



# The Effects of Colorants Used in Hotel Kitchens in Terms of Child Health

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## Abstract

Colour loss of food may occur during storage, transport or processing. The fact that the physicochemical properties of artificial colorants are superior to those of natural colorants have led to a widespread use in the food industry. Artificial colorants have been reported to cause various health problems. It has been noted that candies and fruit drinks used in artificial colorants cause behavioural disorders in children. Children may consume more artificial food colorants because they consume more colouring-containing confectionery and beverages than adults. In recent years, various colorants have been used especially in big hotel kitchens both for decoration purposes and for gaining children's attraction. As the product range in the kitchen expands, the artificial decor material used increases. The occupancy rate of the hotels preferred by the families with children is also increasing with the opening of the tourism season. In particular, the use of artificial colorants should be controlled and reduced in such kitchens. In addition, natural colorants should be preferred to artificial colorants. These colorants can be readily purchased, as well as can be prepared in the kitchen. Thus, while the criteria for child-friendly tourism management are set, the commitment to use homemade and natural ones instead of ready-made and artificial ones, especially colouring materials used in children's menus should be regarded as a plus point for that business.

**Keywords:** nutrition, child health, colorants, gastronomy, hotel cuisine.

## 1. Introduction

The colours of the foods are an important factor in the formation of the consumer's preference. The usual colour is required for the foods to be consumed. Raw material is discoloured during storage, transport or processing. Colorants are used to make food more visually appealing or to correct these colour change changes that occur. (Batu and Molla, 2008; Boğa and Binokay, 2010).

It has been a major influence of the social, geographical, ethnic and historical backgrounds of the communities in terms of consumer acceptability of colour materials which can be used at different stages from raw to final product. For example; consumers in the America and Europe that have reached advanced technological level, consumers in the evening dinner blue soup, yellow meat, red potatoes etc. with different colours and taste appeal. Because consumer acceptability is being more efficient factor in marketing nowadays (Yılmaz, 1999).

The International Codex Alimentarius Commission defines colorants as "substances that regulate the colour of the food or are added to give colour". Many substances with colouring properties have different physical, chemical and physicochemical properties due to differences in their chemical structure, and these properties determine what type of products and for what purpose they are to

be used. The adverse effects of today's applied food processing techniques on the appearance characteristics of foods reveal the need to colour foods with technological reasons. The use of artificial colorants in foodstuffs has increased rapidly and the interest in natural colorants has decreased because of their strong colour tones and colour intensities compared to natural colorants, high stability at different pH levels, ease of application and cheapness. (Kimyaevi Org, 2018).

Usage quantities of artificial colorants which are widely used for colouring food are important for consumer health. The widespread of the use artificial colorants increases the risks to human health and even the economy (Atli, 2000).

Studies on the health effects of artificial colorants have shown that these colorants lead to various disorders. Many artificial colours, especially in child nutrition, have been found in many diseases such as cancer, chromosomal disorders and asthma, especially attention deficit and behavioural disorders (Omaye, 2004; McCann et al. 2007).

As well as the opening of the tourism season, the occupancy rate of the hotels preferred by the families with children is also increasing. Colorants are used intensively in such kitchens to attract children and make them more attractive. It is used more often in this type of kitchens because it is cheaper than natural ones, its shelf life is longer and its wider colour range is available.

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The use of these artificial colorants should be controlled and reduced in hotel kitchens. The control of colorant usage in food plants is periodically carried out by the relevant ministry officials. However, the absence of such a control mechanism in hotel kitchens causes permissiveness in the use of artificial colorants. In addition, natural colorants should be preferred to artificial colorants. These colorants can be readily available, as well as in the kitchen. Thus, while the criteria for child-friendly tourism management are determined, the commitment to use homemade and natural ones instead of ready-made and artificial, especially for colouring foods used in children's menus, should be regarded as a plus point for that business.

## **2. Usage Colorants in Food**

The colours of natural foods are due to the substances expressed as pigments. The basic requirement for colouring food is that the applied food processing techniques have negative effects on the appearance characteristics of foods (Karaali and Özçelik, 1993).

The safety of foodstuffs is determined by changes in colours (Erdal and Ökmen 2013). These changes are based on bad processes and incorrect transport methods. At the same time, unnatural products (green cheese or blue drink) are often rejected by consumers. (Clydesdale, 1993). For this reason, colour serves as a precaution against the identification of primer of food and the consumption of degraded foods (Stich, Chaundry and Schnitter, 2002). Many studies on the subject have revealed that there is a positive relationship between colour and flavour. In sensory terms, colour creates an expectation on flavour. In a study conducted on this subject, the flavours of white chocolate-flavoured and brown vanilla-flavoured ice creams presented to trained panellists were sensed by almost all panellists as inverse, white-coloured ice cream was rated as vanilla, brown ice cream as chocolate (Kimyaevi Org, 2018).

