

Food Adulterants

Dr. Darshana Mehta

- ✓ Food is the basic necessity of life. Synonyms like admixture and substitution helps to define the word adulteration.
- ✓ Food adulteration can be defined as lowering the quality of food by intentional or unintentional substitution of food with some inferior foreign particle or by removal of some value added food substitute from main food item.
- ✓ Food Safety and Standards Act of India (FSSA) defined “adulterant” as any material which is or could be employed for making the food unsafe or sub-standard or mis-branded or containing extraneous matter.

- ✓ According to Federal Food, Drug and Cosmetic Act (FFDCA), the primary food safety law administered by the Food and Drug Administration (FDA), food can be declared adulterated if:
 - a) A substance is added which is injurious to health
 - b) Cheaper or inferior quality item added to food
 - c) Any valuable constituent is extracted from main food article
 - d) Quality of food is below the standards
 - e) Any substance has been added to increase bulk or weight
 - f) To make it appear more valuable
- ✓ Adulterated food is dangerous as:
 - (a) it may be toxic and effect health;
 - (b) it could deprive nutrients required to maintain proper health,
 - (c) it may cause intoxication or problems such as allergy in sensitized individuals.

However, some foods may contain toxin naturally and their consumption in large quantities can lead to serious illness.

- ✓ Lathyrus sativus is one such example which contains a neurotoxin namely b-N-oxalyl-amino-L-alanine (BOAA). Consumption of Lathyrus sativus in large amounts result in a crippling disease known as lathyrism.
- ✓ Another example is various toxic varieties of mushrooms, like phalloidin toxin present in amanita mushroom may cause liver and kidney damage.
- ✓ Roasted chicory roots used as an adulterant for coffee
- ✓ Diethylene glycol, used dangerously by some winemakers in sweet wines

- ✓ Apple jellies (jams), as substitutes for more expensive fruit jellies, with added colorant and sometimes even specks of wood that simulate raspberry or strawberry seeds
- ✓ Water, for diluting milk and alcoholic beverages
- ✓ Cutting agents used to adulterate (or "cut") illicit drugs—for example, shoe polish in hashish, amphetamines in ecstasy, lactose in cocaine
- ✓ Urea, melamine and other non-protein nitrogen sources, added to protein products to inflate crude protein content measurements.
- ✓ High fructose corn syrup or cane sugar, used to adulterate honey
- ✓ Water or brine injected into chicken, pork, or other meats to increase their weight

- ✓ Food adulteration involves the infusion of useless, harmful, unnecessary substances to food which decreases the quality of food.
- ✓ adulterations. Adulterants in food can be categorized into following categories:
- ✓ Intentional adulteration is the inclusion of inferior substances having properties similar to the foods in which they are added. They are thus difficult to detect.
- ✓ The adulterant could be physical or biological in nature. Some examples of intentional adulteration include addition of water to liquid milk, extraneous matter to ground spices, or the removal or substitution of milk solids from the natural product etc.

- ✓ Unintentional adulteration is inclusion of unwanted substances due to ignorance, carelessness or lack of proper facilities and hygiene during processing of food.
- ✓ This can be of acquired type like contamination of foods by bacteria or fungi, spoilage of food by rodents, entry of dust and stones, harmful residues from packing material, etc. or inherent adulteration e.g. the presence of certain chemicals, organic compounds, or radicals naturally occurring in foods like toxic varieties of pulses, mushrooms, green and other vegetables, fish and sea foods.
- ✓ In India, the Prevention of Food Adulteration Rules, 1955 (now covered under FSS act) sighted crop contaminant as another category of unintentional adulterant which gets added to articles of food in the process of their production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging, transport or holding of articles of such foods as a result of environmental contamination.

TYPE	FEW EXAMPLES OF SUBSTANCES ADDED
Intentional Adulterants	
<ul style="list-style-type: none"> ● Physical adulterant ● Biological adulterant 	Sand, marble chips, stones, mud, other filth, talc, chalk powder, water, mineral oil Papaya seeds in black pepper, Argemone seeds in mustard seed etc.
Incidental Adulterants	
<ul style="list-style-type: none"> ● Natural adulteration ● Non natural adulteration 	Toxic varieties of pulses, mushrooms, green and other vegetables, fish and sea foods Pesticide residues, tin from can, droppings of rodents, larvae in foods
Metallic Contaminants	Arsenic from pesticides, lead from water, mercury from effluent, from chemical industries, tins from cans
Microbial contaminant	
<ul style="list-style-type: none"> ● Bacterial 	<i>Bacillus cereus, Clostridium botulinum toxins, Clostridium perfringens (welchii), Salmonella, Shigella sonnei, Staphylococcus aureus, Streptococcus pyogenes</i>
<ul style="list-style-type: none"> ● Fungal 	<i>Aspergillus flavus (aflatoxin), Claviceps purpurea (Ergot), Fusarium sporotrichoides, Penicillium islandicum</i>
<ul style="list-style-type: none"> ● Parasiticus 	<i>Trichinella spiralis, Ascaris lumbricoides, Entamoeba histolytica, Ancylostoma duodenale (hookworm)</i>

- ✓ Metallic contamination is the intentional or unintentional inclusion of different types of metals and metal compounds in food. Out of all, lead, arsenic, mercury and cadmium are considered most toxic as their intake is highly chronic.
- ✓ If they accumulate in body they can cause organ damage.
- ✓ Microbial contamination is the spoilage of food due to infusion of different microbes through various sources. Foods may be contaminated by microorganisms at any time from several sources during food processing like during harvest, storage, processing, distribution, handling, or preparation.

