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The Biochemistry of Food Colouring Agents

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Abstract: ***In today's scenario, a variety of food items mainly the fast foods are much in demand among the food lovers. Now a days, due to tremendous advancement, synthetic and natural supplements are added to food items and beverages in huge amount. Food colorants can be categorized under the following divisions according to several criteria. Basic three are as follows: Origin, solubility and covering ability. Food supplements are quantised to modify the natural or original colour of foods.***

The synthetic or artificial colours need a strong accreditation from the administrative bodies for their consumption. They scrutinize the synthetic additives or natural additives one at a time. Synthetic and natural dyes have not been evaluated by any of the mentioned methods in a single run. To determine the biology of the food colours, an integrative study of the biological activity at the individual, cellular and molecular levels based on in vivo and in vitro assays was carried out using two model systems.

In a survey conducted within people with chronic hives, many of them had an allergic reaction to the artificial or man- made food dyes. Some supplements may also contain certain contaminants that could even cause cancer like problems.

This study reports an overall study of the natural and artificial food colourants used along with their beneficial and harmful effects focussing on the Biochemistry of these food colourants.

1. INTRODUCTION

Food colours are basically the supplements that are called as pigments or dyes. When these supplements are added to the food, these improve colour of the eatables. These type of colour supplements are basically increased within the food just to overcome the colour loss that is caused due to the prolong storage conditions. These additives also provide colour to the colourless food that makes them more attractive. Food colorants are being added to food in one or another form since many years. Food colour plays an eminent role in today's scenario. Foods with peculiar charm appear attractive to the world.[1]

When the colour preservatives overshoot the sanctioned limit it gradually causes hyperactivity in children and other symptoms in adults. It is mandatory to ensure the food quality and supplements being added to the food for consumption. Many analytical techniques like High Pressure Liquid Chromatography (HPLC), Thin Layer Chromatography (TLC), spectroscopic and gas chromatographic methods are used to analyse food dyes and pigments.[2]

2. HISTORY

It is a well-known fact that the Egyptians coloured their candies as long before as in 400 BC. Natural dyes were used in china about 2600 BC. Saffron is even mentioned in the Bible and Heena was used before 2500 BC. Red dye which is obtained from Rubia tinctorium; blue dye obtained from the leaves of Indigofera tinctoria and a yellow dye obtained from the stigma of saffron are some of the well-known dyes used in ancient times. This made the colours very advantageous. They were used for decorative purposes and also to disguise low quality foods to make them more attractive. In the past few years, the consumers have now become increasingly apprehensive of the constituents of their foods and they now demand for 'natural' foods only. German food regulations listed many dangerous minerals like arsenic, copper lead, chromium, mercury and zinc. These materials were frequently used as some of the sources in the food colorants. Now a days, the substances that are used for human consumption are safety tested and even certified.

3. CATEGORIES OF FOOD COLOURS

Food colours are classified into three categories:

1. *Natural colours*: Natural colours are the pigments that are made by living organisms. For example: Beetroot extract, luetin, annatto

2. *Nature - identical colours*: Nature-identical colours are the man-made pigments which are basically found in nature. For example: Beta-carotene and canthaxanthin

3. *Artificial colours*: Artificial colours are purely man-made colours. For example: Alura red, brilliant blue

4. PURPOSE OF FOOD COLOURING

People generally connect some colours with assertive flavours and the colour of the food can surely affect the attained flavour in anything. [3]

Colour additives or supplements are mainly used in foods for many reasons like:

i. To make food more attractive and appealing

ii. Correct some natural variations in the colour

iii. Enhance the colours that occur naturally

iv. Provide colour to the colourless foods

v. To maintain food's freshness

5. TYPES OF FOOD COLOURS

Food colourants can be categorized under the following divisions according to several criteria. Basic three are as follows: *Origin, solubility and covering ability*

SOLUBLE COLOURANTS:

These colourants can be categorised into the following categories:

Natural dyes or supplements extracted from food materials. These include riboflavin (E101), chlorophyll (E140), carotenes (E160a), betalain (E162) or anthocyanins (E163). The dyes of natural origin are basically not very stable and are mainly characterised by their physiological activity.

Synthetic dyes were previously obtained from coal tar but now a days, these are extracted mainly from highly purified oilproducts. These include azo dyes, xanthan, chinilin and antrachinon supplements that have much concentrated and even everlasting colour in comparison to the natural substances. They do not transmit any type of additive flavour to the products. They are generally more stable.

