WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP
Impact Factor 8.453
Volume 15, Issue 1, 456-477.
Review Article
ISSN 2277–7105

BEYOND THE LABEL: HEALTH CONCERNS OF ARTIFICIAL COLORS AND SWEETENERS

Asiya Shaik*[1], Swechha Gouravelli[2], Gudisela Geyasri[2], Gubbala Naga Vinay[2], Gogineni Sriram[2], Gorrekanti Sindhuja[2]

[1]Assistant Professor, Department of Pharmaceutics, Malla Reddy College of Pharmacy, Maisammaguda, Secunderabad, Hyderabad, 500100, Medchal District.

[2]B. Pharmacy, Department of Pharmaceutical Analysis, Malla Reddy College of Pharmacy, Maisammaguda, Secunderabad, Hyderabad, 500100, Medchal District.

Article Received on 04 Dec. 2025,
Article Revised on 25 Dec. 2025,
Article Published on 01 Jan. 2026,

https://doi.org/10.5281/zenodo.18093883

***Corresponding Author**
Asiya Shaik
Assistant Professor, Department of Pharmaceutics, Malla Reddy College of Pharmacy, Maisammaguda, Secunderabad, Hyderabad, 500100, Medchal District.

How to cite this Article: Asiya Shaik*[1], Swechha Gouravelli[2], Gudisela Geyasri[2], Gubbala Naga Vinay[2], Gogineni Sriram[2], Gorrekanti Sindhuja[2]. (2026) BEYOND THE LABEL: HEALTH CONCERNS OF ARTIFICIAL COLORS AND SWEETENERS. World Journal of Pharmaceutical Research, 15(1), 456–477.

ABSTRACT

This review comprehensively discusses artificial sweeteners and food color additives from the perspective of safety, legislation, and health impacts. First, it provides background information about artificial sweeteners, including historical development, major compounds such as saccharin, aspartame, and cyclamate, and the introduction of new alternatives like rare sugars. Further, the review discusses the physiological effects of artificial sweeteners, which include potential harmful effects on blood glucose levels, obesity, gut microbiota, cardiovascular health, and carcinogenesis. Additionally, it goes into discussion of the safety and adverse impacts of food colorants-including the regulatory standards-and underlines that synthetic food colorants, such as tartrazine and rhodamine B, may pose health risks. It concludes by calling for prudent intake, especially in children and pregnant women, and continued research to inform evidence-based diet recommendations and regulatory policy.

KEYWORDS: Artificial sweeteners, food colorants, rare sugar, diabetes, obesity, and cancer.

INTRODUCTION

Recent trends show a rise in diabetes and cardiovascular diseases (CVD), which is closely linked to consuming added sugars. High sugar intake is a major contributor to the global obesity epidemic, with over 1.9 billion adults classified as overweight and 650 million as obese in 2016. Since the 1970s, changing dietary habits, driven by globalization, have resulted in a high-sugar diet that promotes both obesity and CVD, and is also associated with increased cancer rates. Despite these risks, the food industry's aggressive marketing has shifted artificial sweeteners from simple sugar substitutes to products marketed as healthy alternatives.[1],[2],[3]

Artificial Sweeteners (ASs), also known as high-intensity sweeteners, offer a powerful sweet taste with minimal or no calories. Since the 1970s, the FDA has approved six ASs as food additives: Aspartame, Acesulfame potassium (Ace-K), Advantame, Sucralose, Neotame, and Saccharin. Additionally, naturally-derived sweeteners like steviol glycosides (from the stevia plant), monk fruit extracts, and Thaumatin are widely considered safe. The World Health Organization (WHO) recommends limiting free sugar intake to less than 10% of total energy intake, ideally below 5%.

Food colorants, also called color additives, are substances like dyes or pigments used to add color to foods and drinks. Research strongly indicates that a food's color significantly influences how we anticipate its flavor, affecting our brain's taste expectation even before we eat. Regarding regulation, the FDA authorizes nine certified food colorants in the United States, while the European Union permits sixteen. In India, the FSSAI has published lists of both natural and synthetic colorants, specifying their approved usage limits in Food Safety and Standards regulations released in 2009 and 2011.

ARTIFICIAL SWEETENERS

Non-nutritive sweeteners (Artificial Sweeteners or ASs) offer a significantly low-calorie alternative to traditional caloric sugars like sucrose, making them valuable tools in managing sugar intake and weight. The first widely recognized AS, Saccharin, was chemically synthesized in {1879}.[4] Remarkably, this compound is a derivative of petroleum, giving it a unique origin, and it is known to be approximately 200 to 700 times sweeter than common table sugar (sucrose), necessitating only tiny amounts to achieve the desired sweetening effect.

