigments derived from plants, offering a spectrum of colors to choose from.
13. Chlorophyll, found abundantly in green plants, can be used as a natural food color pigment to create green hues.
14. Anthocyanins, present in certain fruits and vegetables, are responsible for the red, purple, and blue colors in natural food colorings.
15. Betalains, found in beets and other related plants, contribute to the vibrant red and purple shades in natural food colors.
16. From the question asked i observed is that using natural alternatives like beetroot juice and turmeric in cooking or baking can give dishes a beautiful and vibrant color.

Conclusion

The natural way of food colorings offers a promising and healthier alternative to synthetic additives. Through our exploration of various natural sources like fruits, vegetables, and spices, we have uncovered a vast array of vibrant and safe color options for the food industry. These natural alternatives not only provide appealing hues but also offer potential health benefits, including antioxidants and phytonutrients. While challenges such as stability and consistency may need further research and development, the shift towards natural food colorings aligns with consumer demand for more wholesome and sustainable food products. Embracing the natural way of food colorings is not only a testament to our understanding of the importance of natural

ingredients but also a step towards a more sustainable and vibrant culinary future.

Bibliography

1. Lawrence L. Garber, Eva M. Hyatt, Richard G. Starr: The effects of food color on perceived flovor, Journal of Marketing Theory and Practice, 59, (2000)
2. M. Madhava Naidu, H.B. Sowbhagya: Technological Advances in Food Colors, Chemical Industry Digest., (2012)
3. Sahar S.A. Soltan, Manal M.E.M. Shehata: The Effects of Using Color Foods of Children on Immunity Properties and Liver, Kidney on Rats, Food and Nutrition Sciences, 3, 897-904, (2012)
4. Adam Burrows J.D., Palette of Our Palates: A Brief History of Food Coloring and Its Regulation, Comprehensive Reviews in Food science and Food Safety, 8, 394. (2009)
5. Charles Spence, Carmel A. Levitan, Maya U. Shankar, Massimiliano Zampini: Does food color influence taste and flavor perception in humans? Chem. Percept, DOI 10.1007/s12078-010-9067-z, 3, 68, (2010)
6. Betina Piqueras Fiszman, Agnes Giboreau, Charles Spence: Assessing the influence of the color of the plate on the perception of the complex food in a restaurant setting, Flavour Journal, 2, (2012)
7. Ree E: Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food on a request from the Commission related to Lutein for use in foods for particular nutritional uses, The EFSA Journal, 315, 1, (2006)
8. Costa Magoulas: How color affect food choices?, University of Nevada, (2009)
9. Amy Mahony: Effect of color on odour, flavorand acceptance properties of food and beverages, M.Tech Thesis, B.S., Chapman University, (2001) Giuseppe (Joe) Mazza: Anthocyanins and heart health, Ann Ist super sAnItà, 43(4), 369 (2007)
10. Kimberly Hamblin Hart, Paulalan Cox: A cladistic approach to comparative Ethnobotany: Dye plants of the southwestern United States, Journal of Ethnobiology, 20(2), 303 (2002)
11. Pandey R.M. and Upadhyay S.K.: Food Additive, www.intechopen.com (2013)
12. Vaccinium myrtillus (Bilberry), Alternative Medicine Review, 6(5), (2001)
13. F. Delgado-Vargas, A.R. Jiménez, O. Paredes-López: Natural pigments: carotenoids, anthocyanins and betalins—characteristics, biosynthesis, processing and stability. Critical Reviews in Food Science and Nutrition, 40(3), 173, (2000)
14. Mott MacDonald, Project Profile on Natural Food Colors – Marigold, Annatto, iNDEXTb (2000)
15. Aura Sturzoiu, Marta Stroescu, Anicua Stoica, Tnase Dobre: Betanine extraction from beta vulgaris – experimental research and statistical modeling, U.P.B. Sci. Bull., Series B, 73(1), (2011)
16. Bernard Weiss: Synthetic food colors and neurobehavioral hazards: The view from environmental health research, Environmental Health Perspectives, 120, (2012).
17. Sincich. F: Citrullus colocynthis (L.) Schrad, Bedouin traditional medicine in the Syrian Steppe, Rome, FAO, 114 (2002)
18. European Medicines Agency Evaluation of Medicines for Human Use, London, 12 November 2009, Doc. Ref.: EMA/HMPC/101303/ (2008)
19. Rajashekaran J. Nair, Devija Pillai, Sophia M. Joseph, Gomathi. P, Priya V. Senan, Sherief P.M: Cephalhopod research and bioactive substances, NISCAIR online periodicals repository (NOPR), 13-27,