- ✓ Food additives are substances added to food to preserve flavor or enhance its taste and appearance. Some additives have been used for centuries; for example, preserving food by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulfur dioxide as with wines.
- ✓ With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin. NICH
- ✓ Types of Food additives -
 - ❖ Direct food additives
 - ❖ Substance intended for use in food.
 - ❖ Serve a particular functional effect
 - ❖ Indirect food additives
- ✓ Substances that become a part of food from processing, packaging or food contact surfaces reasonably expected to become part of food

SYNONYMS

- Food Coloring Agents
- Food Colorants
- Colorants
- Color additives
- Food dyes

Why are color additives added?

The primary reasons include:

- Offsetting color loss due to light, air, extremes of temperature, moisture, and storage conditions.
- Masking natural variations in color.
- Enhancing naturally occurring colors.
- Providing identity to foods.
- Protecting flavors and vitamins from damage by light.
- Decorative or artistic purposes
- Increase appetite appeal
- To make less desirable food more desirable
- To mask defects
- May keep certain foods tasting fresher for long time

Classification of food colors

FDA classification

1. Non certified

Do not need certificate to sell or use

- Derived from plants, animals, minerals , other than coal & phenol
- These are mainly foods and /or food ingredients rather than food additives

2. Certified

Permitted Natural Colours-India

- a) Beta-carotene
- b) Beta-apo-8' carotenol
- c) Methyl ester of Beta-apo-8, carotenoic acid
- d) Ethyl ester of Betaapo-8' carotenoic acid
- e) Canthaxanthin
- f) Chlorophyll
- g) Riboflavin (Lactoflavin)
- h) Caramel
- i) Annatto
- j) Saffron
- k) Curcumin or turmeric

Natural ingredients -code of federal regulation (CFR)

- ✓ FD&C Blue No.2 (dye &lake)
- ✓ FD&C Green No.3 (dye &lake)
- ✓ FD&C Red No.3 (dye)
- ✓ FD&C Blue No.1 (dye &lake)
- ✓ FD&C Red No.3 (dye)
- ✓ FD&C Red No.40 (dye &lake)
- ✓ FD&C Yellow No.5(dye&lake)
- ✓ 4FD&C Yellow No.6(dye&lake)
- ✓ ■Orange B
- ✓ ■Citrus Red No.2
- ✓ ■Annato extract
- ✓ ■B-Apo-8' carotenol
- ✓ ■Beta carotene
- ✓ ■Beet powder
- ✓ ■Canthaxanthen
- ✓ ■Carrot oil
- ✓ ■Cohineal extract

Natural ingredients -code of federal regulation (CFR)

- Grape color extract
- Grape skin extract
- Paprika
- Paprika oleo-resin
- Riboflavine
- Saffron
- Titanium dioxide
- Turmeric
- Turmeric oleo-resin
- Vegetable juice
- Cotton seed flour-toasted partially,cooked
- Ferrous gluconate
- Fruit juice
- Grape colour extract
- Grape skin extract
- Paprika

Commercially produced

- Annatto-from seed of the Achiote
- A green dye -from chlorellaalgae.
- Cochineal--from the cochineal insect, *Dactylopius coccus*.
- Betanine-from beets.
- curcumene –Turmeric
- Saffron-
- Paprika--red chilly
- anthocyanene --Elderberryjuice
- Caramel-from sugar

Food Coloring

- ✓ Color is the first characteristic of any quantity one can observe. This applies to food also.
- ✓ Color pre-determines the expectation of food before examining its flavor and taste. It is a way of identification of food in the view of consumer perception.
- ✓ Consumers also predict the strength/quality of the food based on color. For example: A light-colored drink will be less stronger than the dark-colored one. A bright (intense) colored drink will be sweeter than the pale colored drink.
- ✓ Color is an important property which makes first impression about food to the consumers.
- ✓ To make the food look colorful, some substances like pigments, dyes are added to food or beverage. These are called Food Colors or Color additives.
- ✓ Food & Drug Administration(FDA) states Color additive as “Any dye, pigment or substance which when added or applied to a food, drug or cosmetic, or to the human body, is capable of imparting color”.
- ✓ These additives provide wonderful colors to color-less foods.

1. To preserve the food

- ✓ Either natural or synthetic, the purpose of adding these additives to preserve the foods.
- ✓ Food products are preserved from microbes, enzymes and oxidation.

2. *To maintain the freshness*

- ✓ Everyone likes to eat fresh food products. Addition of flavors, flavor enhancers and spices can make your food more fresh and pleasant.
- ✓ While both natural, nature-identical and synthetic flavors add freshness to foods, it is advisable to go for natural flavors for better health.