Global food safety concerning these additives is a high-priority function maintained by leading regulatory agencies such as the U.S. Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA). These bodies ensure that ASs do not pose long-term health risks, including cancer, when consumed within established limits. The FDA ensures this stringent safety standard by establishing the Acceptable Daily Intake (ADI) for each sweetener. The ADI is a quantifiable metric, defined precisely in {mg} per {kg} of body weight per day ({mg/kg/day}), representing the maximum amount deemed safe for daily consumption over an entire lifetime. Crucially, the ADI is designed to incorporate a massive safety margin: it is 100-fold lower than the No-Observed-Adverse-Effect Level (NOAEL)—the dosage of the sweetener that triggered the slightest toxic or adverse effects in extensive animal trials. For a new or existing sweetener to receive or maintain approval, the FDA must meticulously confirm that the anticipated typical human intake, known as the Estimated Daily Intake (EDI), reliably falls below this established, highly conservative ADI threshold. When the EDI is proven lower than the ADI, the sweetener is formally deemed safe for long-term human consumption.

The usage of these approved ASs is widespread and increasing globally, reflecting their successful integration into the modern diet, often found in diet beverages and nutritional products. This growing consumer preference is evidenced by robust market data: the global market value for artificial sweeteners reached a substantial $2.2 billion in 2020. Furthermore, internal usage data highlights significant consumption patterns within the United States, where high consumption rates among US adults (reported at over 41%) and children (at about 25%) were noted in the period between 2009 and 2012, underscoring their prominence in the food supply chain.[5]

Types of Artificial Sweeteners

The food and beverage industries utilize several major artificial sweeteners (ASs) (as outlined in Table 1). These non-nutritive substitutes offer intense sweetness without the caloric content of traditional sugar, and each possesses unique properties regarding stability and relative sweetness.

1. Saccharin

Pioneer Sweetener: Saccharin is historically significant, being one of the oldest artificial sweeteners in continuous use for approximately a century.

Calorie Content and Sweetness: It provides zero calories and offers intense sweetness, typically being about 300 times sweeter than common table sugar (sucrose). (See Figure 1 for its structure/representation).[6]

2. Acesulfame Potassium (Ace-K)

Thermal Stability: Ace-K is distinguished by its remarkable resistance to heat, exhibiting high thermal stability up to 250 Celsius.

Applications: Due to this stability, it is frequently used as an ingredient in baked goods where high temperatures are required. (See Figure 2 for its structure/representation).

Composition: It presents as a white, crystalline powder.[7]

3. Aspartame

Taste Profile: Aspartame is a popular and often-discussed sugar substitute known for closely mimicking the flavor profile of sugar.

Stability and Solubility: Although generally stable at high temperatures, a crucial characteristic is that its solubility in water increases with rising temperature. (See Figure 3 for its structure/representation).[8]

4. Sucralose

Popularity and Consumption: Sucralose stands out as one of the most heavily consumed sugar substitutes in the market.

Safety and Stability: It is considered highly stable and safe, making it appropriate for a wide range of uses, including high-temperature processes like baking.

Extreme Sweetness: Sucralose is exceptionally potent in terms of sweetness. It is up to 1,000 times sweeter than sucrose. Its sweetness level is also triple that of aspartame and Ace-K, and twice that of saccharin. (See Figure 4 for its structure/representation).[9]

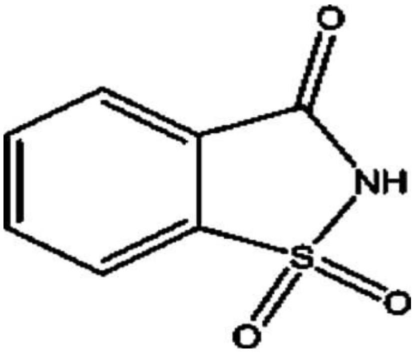


Figure: 1 Saccharin.

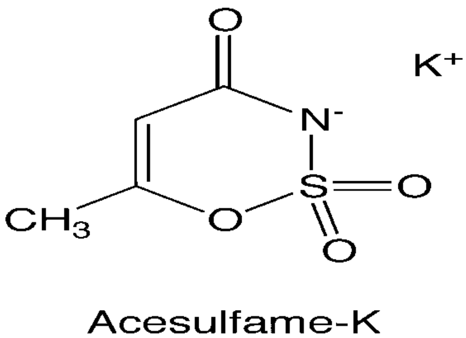


Figure: 2 Acesulfame Potassium.

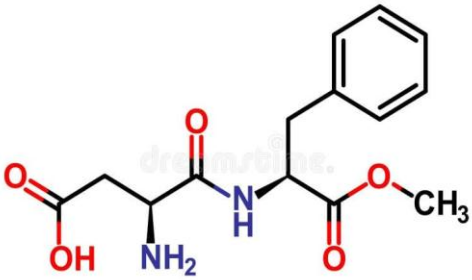


Figure: 3 Aspartame.