The main reasons for using colorants in foods are:

- To compensate for colour loss due to light, air, temperature and storage conditions,
- Making food more attractive and appetizing,
- Providing colour to colourless foodstuffs,
- To ensure that consumers know products in a visible way (Barrows, Lipman and Balley, 2003).

There are several organizations authorized to standardize stages such as processing and packaging of food and investigating the effects on human health. These organizations; The Food Codex Commission (CAC), The Codex Committee on Food Additives and Contaminants (CCFAC), The Joint FAO/WHO Expert Committee on Food Additives (JECFA). The use of colorants in food industry is subject to stringent legal provisions in all developed countries and a wide range of toxicity tests (detection of acute, subchronic and chronic toxicity, carcinogenicity, mutagenicity, teratogenicity, reproductive toxicity, accumulation in the body, bioenergetics and immunological effects etc.). Existing toxicological data are evaluated and then verified in species. Toxicity is observed from six species and at least three must be mammals. Most of the tests use small rodents (mouse, rat, guinea pig, etc.) as well as special breed rabbits, dogs, cats or pigs that are particularly close to the physiology of the human body (Hallagan, Allen and Borzelleca, 1995; Kumar et al., 2015; Magnuson et al., 2013). Preclinical studies are undertaken to determine the NOAEL value, which is

defined as the highest concentration that does not exhibit the morphology, functional capacity, developmental or life-sustaining side effects of the target organism, and the potential toxicity of the food additive is determined. The value obtained from these clinical data is divided by the safety factor (usually 100 is chosen). The safety factor varies for animal models individually. The value found is expressed as ADI (Acceptable Daily Intake). This value represents the amount of food additive that can be consumed on a daily basis without posing a significant risk for consumer health. It is considered that certain nutritional habits of certain consumer groups will not exceed the ADI value. The values set by the regulatory authorities can not completely eliminate the potential negative reaction to a particular substance, especially in terms of vulnerable or hypersensitive individuals. However, even in such cases, no anaphylactic reactions likely to occur after ingestion of the colouring agent in the food, as well as any threat to life, should be established (Amchova, Kotolova and Ruda-Kucerova, 2015; Duffus, Nordberg and Templeton, 2007). The ADI value is not invariant and can be reduced or increased according to new research data.

In addition to being allowed to use a colorant in foods, it is also necessary to specify which product will be more suitable for use. For the same product, colouring materials with different structural properties can be used. Colorants used in foods are usually divided into two groups; soluble and insoluble (Amchova et al., 2015). Soluble colorants can be classified as natural and artificial. Natural colorants are derived from various foodstuffs or other natural substances. For example, riboflavin (E101), chlorophyll (E140), carotene (E160a), betalaine (E162) or anthocyanin (E163) etc. Naturally origin colorants are not very stable as they are affected by heat and pH changes and can be characterized by their own physiological activities. Artificial colorants are produced by chemical synthesis, but are naturally non-existent and all are certified. Originally obtained from coal tar and highly purified petroleum products. The group of artificial organic colorants are derived from azo-dyes, xanthan, chinylin and anthraquinone dyes, which generally have a denser and permanent colour than natural ones, do not give any taste to the product and are generally more stable. Insoluble colorants are called pigments. These are highly stable colours that exhibit good coating properties and are also insoluble in common solvents. The pigments may be inorganic with a limited colour range, such as white titanium dioxide, calcium carbonate, red iron oxide and black adsorbent carbon, and the like. Organic pigments are usually in the form of lacquers which are insoluble complex salts of water-soluble azo-dyes in a wide colour palette. The fact that the physicochemical properties of artificial colorants are superior to those of natural colorants cause them to find a wide use in the food industry (Kimyaevi Org, 2018).

After the adverse health effects of artificial colorants used in foods for many years, both the preferences of scientists and consumers have focused on natural colorants (Wissgott and Bortlik, 1996).