3. To improve nutritional content

- ✓ Fortify your food. May it be meals or yogurt or juices !!!
- ✓ Lot of nutrients are destroyed (during food processing) in case of processed food products. Even fruits and vegetables lose vitamins when boiled or cooked.
- ✓ Adding anti-oxidants to your foods can be healthy. Also, adding natural food colors/colored fruits can provide you phytochemicals (betalanins, carotenoids, flavonoids) apart from imparting pleasant color to your foods.

4. To balance the deficiencies

- ✓ Few food products are deficit in special molecules which provide functional properties like gelation, emulsification etc.,
- ✓ These special functioning molecules are added to products to exhibit diverse functional properties.
- ✓ Whey proteins, soy proteins are some proteins which exhibit functional properties.
- ✓ Also, natural fat replacers can add the fat flavor and mouth feel to those foods which do not contain fats.

5. To improve taste, texture, appearance

- ✓ Better the taste and appearance of food product, higher the chance of acceptance of food products by consumers.
- ✓ Food coloring, flavor enhancers, color retention agents, stabilizers, thickeners etc., can make food products more tasty and improve the texture.

6. To offset the color and flavor losses

Color losses:

During the preparation of foods, lot of chemical reactions occur. They alter pH, temperature and viscosity of food products.

These alterations will lead to food color losses (in many cases). To retain the original color or to replace with new color; food colors can be used.

Flavor losses:

Foods lose their flavors as the time passes. Nature extracts of citric acid or cinnamic acid can be added to foods for lemon or cinnamon flavor. Many other fruits and spices give pleasant flavors.

7. To enhance the existing features

- ✓ Color, taste and odor are important sensory parameters which decide the fate of food products in market.
- ✓ Colors or color retention agents can make the food look more attractive to customers.
- ✓ Flour treating agents can be used in bakery products to enhance the food product qualities.
- ✓ Another set of additives enhance the existing flavors of food. They do not impart any flavor. They are called flavor enhancers.
- ✓ Flavor enhancers can increase the flavor intensity of foods without imparting their own flavor.
- ✓ Mono-Sodium Glutamate (MSG), Glycine, maltol, glutamic acid are chemical flavor enhancers available in market. (They are not recommended due to adverse health effects)
- ✓ Natural additives are preferably healthier than synthetic ones.

8. To control pH, moisture content, viscosity

Have you prepared food products using vinegar or lemon juice?

Why do you add acids to foods?

The answer is Simple !!!

Acids add sharper taste to foods and make the foods soury and tangy. Also, few ingredients like acidity regulators can control the pH of foods.

Viscosity of foods can be improved by adding thickening agents. Your soups, sausages, gravies look good when they are more viscous in nature.

Also, there are few molecules which prevent foods from drying. They are called humectants. Honey, lactic acid, sorbitol etc., are the known ones.



Beet roots treated in acidic, neutral and basic mediums

What these food colors do??? (As per FDA)

1. Offset color loss due to exposure to light, air, temperature, moisture
2. Correct natural variations in color
3. Enhance colors that occur naturally
4. Provide color to colorless and “fun” foods

Based on their method of extraction, color additives are available in markets under 2 categories - Natural and Synthetic

Natural Food Colors:

Any dye, pigment or substance obtained from plant, animal, bacteria or any other living source; capable of coloring food; can be considered as Natural food color.

‘Yellow’ riboflavin, turmeric, lutein; ‘Orange’ beta carotene; ‘Red’ lycopene; ‘Purple’ anthocyanin; ‘Green’ chlorophyll are some of the natural food colors available in market.

- ✓ They are considered less stable than synthetic ones and easily affected by pH.
- ✓ These additives are not considered completely “natural” because organic solvents are used to break the cell wall of fruits and vegetables for extracting the colors.
- ✓ Also, chemicals are used to purify the natural colors during refining process.
- ✓ But they are considered safer than synthetic colors as the artificial colors are prepared from petroleum where as the natural colors are purified using chemicals.

Why to waste money by purchasing these natural colors ?

- ✓ Try to extract natural colors from your fruits and vegetables instead. Extract colors by squeezing them naturally without using any chemicals.
- ✓ The phytochemical and antioxidant properties of fruits and vegetables are derived from their indigenous bio-active colors such as lycopene, lutein, anthocyanin, chlorophyll and beta-carotene.