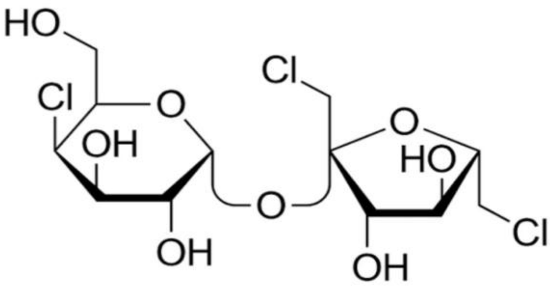
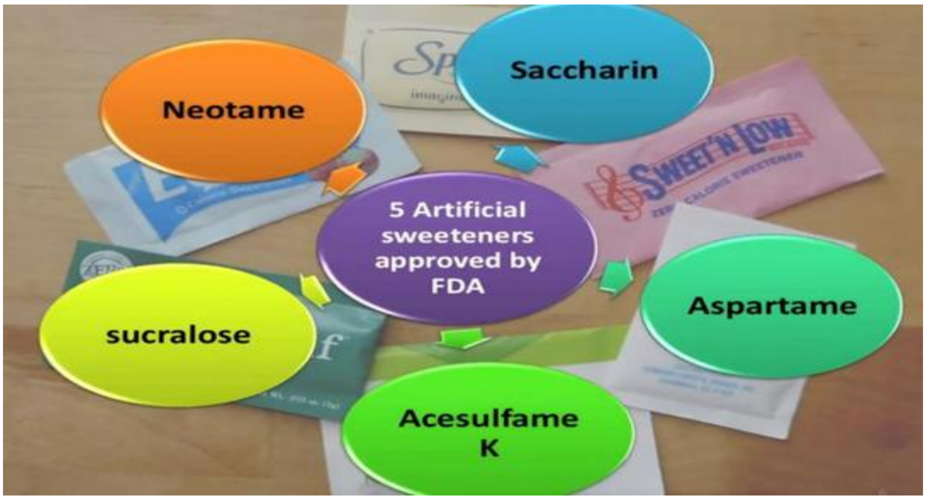


Figure: 4 Sucralose.

Table 1: Characteristic features of artificial sweeteners.

General name or common name	Most popular brand names	Intensity of sweetness compared to table sugar	Kilo calories per gram (kcal/g)	Uses
Saccharin	Sweet' N Low, Sweet Twin	300	0	Soft drinks, beverages, fruit drinks, powdered dessert mixes, Tabletop sweetener, Jams, Chewing gum, Baked goods, canned fruits
Acesulfame K	Sunett, Sweet One	180-200	0	Tabletop sweeteners (in packets), carbonated beverages, desserts which are frozen, Candies, Chewing gum, Dairy products, syrups and sauces
Aspartane	NaturaSweet, Natrataste, sugar twin, Equal	200	4	Tabletop sweetener (in packets), chewing gums, instant coffee and tea, gelatins, puddings, soft drinks, Yoghurt, Pharmaceuticals

Neotame	Neotame	10000	0	Baked goods, soft drinks, Chewing gum, Jams, Jellies, Puddings, Processed fruit and fruit juices
Sucralose	Splenda	600	0	Tabletop sweetener (in packets), baked foods, Frozen desserts and dairy products, Fruit juices, Chewing gum, gelatin, gelatin



Toxicological effects

The main physiological effects of artificial sweetener use are widespread, touching on: (Table:2)

The Glucose & Diabetes Dilemma: Artificial sweeteners can give you high blood sugar, but nothing as extreme as regular glucose. The truth is, the interaction of these things with the body's sugar-handling mechanism remains a bit of a mystery.

The Gut Connection: Some studies point a finger at the gut microbiome, suggesting that sweeteners alter your gut bacteria, and that, in turn, throws off glucose metabolism.

Conflicting Results: The science isn't settled; some studies find no impact on glucose regulation.

Issues Specific to Sweetener Type: It would seem that not all sweeteners are made equal. For example, some research has highlighted that saccharin may be more prone to glucose intolerance when compared to others.

Obesity: Of course, artificial sweeteners are a low-calorie substitute for sugar, but they may be less good for weight management than we might wish. For every 250 ml/day increase in artificially sweetened soft drinks, one meta-analysis found a 21% higher risk of obesity. The putative mechanisms of this are rather sneaky: they do not trigger the necessary fullness signals and thus may lead to overeating later in the day; they may even mess with your gut microbiome to affect metabolism and insulin sensitivity.[10]

Moreover, the sweetener agents are not just a problem regarding your waist. They also have been linked to an increased risk of cardiovascular disease-specifically ACEK and sucralose- and even a higher risk of cancer-aspartame and ACE K, though the latter finding comes with a caveat given the limitations of the study.

