Paper No.: 13

Paper Title: Food Additives

Module – 5 Colourings for the food industry – Synthetic colours

5.1 Introduction

Colour is an important feature of food, and consumers often associate it with quality, taste, and flavor. Colourants were used for centuries to improve the appearances of foods, cosmetics, and clothing. Until the 19th century, the colourants used were of natural origin like henna for hair dying or saffron for providing colour and flavor to food. During the 19th century, inorganic colour compounds such as copper sulfate and red lead were used to colour foods, from tea leaves to cheese. At the same time, the rapid development of chemical synthesis led to the industrial production of a large number of organic synthetic colourants. More than 80 synthetic colourants were available, mostly derived from coal tar and petroleum, and some were used as food additives without proper safety evaluations. Several reported health problems, intoxications, and even deaths were related to the consumption of foods containing synthetic colourants.

Despite the new orientation toward utilization of natural compounds, synthetic colourants are still used as food additives. Synthetic colourants are easy to produce, stable, less expensive, and have better colouring properties than natural colourants. Still, synthetic colourants are considered to belong to concern a category that requires the strictest safety evaluations. The use of synthetic colourants is subjected to strict rules.

Synthetic colourants or dyes are attractive to the food industry because they are superior to natural colourants in tinctorial power, consistence of strength, range and brilliance of shade, hue, stability, and ease of application. Synthetic colours provide a larger spectrum of colours. They also have lower prices and greater availability. A various food colorant with colour produced by them are given in Table 1.

Table 1: Synthetic Food Colourants

Food Colourant	Colour
Allura Red AC	Yellowish red
Amaranth	Red
Azorubine (Carmoisine)	Red

Brilliant Blue FCF	Greenish blue
Brilliant Black BN	Black
Brown FK	Brown
Brown HT	Brown
Citrus Red No. 2	Red
Erythrosine	Bluish pink
Fast Green FCF	Bluish green
Fast Red E	Red
Green S	Green
Indigotine	Deep blue
Lithol Rubine BK	Deep red
Orange B	Orange
Patent Blue V	Blue
Ponceau 4R (Cochineal Red A)	Red
Red 2G	Red
Quinoline	Yellow Yellow
Sunset Yellow	Reddish yellow dye and lake
Tartrazine	Lemon yellow dye and lake

Previously, several different colourants were used in foods. However, there has been a decrease in the number of synthetic colourants permitted in many countries. Today, the types of colourants allowed vary greatly among countries, which reflect the different opinions about their toxicity. However, there is a trend toward using fewer synthetic colourants. It is hoped that the trend to international standardization of food colourants will gain momentum. In order to prevent indiscriminate use many countries limit the types, uses, and amounts of colourants permitted in foods. Since different countries allow the use of specific food colourants, it is possible that foodstuffs may be imported into a country that forbids the colouring agent present in the product.

Therefore, methods capable of identifying and quantifying several colours simultaneously are desired in order to verify compliance to regulations. Information on the levels of these compounds in foods is also important to assess where the dietary intake stands compared to the ADI. According to the JECFA (Joint FAO/WHO Expert Committee on Food Additives), each country should verify periodically the dietary intake of colourants, and additives in general, to make sure that intake does not exceed the ADI.

5.2 Synthetic Food Colourants and Their Uses as Food Additives

A various synthetic food colourants and their possible uses in food matrix as food additives are summarized below.