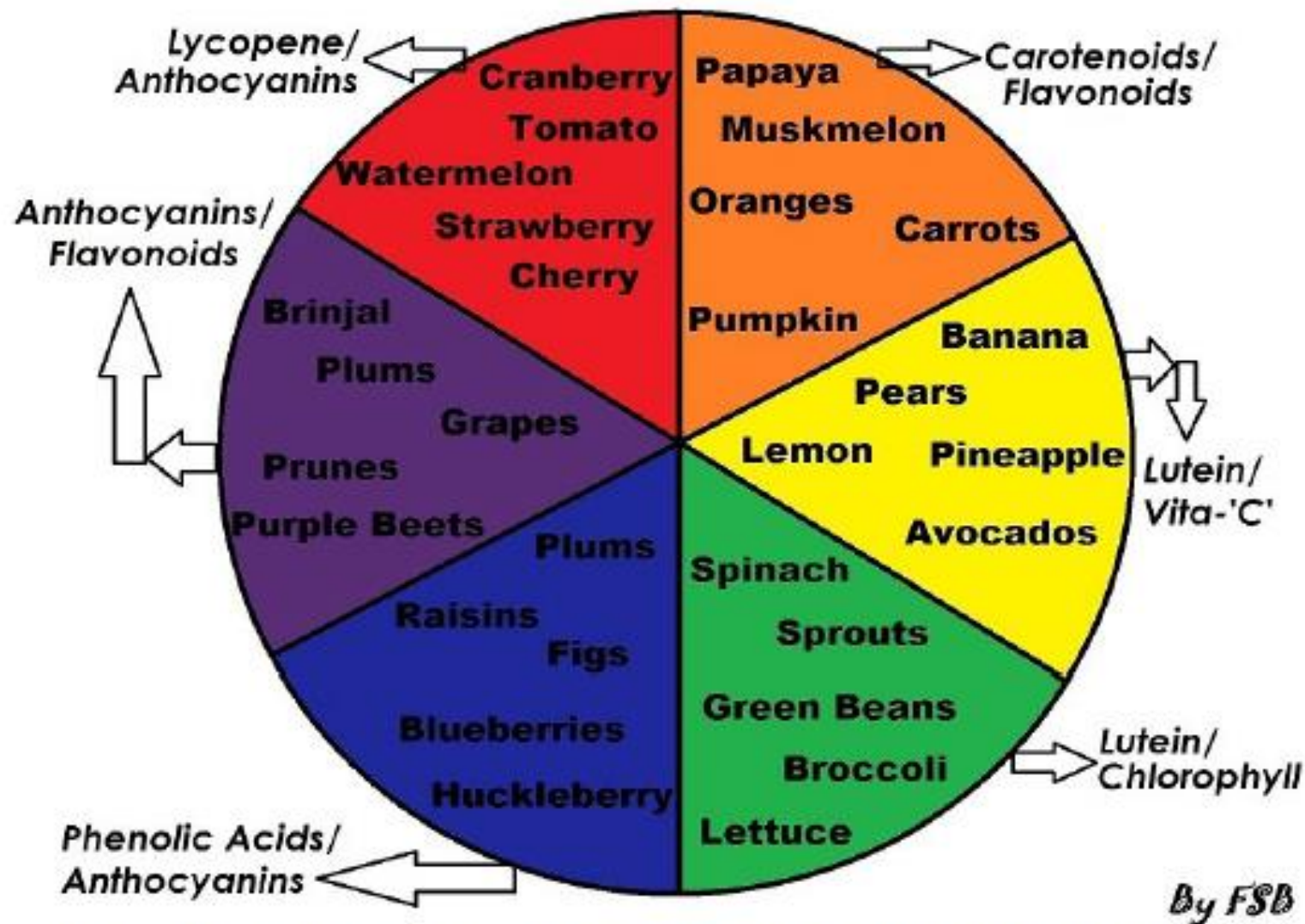
Colourant	Colour	Uses
anthocyanin	Blue-reddish shades	Soft drinks, alcoholic drinks, pickles
annatto	Orange shades	Dairy & fat products, desserts
Beta-carotene	Yellow-orange	Butter, fats, oils, soft drinks, fruit juices, ice creams
canthoxanthin	Orange red-red	soups, soups, meat & fish dishes
paprika	Orange-red	Meat products, snack, soups, salad
saffron	yellow	Baked goods, rice dishes, meat dishes, soups
crocin	yellow	Dairy products, jams, pasta, rice
lucin	yellow	ice creams, dairy products, sugar, flour
Beet powder	Bluish red	Frozen, ice creams, flavored milk
Cochineal	orange	soft, alcoholic drinks
carmine	Bluish red	Soft drinks, sugar & flavor confectionary, pickles, soups
Sandal wood	Orange-orange red	Fish processing, alcoholic drinks, sea food dressings, meat products

Colourant	Colour	Uses
chlorophyll	Olive green	Soups ,souses ,fruit products ,jams
caramel	Yellowish tan-red brown	Alcoholic drinks ,soft drinks ,desserts ice creams ,souses
turmeric	Bright yellow	Yogurt ,frozen products ,pickles
riboflavin	yellow	Cereal products ,sherbet ,ice cream
safflower	yellow	Soft drinks ,alcoholic drinks
Titanium dioxide	white	Sugar coated confectionary
Iron oxide	red	Sugar coated confectionary ,meat & fish pastes
Silver ,gold ,aluminium		Surface coating of sugar confectionary ,cake decoration