Possible Cancer Hazard: Aspartame & Cyclamate Several years ago, cyclamate was prohibited (in 1970), owing to apprehensions of its carcinogenicity, although these have not been substantiated in human studies. Aspartame has also been under suspicion, mainly because of its decomposition product diketopiperazine and the possibility of cancer-promoting nitrosated compounds when combined with dietary nitrates.[11]

Alterations in Gut Health: Artificial sweeteners have the potential for disrupting the gut microbiota, one of the important bacterial communities. Research has shown that they could lead to dysbiosis by elevating the Firmicutes/Bacteroidetes ratio, as in obesity. This may predispose some individuals to glucose intolerance. Pregnancy Risks: Research has linked artificially sweetened beverage consumption during pregnancy with increased risk of preterm delivery. Consumption of as little as one serving per day of sugar-sweetened beverages also was related to higher risk. Children's Health: There is a general advisory against marketing artificially sweetened beverages to children. Observational studies suggest that intake of artificial sweeteners in children is associated with higher weight gain over time. According to major health organizations, they are generally safe as long as taken within the established limits of Acceptable Daily Intake.[12]

Table 2: Toxic effects of Artificial Sweeteners.

Name of Artificial Sweetener	Metabolites	Annual Day Intake (mg/kg)	Acute problems	Chronic problems
Saccharin	Ortho Sulfamoylbenzoic acid	5	Nausea, vomiting, diarrhea	Low birth weight, bladder cancer, hepatotoxicity
Acesulfame-K OR acek	Acetoacetamide	15	Headache	Thyroid tumors in rats, clastogenic, high doses cause genotoxicity
Aspartame	Methanol, Aspartic acid & Phenylalanin	50	Headache, dry mouth, dizziness, nausea, vomiting, thrombocytopenia, mood swings	Lymphomas and leukemia in case of rodents
Neotame	Methanol and Deesterified neotame	2	Headache, hepatotoxic at high doses	Lower birth rate, weight loss, cancer in offspring, hepatotoxicity
Sucralose		5	Diarrhea, dizziness, stomach pain	Thymus shrinkage, enlargement of cecal in rodents

Alternatives of Artificial Sweeteners

The Dietary Guidelines Advisory Committee recommends that people reduce added sugars in their diets (limiting consumption to 100 calories for women and 150 calories for men), but it does not suggest replacing them with artificial sweeteners. This recommendation is based on scientific evidence that too much sugar can cause health problems like obesity and type 2 diabetes.

Instead of artificial options, the text highlights two primary alternatives: rare sugars and natural sweeteners.

Natural Sweeteners

1. **Stevia:** This is a natural sweetener derived from the leaves of the Stevia rebaudiana plant (native to Paraguay and Brazil). It is a popular substitute for sugar because it contains no added calories, making it a healthier alternative for people managing weight or calorie intake.(Figure:5)[13]

2. **Monk Fruit:** Also known as Siraitia Grosvenor, this small green fruit from southern China and northern Thailand has a long history in traditional medicine. Its sweetness

comes from mogrosides, which are antioxidant-rich compounds. The text cautions consumers to check product labels to ensure the monk fruit sweetener is pure and free of unwanted additives.(Figure:6)[14]

Rare Sugars

Rare sugars, such as D-psicose and D-tagatose, have shown potential health benefits in both human and animal studies. These benefits include improving glucose control and reducing body fat. They help regulate blood sugar because they have a lower glycemic index than sucrose (table sugar). (Figure:7)

1. **D-Psicose (Allulose):** Source: Found naturally in small amounts in wheat, figs, raisins, and maple syrup. Commercially produced via enzymatic conversion of fructose.

Health Mechanism: Allulose is absorbed in the small intestine but is not metabolized for energy (less than 10% is converted to glucose). It is primarily excreted intact in the urine.

Calorie Content: Almost zero-calorie (it provides about 0.4 calories per gram, compared to 4 calories per gram for table sugar).

Glycemic Index (GI): Near Zero. It has been shown to potentially suppress the post-meal glucose increase from carbohydrates consumed simultaneously.

Use: It has 70% the sweetness of sugar and a texture/browning capacity similar to sucrose, making it ideal for baking, caramelizing, and making sauces.[15]

2. D-Tagatose: Source: A low-calorie sugar naturally found in small amounts in dairy products (like milk) and often produced from the lactose in whey.

Health Mechanism: Tagatose is poorly absorbed by the body (only about 20% is absorbed). The small amount that is absorbed is processed differently, requiring insulin but resulting in a much lower blood sugar spike.

Calorie Content: Provides about 1.5 calories per gram.

Glycemic Index (GI): Very low (around 3 to 10, depending on the study).

Reported Benefits: Studies have shown it may help improve blood glucose response and has prebiotic effects, potentially improving gut health and supporting beneficial gut flora.

Use: Often used as a functional ingredient in foods like chewing gum, diet sodas, and nutritional bars.[16]

Figure 5: Stevia.

Figure 6: Monk fruit.