(2011)
20. Chengaiah B., Mallikarjuna Rao K., Mahesh Kumar K., M. Alagusundaram C. Madhusudhana Chetty, Medicinal importance of natural dyes – a review, International Journal of PharmTech Research, 2(1), 144 (2010)
21. Mersereau D. and Di Tommaso A., The biology of Canadian weeds. 121. Galium mollugo L., Canadian Journal of Plant science, 453, (2002)
22. Richard Cantrill, Chemical and Technical Assessment (CTA), Lutein from Tagetes erecta FAO, 63rdJECFA, (2004)
23. M Luisa Vázquez de Ágredos Pascual, María Teresa Doménech Carbó, Dolores Julia Yusá-Marco, Sofía Vicente, Palomino and Laura Fuster López: Kermes and Cochineal; woad and indigo repercussions of the discovery of the new world in the workshops of european painters and dyers in the modern age, Arché. publicación Del Instituto Universitario De Restauración Del Patrimonio De La UPV- 2, 131, (2007)
24. Ana López-Montes a, Rosario Blanc b, Teresa Espejo a, Alberto Navalón b, José Luis Vílchez: Characterization of Sepia ink in ancient graphic documents by capillary electrophoresis, Microchemical Journal 93, 121, (2009)
25. Huazhong Liu, Ping Luo, Shaohong Chen and Jianghua Shang, Asian-Aust: Effect of squid ink on growth performance, antioxidant functions and immunity in growing broiler chichkens. J. Anim. Sci., 24(12),1752, (2011)
26. Júlio Cesar de Carvalho, Bruno Oliva Oishi1, Ashok Pandey, Carlos Ricardo Soccol: Biopigments from Monascus: Strains Selection, Citrinin: Production and Color Stability, Brazilian Archives of biology and technology, An International Journal, 48(6), 885, (2005)
27. Ozlem Erdogrul, Sebile Azirak: Review on the studies of red yeast rice (Monascus purperius) Turkish Electronic Journal of Biotechnology, 2, 37, (2004)
28. Shouqin Z., Jun X. and Changzheng W., High hydrostatic pressure extraction of flavonoids from propolis, Journal of Chemical Technology and Biotechnology, 80(1), 50, (2005)
29. Mason T.J. and Zhao Y., Enhancement of ultra sonication cavitation yield by multi frequency sonication, Ul- trasonics Sonochemistry, 29(5), 567 (1994)
30. Nayak, C.A., Suguna, K., Chethana, S., Narasimhamurthy, K., Rastogi, N.K: Enhanced mass transfer during solid-liquid extraction of gamma-irradiated red beetroot, Journal Food Engineering, 79 (3), 765, (2007)
31. Sowbhagya H. B. and Chitra V. N: Extraction of flavorings and colorants from plant materials, Critical Reviews in Food Science and Nutrition, 50(2), 146, (2010)
32. Rodriguez-Saona, L.E., Giusti, M.M., Durst, R.W., and Wrolstad, R.E: Development and process optimization of red raddish concentrate extract as potential natural red colorant, Journal of Food Processing Preservation, 25, 165, (2001)
33. Alison Downham, Paul Collins: Coloring of our foods in last and next millennium, International Journal of Food Science & Technology, 35(1), (2001)
34. Spence, Levitan, Shankar, & Zampini: The multi sensory perception of flavor. www.thepsychologist.org.uk, , 720, 23 (9), (2010)