Physiological properties

natural colours

- ✓ Besides coloring food, several natural dyes possess bioactive properties and have been used as therapeutic agents and as diagnostic tools.
- ✓ Some of the dyes have been reported for following curative effects; analgesics, antibacterial, antifungal, antileprotic, antiviral and anti-inflammatory
- ✓ Choleric and hydrochologic action- CURCUMINE
- ✓ Deodorant, reduce halitosis, healing- CHLOROPHYLL
- ✓ Pro vitamin A ,prevention of UV sunburns ,antioxidant and radical scavenger ,prevention of lung and breast tumor –CAROTENE
- ✓ Prevention of macular degeneration- LUTEIN
- ✓ Prevention of cardiovascular disease and tumors –ANTHOCYANINS



Fruits and vegetables along with their bio-active compounds (Natural Colors)

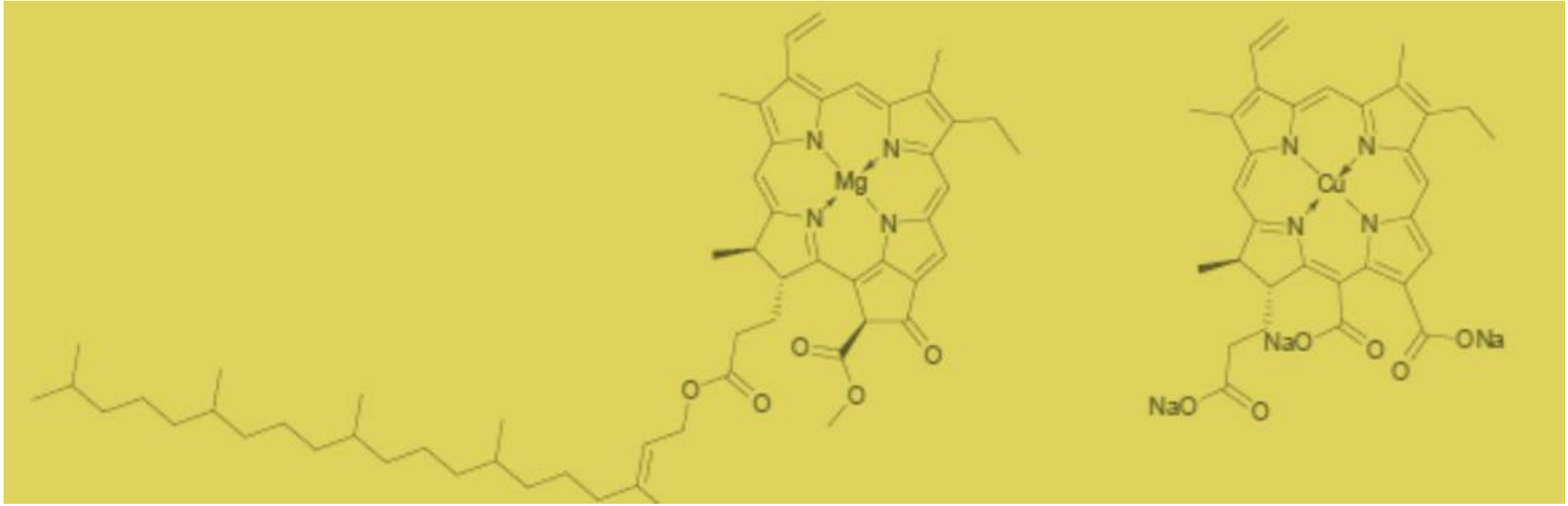

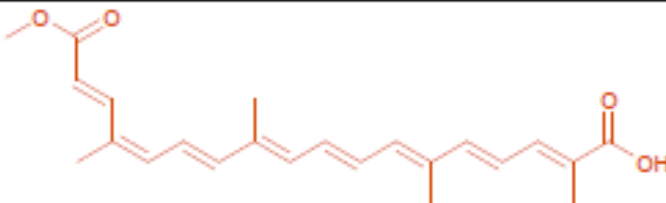

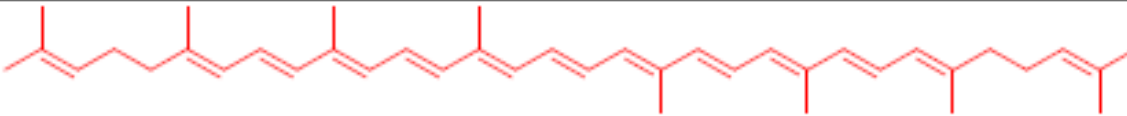
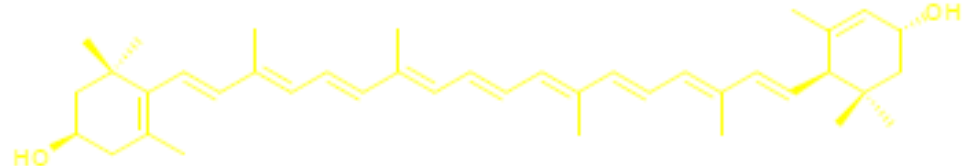
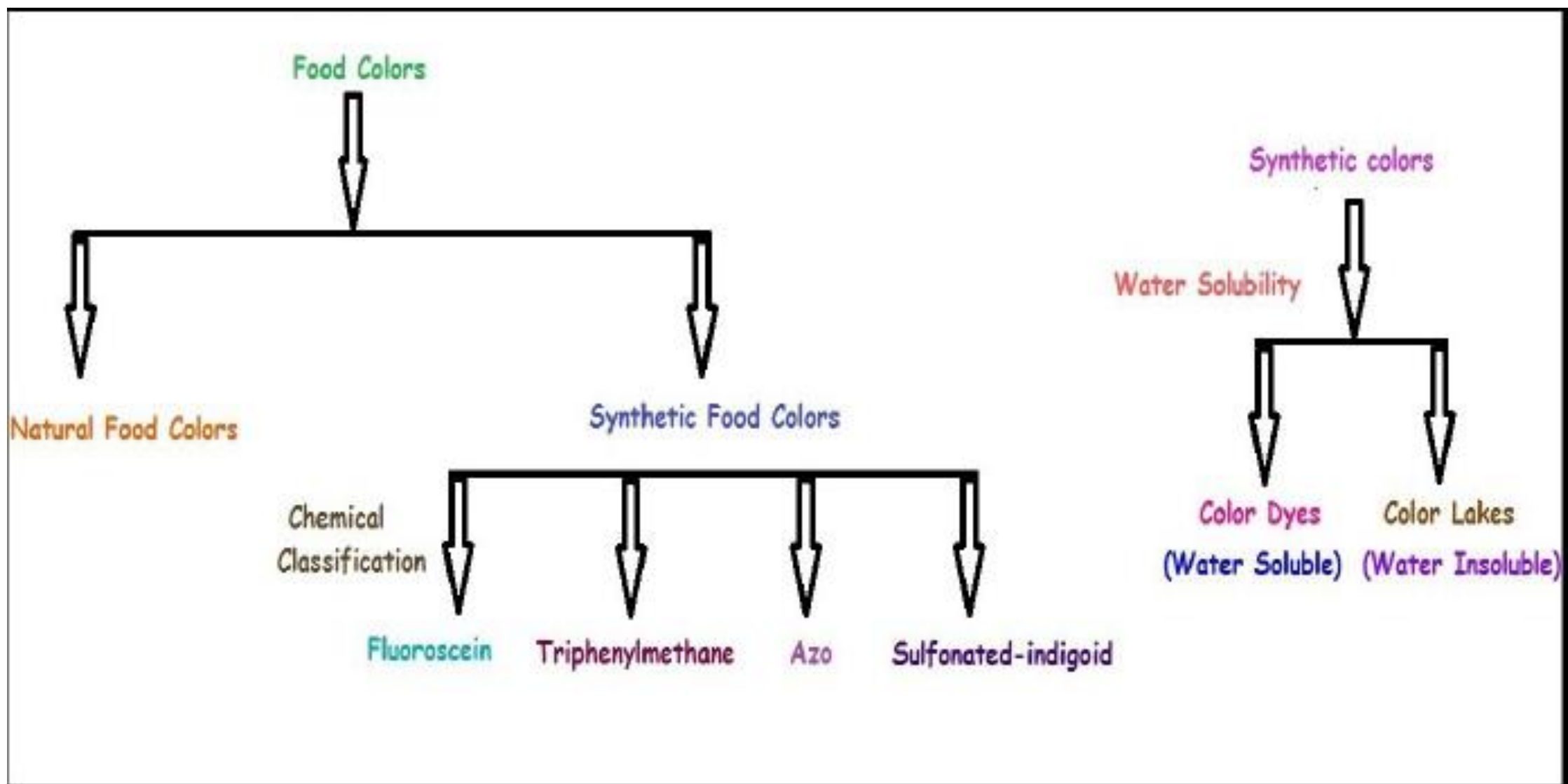


Table 2. Carotenoids widely used for food coloration and related details of food colorants exempt from certification by FDA.

Common name	E-number	Colour Index name	FDA	Structure
β -carotene	E160a	C. I. Food Orange 5	Natural and synthetic permitted	 20
bixin	E160b	C. I. Natural Orange 4	Annatto extract permitted	 21
capsanthin	E160c	C. I. Natural Red 34	Paprika and paprika oleoresin permitted	 22
lycopene	E160d	C. I. Natural Yellow 27	Lycopene, tomato extract or concentrate permitted	 23
lutein	E161b	--	Tagetes (Aztec marigold) meal and extract permitted for chicken feed only	 24



- **Natural colorants**

- Obtained from natural sources
- Processed by physical means
- May be less stable
- Less bright
- Not uniform
- No health harm
- Good consumer acceptability
- Expensive
- High microbiological contamination

- **Synthetic colorants**

- Obtained by chemical reaction
- High stability to light, O₂, pH
- Highly colored
- Color uniformity
- Health problems
- Consumer acceptability questionable
- Less costly
- Low microbiological contamination

Color Dyes are water-soluble chemicals which exist in the form of powders and liquids. They are used in bakery, confectionery, dairy and beverage industries.

Color Lakes are water-insoluble chemicals and used for coloring foods involved in oil/fat emulsions. Some examples include cake mixes, chips, candies and chewing gums.