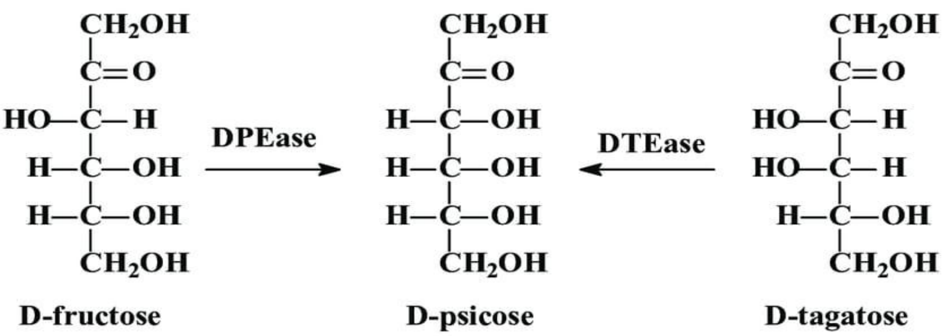


Figure 7: Rare Sugars.

FOOD COLOUR ADDITIVES

In many places, the use of color additives in products such as foods, drugs, cosmetics, and certain medical devices is strictly regulated.

In the United States, the Federal Food, Drug and Cosmetic Act requires all color additives, with the exception of coal tar hair dyes, to be approved by the FDA prior to use.

Internationally, there is concern over certain colors; for instance, black and brown dyes for eyes are banned in developed nations due to their harmful effects that may be very serious and adverse to health.

Consequently, food dyes are subjected to very strict maximum limits as set by regulatory bodies worldwide to offer protection to consumers.

A general maximum limit commonly found is 0.1 g per kg of food product.

The regulations by FSSAI in India have a ceiling on the total amount of synthetic food colorants in food and beverages at 100 parts per million.

Despite these limits, it is estimated that the average Indian citizen consumes about 220 mg of food colorants yearly.[17],[18]

FSSAI has approved a specific list of both synthetic and natural colorants for use.

Synthetic Colors

These include various shades of Red (Ponceau 4R, Carmoisine, Erythrosine), Yellow (Tartrazine, Sunset Yellow FCF), Green (Fast Green FCF), and Blue (Indigo Carmine, Brilliant Blue FCF). (Table:3)

Natural Colors

These are derived from sources like Carotenes, Chlorophyll, Caramel, Riboflavin, Annatto, Curcumin, and Saffron.

The range of synthetic colors is maximal. Typically, this represents 100 ppm of the finished product intended for ingestion. However, the maximum limit of approved synthetic food colors in various foods and beverages, as noted in regulations, could be up to but not exceed 200 ppm of the finished food or beverage intended for human consumption. This review paper's objective is to provide the most recent information on the numerous issues raised by the usage of food coloring additives. The most important food health and safety concerns in the area of food colors are the lack of global regulation on legal food colors, the replacement of synthetic colors with natural ones, and the presence of harmful illegal colorants - both well-known and new, developing ones - in food.(Table:4).[19] [20]

Table 3: Artificial Food Colors are classified: As per PFA.

S.No	Colour	Common Name	Color Shade	Color Index
1.	Red	Carmoisine Erythrosine Ponceau 4R	Red Bright Pink/Red Strawberry Red	14720 45430 16225
2.	Yellow	Tartrazine Sunset Yellow	Lemon Yellow Orange	19140 15985
3.	Blue	Indigo Carmine Brilliant Blue FCF	Royal Blue Turquoise Blue	73015 42090
4.	Green	Fast Green FCF	Sea green	42053

Table 4: Natural food colours.

Class	Color	E-number
Chlorophyll	Olive Green	E 140
Anthocyanins	Red, Purple, Blue, Pink, Magenta	E 163
Carotenoids	Red, Orange, Yellow	E 160
Betalains	Red, Yellow	E 162

Potential Adverse Effects of Food Colorants

This passage details the specific health risks tied to several individual synthetic colorants, highlighting issues ranging from allergic reactions and organ damage to potential carcinogenicity and hormonal effects.[21]

Tartrazine (Yellow 5): This azo dye is identified as the most common trigger for allergic and intolerant reactions, particularly affecting asthmatics and those with an aspirin intolerance.

Brilliant Blue FCF: Research suggests that high doses of this dye could potentially settle in the kidneys and lymphatic vessels.

Azo Dyes (General): When metabolized in the body, azo dyes containing Benzedrine rings can create aromatic amines, which are recognized as carcinogenic substances that may promote the development of intestinal cancer.

Auramine (Yellow) & Rhodamine: Exposure to these dyes can cause damage and dysfunction to the liver and kidneys, significantly hindering growth and normal function.

Sunset Yellow & Tartrazine: Excessive consumption of these common synthetic colorants is linked to increased estrogen levels, which can cause various health problems in both males and females.[22],[23]

Rhodamine B and Regulatory Action in India: Rhodamine B is a vibrant red xanthine dye used across various industries (cosmetics, textiles) and sometimes illegally in popular street foods like gobi manchurian and cotton candy due to its low cost.