## **3. The Usage Areas of The Artificial Colors in Foods**

Artificial colorants are used especially in the production of foodstuffs with industrial shelf life. These colorants, each with a different source and chemical structure, can produce different colours in different colour ranges (Table 1). Many colours can be obtained through these colorants. For example for red colour, Amaranth, Erythrosine, Ponceau 4R, Allura Red 40,

Cantaxanthin, Carmonin; for orange colour  $\beta$ -Carotene,  $\beta$ -apo-8-carotenal, Annatto, Paprika, Sunset Yellow; for yellow colour Riboflavin, Curcumin, Tartrazine, Saffron, Lutein, Turmeric; for green colour Chlorophyll (copper complex and sodium-potassium salts), Brilliant green; for blue colour Brilliant blue, Indigo blue, Indigo Carmine, Patent blue; for brown colour Caramel, Brown FK, Brown HT; for black colour Brilliant black, vegetable carbon, etc. (Karaali and Özçelik, 1993).

Artificial colorants are used at a remarkable level especially in beverages and snacks consumed intensively by children. The use of colour materials in non-alcoholic beverage industry is quite common (Özcan, Artık and Üner, 1997). Other colorants such as Carmicin, Amaranth, Allura Red, Sunset Yellow and Tartrazine, Ponceau 4R, Brown HT, Brilliant Blue, Green S, Quinolin Yellow and Indigo Carmine are also used in the drinks. Artificial colorants are used in many fruit flavoured beverages, while cola and beans are coloured with caramel (Borcaklı, 1999).

Colorants used in the colouring of confectionery products having a very wide range of colours should be stable against the boiling temperature of the sugar (150°C), against the concentration of sulphur dioxide in the flavourings, sugar and glucose groups. Carmocin, Ponceau 4R, Amaranth, Allura Red, Sunset Yellow and Tartrazine are the most commonly used artificial colorants in candies. Colorants must have high colour stability to high temperatures (250°C), carbon dioxide and, in some cases, alkali baking powders, such as in cakes, biscuits, waffles and cereal products. In accordance with these properties, Ponceau 4R, Allura Red, Sunset Yellow, Tartrazine and Brown HT are the most commonly used artificial colorants in baked

products. It is also possible to add dyes dissolved in glycerine or propylene glycol to the pie cores and coatings. In high-fat mixtures, a small amount of lecithin is added to increase the solubility. Also, the coloured sugars used in cake decorations are obtained by adding the lakes to the powder sugar in dry state (Karaali and Özçelik, 1993; Kimyaevi Org, 2018).

Colorants used in dairy products must have high pasteurisation temperatures and high light stability (Atlı, 2000). Carmicin, Ponceau 4R, Amaranth, Allura Red, Sunset Yellow, Tartrazine, Erythrosine and Indigo Carmine are frequently used artificial colorants in dairy products. In icing, colorants are added in liquid form immediately after pasteurization. Artificial colorants are mostly used in all kinds of ice cream. Since artificial colorants in cheese, butter and margarine are not stable enough, natural colorants such as oil-soluble starch and  $\beta$ -carotene are preferred (Özcan et al., 1997). Carmicin, Ponceau 4R, Allura Red, Tartrazine and Erythrosine are frequently used in meat products such as sausage, bacon, meatballs and roast (usually salami, sausage and ham) which are resistant to sulphur dioxide in the form of bisulphite or meta-bisulphite. Dry powder beverages, desserts, creamy desserts, garbage and sauces should be used with high-resolution, light-resistant colorants (Atlı, 2000). Colors used in this type of food should be stable against moderate heat treatments. Carmocin, Ponceau 4R, Amaranth, Allura Red, Sunset Yellow and Tartrazine are the most commonly used artificial colorants. In order to obtain maximum colour in such products, the colouring agent must be dissolved well (Kimyaevi Org, 2018).