Synthetic Colors used in
Confectionery items (Color Dyes)



Synthetic Colors used in
chips, chewing gums (Color Lakes)

Color Dyes & Color Lakes

Based on Certification, the synthetic colors are classified as “Color Dyes” and “Color Lakes”.

In the USA, the following seven artificial colorings are permitted in food as of 2007:

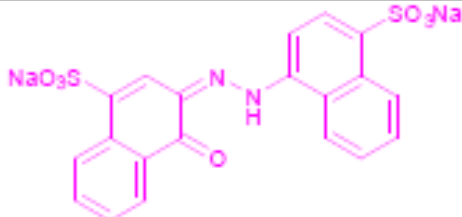
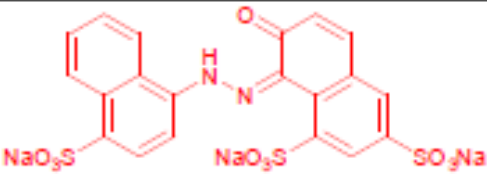
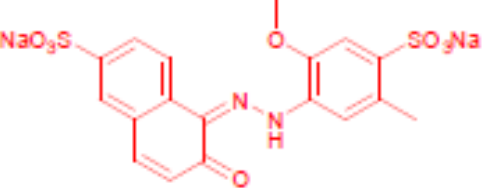
- FD&C Blue No. 1 - Brilliant Blue FCF, E133 (Blue shade)
- FD&C Blue No. 2 - Indigotine, E132 (Dark Blue shade)
- FD&C Green No. 3 - Fast Green FCF, E143 (Bluish green shade)
- FD&C Red No. 40 - Alura Red AC, E129 (Red shade)
- FD&C Red No. 3 - Erythrosine, E127 (Pink shade)
- FD&C Yellow No. 5 - Tartrazine, E102 (Yellow shade)
- FD&C Yellow No. 6 - Sunset Yellow FCF, E110 (Orange shade)

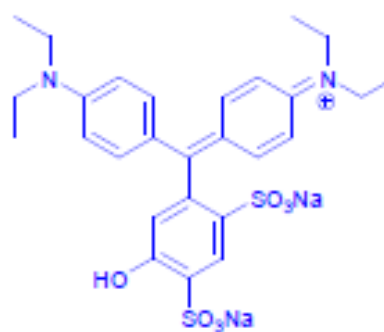
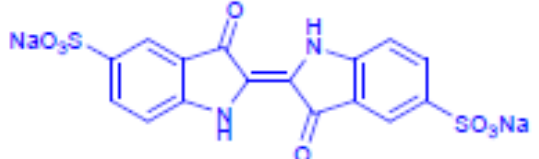
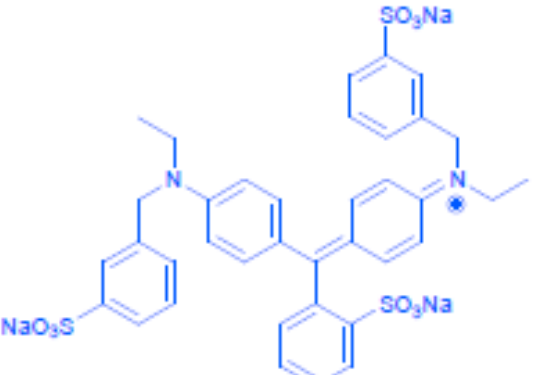
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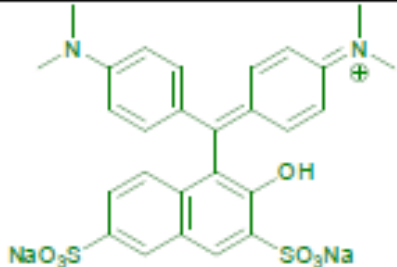
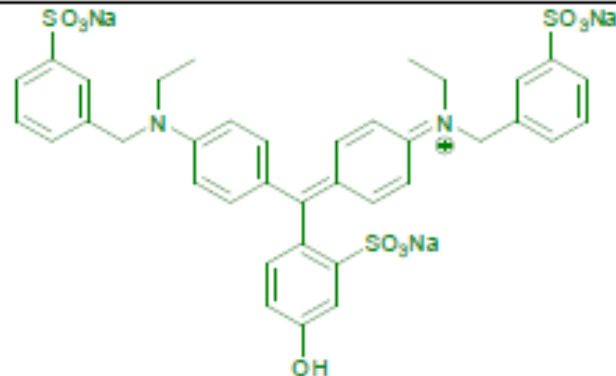
Blue No.1	Beverages ,dairy products ,icings ,syrups
Blue No.2	Baked goods ,snacks ,cereals ,ice creams ,cherries
Green No.3	Beverages ,puddings ,ice creams ,sherbets ,dairy products
Red No.40	Gelatine ,puddings ,dairy products
Red No.3	Cherries in fruit cocktails ,canned fruits for salads
Yellow No.5	Custards ,beverages ,ice creams
Yellow No.6	Cereals ,backed goods ,snacks ,ice creams ,dessert powder