This dye is considered carcinogenic to animals and humans and has been linked to side effects like skin pigmentation, respiratory inflammation, and degenerative changes in the liver and kidneys.

The Government of Karnataka's Department of Health and Family Welfare recently banned the use of Rhodamine B in food.

The passage notes the concern that synthetic food colorants banned in developed countries are still used in food products in parts of India.

This situation emphasizes the need for a revised and updated catalog of authorized and prohibited food colorants in India to better ensure consumer safety and well-being.[27],[28]

Potential Toxicological Effects of Food Colorants

Effects on Children and Behavioral Issues: The Food Advisory Committee of the FDA held a hearing on certified color additives and their possible connection to hyperactivity in children.

Research suggests that young children are particularly sensitive to synthetic colorants, exhibiting symptoms like irritability, sleep problems, lack of attention, impulsivity, and hyperactivity, potentially leading to or exacerbating Attention Deficit Hyperactivity Disorder (ADHD).

Allergic and General Health Reactions: Tartrazine (a yellow azo dye) is noted for triggering the most severe allergic and intolerant reactions among all azo dyes, especially in people with asthma or aspirin intolerance.

General risks associated with these additives include hypersensitivity that can worsen asthma, cause skin allergies, and lead to hyperkinesia (increased muscle movement or excessive mobility).

Specific Dyes and Organ Toxicity: The dye Brilliant Blue FCF has been reported to potentially accumulate in the kidneys and lymphatic vessels at high doses.

Azo dyes that contain Benzedrine rings can be broken down by gut bacteria into aromatic amines, which are known carcinogens and may contribute to intestinal cancer.

Auramine (a yellow dye) and rhodamine are linked to damage and dysfunction in the liver and kidneys, impairing growth and normal function.

Hormonal Impact: Excessive intake of the common synthetic colorants Sunset Yellow and Tartrazine has been associated with increased estrogen levels in the human body, which can lead to various health problems in both men and women.[24],[25],[26]

Safer Alternatives to Synthetic Food Colourants

The modern food industry has for years relied on synthetic additives in order to enhance color, flavor, texture, and shelf life. But growing consumer awareness and mounting scientific evidence of potential health risks associated with these artificial compounds have motivated a search for their safe, natural alternative ingredients. This is not just a matter of replacing synthetics with naturals, but upgrading from inert or potentially harmful chemicals to "functional ingredients"—substances not only safe but actively contributing to consumer health.

1. Curcumin: The Golden Antioxidant

Curcumin is the bright yellow pigment extracted from the root of the spice turmeric Curcuma longa. It represents a prime example of a multi-functioning natural additive.

As a Food Additive: It finds its chief industrial application as a natural food coloring agent, replacing artificial yellow dyes such as Tartrazine (Yellow 5), which has been associated in certain studies with hyperactivity in children and oxidative stress. It imparts a stable, brilliant color to beverages, dairy products, and baked goods and condiments.

Safety and Health Benefits: Its safety is well-established and approved by major regulatory bodies such as the U.S. FDA and the World Health Organization. Beyond its role as a colorant, curcumin is a powerhouse antioxidant. It directly scavenges free radicals, boosting the body's own antioxidant enzymes to offer a potent mechanism of combating the very oxidative stress that many artificial additives can induce.[29]

2. Gum Arabic: The Versatile Stabilizer

Also called acacia gum, Gum Arabic is a natural resin that is extracted from the Acacia senegal and Acacia seyal trees. It is an important ingredient in the natural food processing industry.

As a Food Additive: It is indispensable because of its excellent properties as a natural emulsifier, stabilizer, and thickening agent. Its application in candies prevents the crystallization of sugar, stabilizes flavors in soft drinks, ensures a smooth texture in ice cream, and acts as a binder in snack bars. The safety of the additive is underlined by its approval from the FAO/WHO Joint Expert Committee on Food Additives.

Safety and Health Benefits: Gum Arabic is not just an inert texturizer; rather, it is a complex polysaccharide that functions like a prebiotic fiber and fosters the good gut bacteria related to healthy digestion. Besides this, it possesses real value in antioxidant, anti-inflammatory, and antimicrobial properties, adding a layer of health protection that synthetic emulsifiers such as polysorbate 80 cannot.[30]

3. Nigella Sativa: The Potent Health Promoter

The medicinal plant, scientifically referred to as Nigella Sativa and colloquially known as black cumin or black seed, has immense potential as a functional food ingredient. As a Food Additive: Though less commonly used as a simple texturizer, its seeds and oil have presently been gaining interest as potent additives to "functional foods" and health-promoting products. It can be included in breads, cheeses, and yogurts or used as a preservative. Safety and Health Benefits: The plant is a true pharmacological wonder, cited for a wide range of therapeutic properties. Its bioactive compounds, such as thymoquinone, give potent anti-hypertensive, anti-diabetic, antioxidant, and anti-inflammatory effects. The addition of substances such as Nigella Sativa into the food supply represents a profound shift toward "food as medicine," where additives actively help in the prevention of chronic disease.[31]

Figure 8: Curcumin.