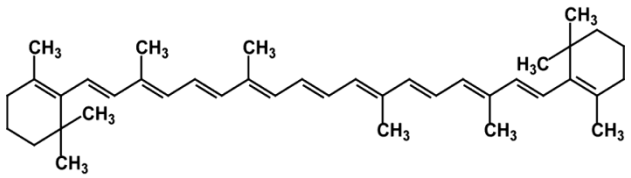
INSOLUBLE COLOURANTS:

Insoluble dyes or supplements are basically called pigments. They are steady colours which show goodcover propertiesand are alsoinsoluble in the easily available solvents. Pigments or supplements can be inorganic with only some finite availability of diversityof colours. Organic supplements are mainly in the formof coverings that are basically the insoluble complex salts of water solubleazo- dyes.

6. NATURAL DYES

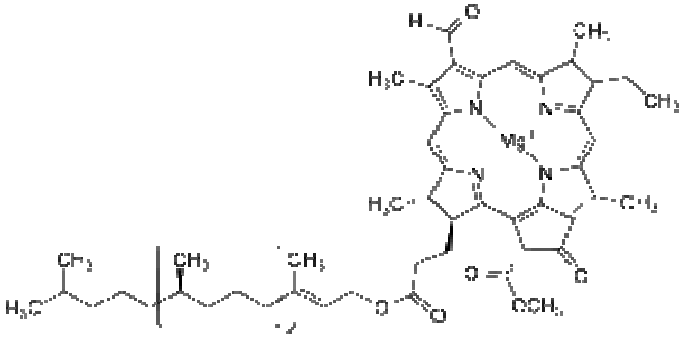
Some of the natural dyes are listed below:

CAROTENOIDS:



Carotenoids belong to tetraterpenoids thathave 40 carbon atoms and 4 terpene units. They take the form of a polyene hydrocarbon chain. Xanthophylls are often yellow. Hence, the range of energies of light absorbed by the molecule decreases. Greater the wavelength of lightabsorbed from the longer end of the visible spectrum, more is the red color acquired by the compounds. Beta-carotene, present in carrots and apricots, is responsible for their orange-yellow colour. Flamingos consume a carotenoid rich diet whichhelps impart the orange-colour to their feathers.

CHLOROPHYLL:

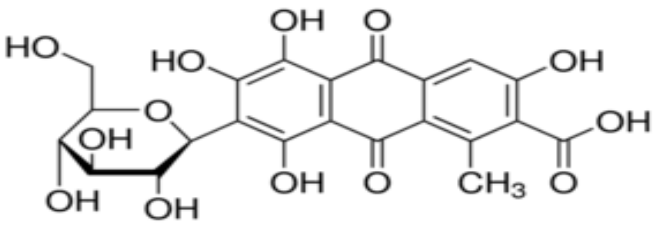


Chlorophylls absorb light strongly in the blue and red spectrum of electromagnetic radiations. It poorlytakes in the green end of the electromagnetic spectrum and hence it reflects thus giving free colour to the tissues. This colouration is provided by anthocyanin in flowers which attracts a huge diversity of insect pollinators mainlyin the fruits. Anthocyanins play a vital role in protecting plants from extreme temperatures. They generallyget degraded at higher pH.

TURMERIC:

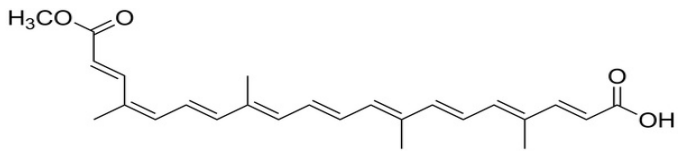
Turmeric is one of the main ingredients that imparts a mustard colour, pungent and a slight bitter flavour to food.It is generally used in savoury dishes. In India, theleaf of turmeric plant is used to prepare sweet dishes. Itis used in the form of rhizome powder that gives a golden yellow colour. It is used asan indicator in chemical analysis for acidity and alkalinity. The paper shows yellow colour in acidic solutions and turns to reddish-brown in alkaline solutions between pH 7.4 and 9.2.

CARMINIC ACID:



Insects produce this acid as a restraint to predators. The chelate carmine is red over a large pH range as it gives a more concentrated red colour than the carminic acid. Carmine is insoluble in acidic solutions, but it can be dissolved in alkaline solutions.[6] Carminic acid and carmine, both can be used to colour foodstuffs generally in North America and Europe, with concentration limitedto the parts-per-million. Carminic acid is the important dye or pigment in the group of anthraquinones. It consistsof a C-glycosidic bond at C7.

ANNATTO:



Annatto is the seed or an extract of the achiote tree, which is indigenous to Central and South America. It is mainly used in Latin America as a dye and even as an ingredient in many foods. Annatto has a strong color hence it is very much in use. Annatto is alsoused as a colorant in a variety of packaged food. It's flavour is somewhat earthy, musky anda bit peppery. Annatto is used as a coloring agent in many soups, stews, and spice rubs. It's seeds are used to make achiote oil, thatis used in rice dishes and stews.