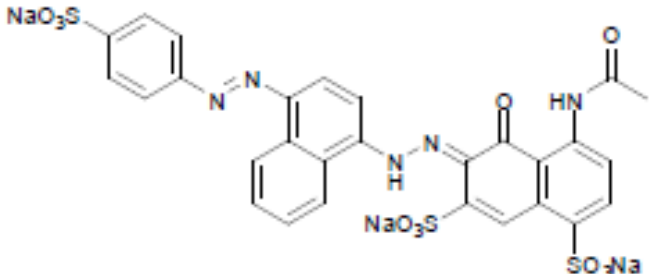
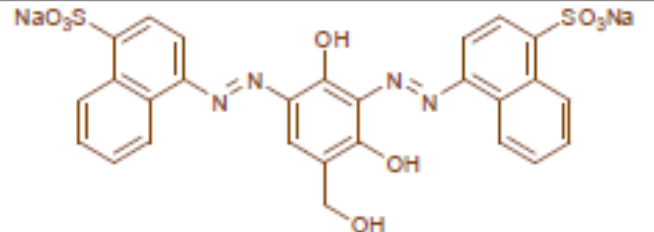
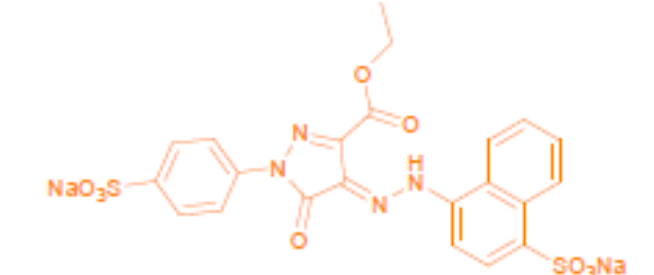
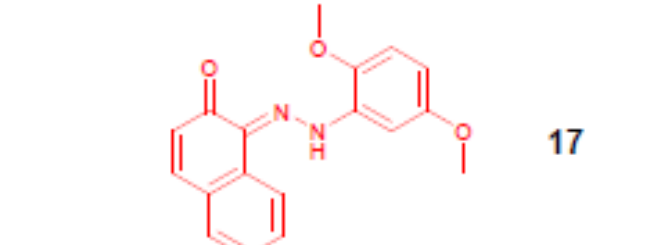
Table 1. Synthetic food colorants currently permitted for us by FDA.

Commercial name	E-number	FD&C	Permitted in EU or US	C.I. Name	Structure
Tartrazine	E102	Yellow No. 5	Both	C. I. Food Yellow 4	<p>3</p>
Quinoline Yellow WS	E104	None	EU only	C. I. Food Yellow 13	<p>4</p>
Sunset Yellow FCF	E110	Yellow No. 6	Both	C. I. Food Yellow 3	<p>5</p>

Carmoisine	E122	None	EU only	C. I. Food Red 3	 6
Ponceau 4R	E124	None	EU only	C. I. Food Red 7	 7
Allura Red AC	E129	Red No. 40	Both	C. I. Food Red 17	 8

Patent Blue V	E131	None	EU only	C. I. Food Blue 5	 <p>9</p>
Indigo Carmine	E132	Blue No. 2	Both	C. I. Food Blue 1	 <p>10</p>
Brilliant Blue FCF	E133	Blue No. 1	Both	C. I. Food Blue 2	 <p>11</p>

Green S	E142	None	EU only	C. I. Acid Green 50	 <p style="text-align: right;">12</p>
Fast Green FCF	E143	Green No. 3	US only	C. I. Food Green 3	 <p style="text-align: right;">13</p>

Brilliant Black BN	E151	None	EU only	C.I. Food Black 1		14
Brown HT	E155	None	EU only	C. I. Food Brown 3		15
Orange B	None	Orange B	US only ^a	C.I. Acid Orange 137		16
Citrus Red No. 2	None	Citrus Red No. 2	US only ^b	C.I. Solvent Red 80		17

REGULATION OF FOOD COLORS

In India

- ✓ control committee for food standards (CCFS)
- ✓ National Codex Committee, under Health Ministry, takes regulations according to PFA act
- ✓ Laws of FDA & British food laws are taken as the basis

HOW FDA ACT

- ✓ Regulate
- ✓ Evaluate
- ✓ Certify
- ✓ Approve

How FDA act...Regulates

- ✓ Types of foods to which color additives to be added
- ✓ Which colorant to add
- ✓ How much to add Labeling, ie, how it should be identified on food label

How FDA approve and certify

- ✓ Monitor quality , consistency, strength & safety of color prior to its use in food
- ✓ Animal studies & studies in humans are conducted
- ✓ Monitor the extent of consumption & any new researches on its safety

E number

- ✓ Are number codes for food additives, usually found on food labels, in European Union
- ✓ The numbering scheme follows that of the International Numbering System(INS) as determined by the Codex Alimentarius committee
- ✓ Accepted internationally, with out the E,

E value classification by numeric range 100–199 Colours

100–109	yellows
110–119	oranges
120–129	reds
130–139	blues & violets
140–149	greens
150–159	browns & blacks
160–199	others