Figure 9: Gum Arabica.

CONCLUSION

Beyond the Label: The Hidden Risks of Synthetic Food Additives

While global regulatory bodies declare that synthetic food additives, including artificial colors and sweeteners, are safe within their established Acceptable Daily Intake (ADI) levels, the scientific literature provides an increasingly compelling case for the notion that potential adverse health outcomes may extend far "beyond the label". The evidence points to concerns beyond basic safety, involving long-term metabolic, behavioral, and toxicological risks.

Artificial Colorants: Behavioral and Allergic Triggers.

The most consistent concern about artificial colorants is a strong link to hyperactivity and other behavioral problems in children.

Exposure to common synthetic food dyes has been repeatedly demonstrated to increase symptoms of hyperactivity and Attention Deficit Hyperactivity Disorder in susceptible children.

It is known that certain azo dyes can provoke allergic and intolerant reactions.

Tartrazine, or Yellow 5, is especially noted to cause symptoms, particularly in those with asthma and chronic urticaria.

Organ-specific toxicity, such as the potential of Brilliant Blue FCF to impair renal and lymphatic function, and possible carcinogenicity are also of concern.

Artificial Sweeteners: Metabolic Complexity and Disease Risk.

The scrutiny on artificial sweeteners (ASs) has centered around their complex, often counterintuitive, metabolic effects and their possible relation to chronic disease.

A change in Gut Microbiota has been a major focus of modern research that suggests high-intensity sweeteners can disrupt the delicate balance of the gut microbiota.

The disruption interferes with normal metabolic activities, most especially glucose metabolism, which is increasingly implicated in the pathogenesis of glucose intolerance and insulin resistance.

Links to Chronic Disease

Several observational studies are continuing to explore the links to serious health outcomes.

Some sweeteners, such as ACE K and sucralose, are under scrutiny for possible linkage to an increased risk of cardiovascular disease.

The link between sweeteners like aspartame and ACE K and an increased incidence of certain cancers remains a focus of continuing research.

Vulnerable Populations Some research has found that the use of artificially sweetened beverages through pregnancy is associated with an increased risk of preterm delivery. Paradoxically, observational studies of children link ASs consumption to greater weight gain over time.

The Way Forward: Policy, Research, and Natural Alternatives

It shows that there is now an urgent need for proactive public health policy and strong, long-term research.

Future studies should target

Cumulative Exposure: To check the effect of combined long-term consumption of several additives that are usually ingested together in processed foods.

Vulnerable Populations: Obtaining a clear understanding of the risks among particularly vulnerable populations such as children and pregnant women.

It is encouraging a shift toward safer, more natural alternatives.

Natural Sweeteners: Stevia, Monk Fruit, and other emerging rare sugars (like D-psicose and D-tagatose) are examples of high-intensity sweeteners with possible health benefits due to their effects on glucose control.

Natural Colorants: It is also possible to replace synthetic food colorants with natural colorants like Curcumin, Gum arabic, and Nigella sativa, which will offer functional health properties.

These diverging results from animal models, observation in humans, and controlled trials call for constant vigilance and transparency. This demands an internationally concerted effort of review, revision, and updating of the catalog of authorized colorants, with especial interest in rapidly developing regions, as a means of protecting public health and well-being.

REFERANCES

1. Malik VS, Hu FB. Fructose and Cardiometabolic Health: What the Evidence from Fructose Restriction and Substitution Trials Tell Us. J Nutr., 2015; 145(6): 1070-1076.
2. Ng M, Fleming T, Robinson M, Thomson B, Graetz S, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet., 2014; 384(9945): 766-781.
3. Spence C. On the psychological impact of food color. Curr Opin Food Sci., 2019; 27: 66-73.
4. Fahlberg C, Remsen I. On the oxidation of orthotoluenesulfamide. Am Chem J., 1879; 1: 426–33.
5. Bleich SN, Vercammen KA, Aherrera A, Wolfson JA, Kontis V, Webb Hooper M. Consumption of low-calorie sweeteners among US adults and youth, 1999–2012. Am J. Public Health, 2017; 107(12): 2044–52.
6. Nabors LO. Alternative Sweeteners. 4th ed. Boca Raton (FL): CRC Press, 2017; 12, Saccharin; 195–218.
7. O'Brien-Nabors L. Acesulfame potassium. In: Nabors LO, editor. Alternative Sweeteners. 4th ed. Boca Raton (FL): CRC Press, 2017; 45–60.
8. Hough L, Kanter M. Aspartame. In: Nabors LO, editor. Alternative Sweeteners. 4th ed. Boca Raton (FL): CRC Press, 2017; 89–120.
9. Goldsmith LA. Sucralose. In: Nabors LO, editor. Alternative Sweeteners. 4th ed. Boca Raton (FL): CRC Press, 2017; 175–194.