Table 2: Synthetic Food Colourants and Their Uses as Food Additives

Colour	ADI According to JECFA	Utilization and Limits in Foods According to EU and US Regulation
Allura Red AC	0 to 7 mg/kg bw	Specific uses: bitter soda, bitter wine, other non-alcoholic flavored drinks alone or combined with other colourants (100 mg/l); luncheon meat (25 mg/kg), breakfast sausages with minimum cereal content of 6% (25 mg/kg); general uses: nonalcoholic flavored drinks (100 mg/l), candied fruits and vegetables (100 mg/l), red fruit preserves (200 mg/kg), confectionery (300 mg/kg), decorations and coatings (500 mg/kg), fine bakery wares (200 mg/kg), edible ices (150 mg/kg), flavored processed cheese (100 mg/kg), desserts including flavored milk products (150 mg/kg), sauces, seasonings, pickles, relishes, chutneys, and piccalillis (500 mg/kg), mustard (300 mg/kg), fish and crustacean pastes (100 mg/kg), precooked crustaceans (250 mg/kg), salmon substitutes (500 mg/kg), surimi (500 mg/kg), fish roe (300 mg/kg), smoked fish (100 mg/kg), extruded or expended snacks (200 mg/kg), other snacks (100 mg/kg), edible cheese rind (*quantum satis*), complete formula for weight control and nutritional supplements (50 mg/kg), liquid food supplement integrators (100 mg/kg), solid food supplement integrators (300 mg/kg), soups (50 mg/kg), meat and fish analogues based on vegetable proteins (100 mg/kg), other spirit beverages (200 mg/l), fruit wine, cider, perry, aromatized fruit wines (200 mg/l); FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with good manufacturing practice; JECFA: 50 mg/kg limit in milk and 300 mg/kg in other foodstuffs
Amaranth	0 to 0.5 mg/kg bw	Aperitif wines and spirit drinks including products with less than 15% alcohol (30 mg/l); can be used in combination with other colourants, but not to exceed 100 mg/l; fish roe (30 mg/kg)
Azorubine (Carmoisine)	0 to 4 mg/kg bw	Specific uses: americano (50 mg/l), bitter and wine, (50 mg/l); general uses: non-alcoholic flavored drinks (50 mg/kg), candied fruits and vegetables, red fruit preserves, confectionery, decorations and coatings, fine bakery wares (50 mg/kg), edible ices (50 mg/kg), flavored processed cheese, desserts including flavored milk products (50 mg/kg), sauces, seasonings, pickles, relishes, chutneys, and piccalillis, mustard, fish and crustacean pastes, pre-cooked crustaceans, salmon substitutes, surimi, fish roe, smoked fish extruded or expended snacks, other snacks, edible cheese rind, complete formula for

		weight control and nutritional supplement, liquid food supplement integrators, solid food supplement integrators, soups, meat and fish analogues based on vegetable proteins, other spirit beverages, fruit wines, cider, perry, aromatized fruit wines; where not mentioned, max. level may not exceed amounts mentioned for Allura Red AC
Brilliant Blue FCF	0 to 10 mg/kg bw	Processed mushy and canned garden peas (20 mg/kg) and all foodstuffs and amounts mentioned for Allura Red general use; FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: amount limited to 150 mg/kg in fermented milk and 100 mg/kg in baked goods
Brilliant Black BN	0 to 1 mg/kg bw	All foodstuffs and amounts mentioned for Allura Red general use
Brown FK	No ADI allocated	Kippers (20 mg/kg)
Brown HT	0 to 1.5 mg/kg bw	All foodstuffs and amounts mentioned for Azorubine general use
Citrus Red No. 2	Not to be used	Permitted only for colouring skins of oranges, not intended for processing; max. concentration is up to 2 ppm of whole fruit.
Erythrosine	0 to 0.1 mg/kg bw	Cocktail and candied cherries (200 mg/kg), Bigarreaux cherries in syrup and in cocktails (150 mg/kg); FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: can be used up to 300 mg/kg in various foods.
Fast Green FCF	0 to 25 mg/kg bw	FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: can be used up to 100 mg/kg in various foods.
Fast Red E No	No ADI allocated	-
Green S	No ADI allocated	Specific uses: jam, jellies, marmalades, other similar fruit preparations including low-caloric products (100 mg/kg), processed mushy and canned garden peas (10 mg/kg); can be used in all other foodstuffs in amounts mentioned for Allura Red general use.
Indigotine	0 to 5 mg/kg bw	All foodstuffs and amounts mentioned for Allura Red general use. FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: can be used up to 300 mg/kg in various foods.
Lithol Rubine	No ADI allocated	Edible cheese rind,
Orange B	Not listed	Approved only in US; may be safely used only for colouring casings or surfaces of frankfurters and sausages, not more than 150 ppm by weight of finished food.
Patent Blue	No ADI allocated	All foodstuffs and amounts mentioned for Allura Red general use
Ponceau 4R (Cochineal	0 to 4 mg/kg bw	Specific use: americano (100 mg/l), bitter and wine (100 mg/l), jam, jellies, marmalades, similar fruit preparations including

Red A)		low-caloric products (100 mg/kg), chorizo sausage, salchichon (250 mg/kg), sobrasada (200 mg/kg); all foodstuffs and amounts mentioned for azorubine general use
Red 2G	0 to 0.1 mg/kg bw	Breakfast sausages with a minimum cereal content of 6% (20 mg/kg), burger meat with minimum vegetable or cereal content of 4% (20 mg/kg)
Quinoline Yellow	0 to 10 mg/kg bw	Specific use: americano (100 mg/l), bitter soda and wine (100 mg/l), jams, jellies, marmalades, similar fruit preparations including low-caloric products (100 mg/kg); all foodstuffs and amounts mentioned for Allura Red general use
Sunset Yellow FCF	0 to 2.5 mg/kg bw	Specific uses: bitter soda and wine (100 mg/l), jam, jellies, marmalades, similar fruit preparations including low-caloric products (100 mg/kg), sobrasada (135 mg/kg); all foodstuffs and amounts mentioned for Allura red general use; FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: can be used up to 300 mg/kg in various foods
Tartrazine	0 to 7.5 mg/kg bw	Specific use: americano (100 mg/l), bitter soda and wine (100 mg/l), processed mushy and canned garden peas (100 mg/kg); all foodstuffs and amounts mentioned for Allura Red general use; FDA: can be safely used generally for colouring foods (including dietary supplements) in amounts consistent with GMP; JECFA: can be used up to 300 mg/kg in various foods.