Table 1. Classification of food colorants in processed foods, with their

		Colorant Name	Code (EU/US)	Colour	ADI (EU/US) mg/kgbw	Product
Synthetic colorants	Azo Dyes	Allura Red	E129/FD&C Red No40	Red	7/7	Baked goods and desserts, donuts, gelatine (jelly,Jell-o), snacks, salad dressing, candies
		Amaranth	E123/FD&C Red No2	Red	0.8/-	Baked goods, tortillas, crackers, porridge, sauces, soups, jellies, confections
		Ponceau 4R	E124/-	Red	4/-	Sweets, jellies, desserts, tinned and canned fruits and foods, cakes, pastries, soups, soft drinks, canned beverages
		Tartrazine	E102/FD&C Yellow No5	Yellow	7.5/5	Baked goods and desserts, donuts, gelatine (jelly,Jell-o), snacks, salad dressing, candies
		Sunset Yellow	E110/FD&C Yellow No6	Yellow	2.5/3.75	Baked goods and desserts, donuts, gelatine (jelly, Jell-o), snacks, salad dressing, candies
	Non Azo Dyes	Erythrosine	E127/ FD&C Red No3	Red	0.1/2.5	Baked goods and desserts, candies, dairy products, snacks
		Brilliant Blue	E133/ FD&C Blue No1	Blue	10/12	Baked goods and desserts, donuts, gelatine (jelly, Jell-o), snacks, salad dressing, candies, beverages, dairy, ice cream
		Indigotin	E132/FD&C Blue No2	Blue	5/2.5	Baked goods and desserts, candies, breakfast cereals, ice cream, snacks
		Patent Blue	E131/-	Blue	15/-	Scotch eggs, certain jelly sweets, blue caracao, certain jelly varieties (though not in actual Jell-O brand products), among others
		Fast Green	FD&C Green No 3	Green	25/2.5	Baked goods, candies, beverages, dairy, ice cream, puddings
Natural colorants	Carmine	E120	Red	5	Baked products, dairy products and yogurt, cake icing, hard candies, ice cream, gelatine desserts, fruit syrups, jams,	
	Annatto	E160b	Orange-yellow	NS	Baked goods, dairy products and yogurt, popcorn oil, butter, ice cream, icings, snack, salad dressing	
	Saffron	E164	Yellow	NS	Risotto, paella, baked goods, pastry and plain biscuits	
	Turmeric	E100	Orange-yellow	1	Baked goods, dairy products and yogurt, ice cream, cakes, cookies, popcorn, candies, cake icings, cereals, sauces, gelatine	
	B-carotene	E160a	Orange	NS	Margarine, non-dairy creamers	
	Anthocyanins	E163	Red, purple	2.5	Non beverage drinks, ice cream, yogurt, fruit fillings, candies	
	Paprika	E160c	Red	NS	Baked goods, sausage, cheese sauces, condiments, salad dressings, snacks, icings, cereals	

Acceptable Daily Intake (Greenhawt and Baldwin, 2014)

## **4. Effects of Food Colorants on Child Health**

Usage quantities of artificial colorants which are widely used for colouring food are important for consumer health. Diversification of use increases the risks that may arise from human health and even from the economic point of view (Atli, 2000).

Studies conducted with experimental animals have shown that the pigments undergo metabolic changes in the digestive system, liver and stomach. They are under the influence of the dyes, digestive system enzymes and intestinal flora. Reductive cleavage of azo bonds in water-soluble dyes leads to amines, absorptions, metabolism, and elimination in the same way (Atli, 2000).

Concern has recently been raised that food colorants may contribute to the development of attention deficit hyperactivity disorder (ADHD) in children (Vojdani and Vojdani, 2015). In many studies, food additives, especially synthetic additives, have negative opinions about child health. These views support each other both clinically and experimentally. In particular, it has been determined that these additives cause behavioural disturbances in age groups with immune system deficient or depressed (Yörük and Central, 2016).

It was declared that colorants have been shown to cause disorders such as hypersensitivity, asthma, skin rashes, migraine, premature labour, cancer, thyroid tumour, chromosomal damage, aspirin sensitivity (Omaye, 2004). A large clinical study was published in the UK in 2007 evaluating the effects of two synthetic dye blends on the development of attention deficit hyperactivity disorder in children aged eight to nine years (McCann et al., 2007). This study assessed the effects of two different drinks stabilized with sodium benzoate on children in two different age groups at three and nine years of age. One of these drinks included Sunset Yellow, Azorubine, Tartrazine, Ponceau 4R and the other one included Sunset Yellow, Azorubine, Quinoline Yellow, Allura Red. The results showed a small clinical difference between the groups. There was a statistically significant relationship between intake of colorants and attention deficit and hyperactivity disorder development. For this reason, parents in the UK are warned about their children's food and drink consumption. (Bateman et al., 2004; McCann et al., 2007).

In a study on mice, after 3 weeks of amaranth and tartrazine dyes given orally at increasing doses starting at the 10 mg/kg body weight resulted in DNA damage to the colon of mice, after 24 hours of tartrazine given at doses of 2000 mg/kg body weight was determined that the colon cells damaged DNA of mice. It was suggested that sunset yellow dye has not caused statistically significant damage to the DNA of colonic cells (Sasaki et al., 2002).