10. Ma Y, Smith KV, Johnson L, Aaron J, Blissett J. Sweeteners: majority of studies confirm no adverse health effects - however, the study situation is insufficient. J Hum Nutr Diet., 2019; 32(4): 451-460.
11. Soffritti M, Belpoggi F, Degli Esposti D, Lambertini L. Aspartame: a multi-potential carcinogenic agent. Am J Ind Med., 2014; 57(7): 727–737.
12. Sylvetsky AC, Vartanian R, Smith G, Ma N, Berrigan D, Pan Y, et al. Consumption of nonnutritive sweeteners in US children and adolescents. J Acad Nutr Diet., 2020; 120(11): 1858–1864.
13. Uddin MN, Khalid M, Barman A, Hossain MS. Health benefits of Stevia Rebaudiana—A review. Int J Med Pharm Res., 2024; 3(1): 333–42.
14. Zeng F, Dong M, Yang X. Health aspects and food applications of Monk Fruit (Siraitia grosvenorii). Foods Raw Mater, 2020; 8(1): 3–10.
15. Levin R, Ran S, Maeng Y. Review on D-Allulose: In vivo Metabolism, Catalytic Mechanism, Engineering Strain Construction, Bio-Production Technology. Int J Mol Sci., 2020; 21(3): 1070.
16. Gomes S, Magalhães AL, Vilarinho F, Silva MA, Santos S. D-Tagatose: a rare sugar with functional properties and antimicrobial potential against oral species. Nutrients., 2024; 16(12): 1943.
17. Rao PS, Sudershan RV. Exposure assessment to synthetic food colours of a selected population in Hyderabad, India. Food Chem Toxicol, Jul. 2008; 46(7): 2334–41.
18. Jindal U, Sahoo S, Dureja N. Usage pattern and exposure assessment of food colours in different age groups of consumers in the State of Uttar Pradesh, India. Food Addit Contam Part A Chem Anal Control Expo Risk Assess, Aug. 9, 2025; 42(8): 1026–39.
19. Mishra A, Sharma P. Status of food colorants in India: conflicts and prospects. J Food Sci Technol, 2023; 60(3): 793-803.
20. Gupta R, Singh B. Food colour additives: a synoptical overview on their chemical properties, applications in food products, and health side effects. Foods, 2022; 11(3): 379.
21. Silva MAA, De Souza JMF, De Souza VMF, De Souza PGF, Dos Santos MP, De Souza KMF. Food Colour Additives: A Synoptical Overview on Their Chemical Properties, Applications in Food Products, and Health Side Effects. Foods, Jan. 28, 2022; 11(3): 379.
22. Bateman B, Warner JO, Hutchinson E, Dean T, Rowlandson P, Grundy J, et al. The effects of a double blind, placebo controlled, artificial food colourings and benzoate preservative challenge on hyperactivity in a general population sample of preschool children. Arch Dis Child., Jan. 2004; 89(1): 108-115.

23. McCann D, Barrett A, Cooper A, Crumpler D, Dalen L, Grimshaw K, et al. Food additives and hyperactive behaviour in 3-year-old and 8/9-year-old children in the community: a randomised, double-blinded, placebo-controlled trial. Lancet, Nov. 3, 2007; 370(9598): 1560-1567.
24. Lockey SD. Hypersensitivity to Tartrazine (FD&C Yellow No. 5) and Other Dyes. Ann.
25. Tanaka T. Reproductive and neurobehavioral toxicity study of tartrazine administered to mice in the diet. Food Chem Toxicol, Jan. 2006; 44(2): 179-187.
26. Chequer FMD, Dorta DJ. Azo dyes and their metabolites: a review. J Environ Manag, Apr. 15, 2017; 192: 140-150.
27. Al-Gubory KH, Al-Dossary S. Reproductive and developmental effects of Brilliant Blue FCF in experimental animals. Reprod Toxicol, Jan. 2019; 83: 18-24.
28. Rana S, Kumar P, Dahiya S, Bhatnagar S, Sharma A. Toxicological Implications of Auramine and Rhodamine B in Food: A Review. Curr Food Nutr., 2023; 16(2): 160-171.
29. Prasad S, Aggarwal BB. Curcumin, the golden spice: From traditional medicine to modern medicine. Adv Exp Med Biol., 2017; 929: 1-12.
30. Al-Sohaimy SA, Allam A, El-Metwally AS, Gomaa MA. Physico-chemical, functional, and antioxidant properties of gum Arabic. Int J Sci., 2015; 4(2): 16-24.
31. Shommu NS, Kabir M, Sayed N, Akter S, Rahman MA, Hoque MM. A comprehensive review on health benefits of Nigella sativa seed (black cumin). Asian J Pharm Clin Res., 2019; 12(5): 1-9.