7. WHY FOOD COLOURS ARE PREFERRED?

Food supplements are quantised to modify the natural or original colour of foods. For example, manufacturing of the strawberry jam that looks much brighter adds certain value to the foods. Sunlight can to a large extent affect the flavours in the foods. Hence, dyes, pigments or colours are added to the foods as they help to conserve the foods preventing the detachment of such nutrients. Food colours also make them look attractive like in cakes. Foods that seem to look more appealing, seem more appetizing and tend to be sold more faster.[7]

8. BIOLOGY OF FOOD COLOURS

To determine the biology of the food colours, an integrative study of the biological activity at the individual, cellular and molecular levels based on in vivo and in vitro assays was carried out using two model systems. The *Drosophila* animal model is known to have more than 75% of human disease homologous genes related to different human degenerative illnesses, such as Parkinson's and Alzheimer's diseases and allergic diseases, among others. For this reason, it is a reliable system to test toxicity, anti-toxicity, longevity and many other processes. Moreover, using an in vitro model of human leukaemia cells (HL-60), the effect of this compound on cell growth inhibition was studied, DNA damage (internucleosomal fragmentation as double-strand breaks leading to DNA laddering associated with the activation of the apoptotic pathway in cells) and the modulation of the methylation status. [11]

9. EXAMINATION OF FOOD COLOURS

Determination of non-permitted food colours [2]

Background: In recent days, food additives are used in a huge quantity as they give an appealing view to the food. Food colours can be categorised into the division of permitted and non-permitted colours. Loss of real quality of food is often seen after using non-permitted food colours. Adulteration of food products is now a major cause of concern these days.

Objective: To examine the presence of non-permitted food colours in food by using the preliminary colour test along with thin layer chromatography.

Materials and methods: Four types of samples for example, turmeric, jelly, green peas and namkeen were gathered from various locations for performing the experiment.

Procedure:

20 samples of each eatable were collected from different locations. Using the preliminarycolour test and thin layer chromatography, non- permitted food colours were detected. About 0.1 gm of standard sample of metanil yellow was taken in test tube. 5 ml of propanol was added to dissolve the sample. 5-10 drops of HCl was added to the sample and then the colour of the samplewas observed. Presence of pink colouration indicates the presence of metanil yellow. The same methodwas followed for procured food samples of turmeric and namkeen samples

Results: The colour change and Rf values of the test samples were observed, recorded and analysed. It was observed that 46% of products were adulterated with metanil yellow whereas adulteration with malachite green was about 44%.

Conclusion: This method of detection is generally used to detect such harmful and banned colours being used in the food.

10. TOXICITY EVALUATION OF FOOD COLOURANTS

In today's scenario, more emphasis is being paid to the toxicity of supplements or additives utilized in food and are mainly the azo-dyes. These set of colorants basically comprises of bright and charming colours. These metabolites are mainly generated in the human body but the clinical significance of their occurrence depends upon the quantity of the colorant used. It is important to routinely survey the toxicity of food colorants by authorised communities.

11. HEALTH IMPLICATIONS

Artificial food colouring causes many ill effects mainly to the health. Some of them are as follows: The major effect caused is the behavioural problems especially in children, Depression in youth is observed on a large scale, Food allergies and food poisoning are quite common, Headaches and migraines in people are also seen.

As per the consumer advocacy group, the Centre for Science in Public Interest believed that the artificial food colouring and food dyes are very harmful for the consumers. Most commonly used artificial food colours aresaid to have many ill effects on health like they damage the DNA or genotoxicity, causes bladder tumours and many other forms of cancer. People believe that artificial food colouring causes ADHD- like hyperactivity especially in children. It was originated by Benjamin Feingold, a paediatric allergist from California, in 1973 proposing that salicylates, artificial colours and artificial flavours cause hyperactivity in children. Some food colourings may even act as a trigger for those who are genetically predisposed. Some of the food dyes can even cause certain type of allergies in the people. It is always better to remove the artificial supplements from the diet. [5]

12. CONCLUSION

Artificial colours are found mainly in junk foods, which are generally high in calories and low in nutrients. Most of the artificial food dyes cause allergic reactions. Yellow 5 which is also known as tartrazine causes hives and asthma symptoms. In a survey conducted within people with chronic hives, many of them had an allergic reaction to the artificial or man- made food dyes. Some supplements may also contain certain contaminants that could even cause cancer like problems. Most of the food dyes does not cause any severe effects. Avoiding the processed foods that consists of the supplements can improve the overall health.

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