In one study, a test was conducted to investigate genotoxic, cytotoxic and cytostatic potential in human peripheral blood cells from food dyes to amaranth, erythrosine and tartrazine 0.02-8 mM. Amaranth showed high genotoxicity, stochitcity and cytotoxicity (cell poisoning) at the highest concentration (8 mM). Erythrosine showed high cytotoxicity and cytostatic effect at 8, 4 and 2 mM. As a result, it has been determined that these food colorants have a toxic potential for human lymphocytes and are directly related to DNA (Mpountoukas et al., 2010).

Stevens et al. (2013), has experimented with food colorants on rats in different colours (red, blue, orange, yellow and green), especially in children's common foods. According to results, artificial food colorants cause to hyperactivity and increases hyperactivity in rats during the first month of life. In addition, positive developments were observed when artificial paints were drawn from the diets of children exhibiting attention deficit and hyperactivity behaviours. It is possible to inhibit artificial additives alternately in some test animals (Shaywitz B., 1997).

The amount of colorant approved for use by the FDA has increased by 5 times from 1950 (12 mg/person/day) to 2012 (68 mg/person/day) for both children and adults. This increase is parallel to the increase in consumption of processed foods such as baked goods, breakfast cereals, snacks and soft drinks (Stevens et al., 2013).

Some risky groups, such as obese children consuming more soft drinks and sweetened drinks than normal weight children, may be exposed to more food colorants (Kanarek, 2011). Children may consume more artificial food colorants as they consume more colouring-containing confectionery and beverages than adults (Stevens et al., 2013).

These studies emphasize that it is still possible to find out new and surprising pharmacological effects of food colorants (Amchova et al., 2015).

## **5. Usage Food Colorants in Hotel Kitchens**

Food colorants are used extensively in industrial kitchens as well as food industry. The occupancy rate of the hotels preferred by the families with children is also increasing with the opening of the tourism season. The expectation of the families of the children with their preferences varies day by day. According to the studies conducted, the most important subjects for the families of the children in the selection of the hotel management are the security, the presence of the children's pools, and the presence of the children's bed and the children's lockers in the rooms. In addition to these, the presence of children's menus, the importance of hygiene and the presence of handrails in the staircase are considered as other important child-friendly hospitality topics (Pekyaman and Emir, 2010).

The new concern of families in choosing a hotel is kitchens of hotels and to be evaluated them in terms of health. Colorants are used extensively in the kitchens of hotels to attract children and make them more attractive. It is used more often in this type of kitchens because it is cheaper than natural ones, its shelf life is longer and its wider colour range is available. In recent years, various colorants have been used especially in big hotel kitchens both for decoration purposes and for gaining the children's attraction. In these kitchens, as the range of products expands, the use of synthetic decor material is also increasing. The control of colorant usage in food plants is periodically carried out by the relevant ministry officials. However, the absence of such a control mechanism in hotel kitchens causes permissiveness in the use of artificial colorants. The use of artificial colorants should be controlled and reduced especially in such kitchens. In addition, natural colorants should be preferred to artificial colorants.

Natural colorants used in the food industry are obtained by traditional methods and/or by suitable physical processes from vegetables, fruits, plants and microbiological sources. These colorants can be readily purchased, as well as can be prepared in the kitchen. Healthier and visually rich foods can be produced by preferring natural sources such as beetroot for red or pink colour; chlorophyll rich clover nettle, spinach, parsley for green colour;

blackcurrant, cherry, red beet for red/blue colour; carrot, orange, saffron for yellow/orange colour; melanoid rich caramel for brown.

Thus, while the criteria for child-friendly tourism management are determined, the commitment to use homemade and natural ones instead of ready-made and artificial materials, especially for colouring materials used in children's menus, should be regarded as a plus point for that business.

## 6. Results and Advices

The contribution of colorants to the preparation of foods is an undeniable fact. Natural and artificial colorants are heavily used both in industrial food enterprises and industrial kitchens. Although the use of these colorants in permitted quantities does not create a health hazard, children are more likely to be more interested in colorant-containing foods and more likely to be exposed to the potential negative consequences of artificial colorants resulting in higher consumption.

The kitchens of the luxurious hotels that families choose show different presentations and different tastes at each meal for customers' summer holidays. Colorants play an important role in the diversification of these presentations. However, the absence of a control mechanism for the use of colorants in hotel kitchens causes the use of artificial colorants for chefs. In particular, the use of artificial colorants should be controlled and reduced in such kitchens. In addition, natural colorants should be preferred to artificial colorants. Thus, while the criteria for child-friendly tourism management are determined, the commitment to use homemade and natural ones instead of ready-made and artificial, especially for colouring foods used in children's menus, should be regarded as a plus point for that business.

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