ADI = acceptable daily intake, estimate of amount of a substance in food or drinking water, expressed as mg/kg body weight, that can be ingested daily over a lifetime without appreciable risk (weight of standard human = 60 kg);
bw = body weight.

5.3 Synthetic Colour and Health

Food colours are being used in beverages, desserts, jams, jellies, sauces, pickles, cosmetics, toothpaste, etc. In addition, medicines, including tablets, capsules and syrups are dyed with food colours. Many of the food industries and other related companies as well as restaurants have relied on colourants in order to sell their products. However, there is a question on the safety and nature of colourants which have been used for these purposes.

Numerous studies have demonstrated the dangers of artificial colourants in food, which include the possibility of onset of attention deficit disorder (ADD), inhibition of the immune system, hyperactivity and allergic reactions. In addition, the use of non-permitted colours or overindulgence of permitted colours may also cause thyroid tumours, urticaria (hives) dermatitis, asthma, nasal congestion, abdominal pain, nausea, eczema, liver and kidney damage and cancer.

In view of the above, several food colourants have been banned in developed countries due to their toxicity observations on experimental animals. Table 3 shows some of the widely used synthetic colourants and their toxic effects.

Table 3: Some of the routinely using food colourants and their effects

Synthetic food colourant	Uses	Possible effects
Quinoline yellow	Sweets, pickles	Asthma, hyperactivity, rashes
Ponceau 4R	Biscuits, drinks	Allergy, intolerance
Allura red	Soft drinks	Hypersensitivity
Azorubine	Sweets	Allergy, hyperactivity
Tartrazine	Sweets, biscuits	Asthma, hyperactivity, rashes
Sunset yellow	Ice creams, biscuits, Sweets	Gastric problem, allergy
Erythrosine	Toothpaste, Cough syrup	Hyperactivity, allergy

5.4 Synthetic Food Colourants and their Application as Food Additives suggested by FSSA (India)

Synthetic food colourants and their possible food application in India with usage limit (singly or in combination) suggested by Food Safety and Standard Authority (India) are summarized in Table 4.

Table 4: Synthetic Food Colourants and their Application as Food Additives suggested by FSSA (India)

Food Applications	Synthetic Colour								
	Ponceau 4R	Carmoisine	Erythrosine	Tartrazine	Sunset Yellow FCF	Indigo carmine	Brilliant blue FCF	Fast green FCF	Titanium Dioxide (TiO_2)
Biscuits	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Powdered Soft Drink concentrate mix / fruit beverage drink	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.

Custard Powder, Jelly Crystal, ice candy, Thread, Candies, Wafers	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Flavour Emulsion, Flavour Paste (for carbonated and non carbonated water only)	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Shrimps	30 mg/kg	-	-	30 mg/kg	30 mg/kg	-	-	-	-
Thermally Processed Fruits (Plums, Chiku, Guava, Strawberries, Raspberries, Lichi, Kenu, Custard Apple, Pomegranate, Papaya)	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Carbonated Fruit Beverages or fruit drinks, Carbonated Water	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Soft drink concentrate (Liquid/ powder)	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Fruit based Beverage Mix. / Powdered Fruit based Beverage	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-

Candid Crystallised & Glazed Fruit	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Squashes, Crushes, Fruit Syrups, Sherbets, Cordial and Barley Water	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Ginger Cocktail (Ginger Beer and Gingerale	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Cherry (Thermally Processed)	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Jam/Jellies/Fruit Cheese	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Fruit Marmalades	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-
Fruit Bar/Toffee	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Thermally processed fruit beverages/ Fruit drinks/ ready to serve fruit beverages	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Thermally processed vegetables (Green Beans/ Wax Bean, Green Peas, Processed Peas)	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	200 ppm max.	-

Soups, Soup powder, Fruit powder, Vegetable powder, Instant Fruit/ Vegetable Chutney Mixed (dry), Culinary Powder, Seasoning Mixed Powder	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Filled Chocolate	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Sugar based/ Sugar free confectionery	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	10000 ppm max.
Lozenges	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Chewing gum/ Bubble gum	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	10000 ppm max.
Flavoured and fruit Yoghurt	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-
Ice cream, Kulfi, Dried icecream mix, Frozen desserts, Milk ice, Milk lollies , Ice candy	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	100 ppm max.	-