



Artificial sweeteners and food colorants their hazardous impact on human health

Kalyani S. Mahalle *, Swati P. Deshmukh and Shivshankar G. Devkunbi

Department of Pharmacology, Shraddha Institute of Pharmacy, Kondala (Zambre), Tq. Dist. Washim-444505, Maharashtra, India.

GSC Biological and Pharmaceutical Sciences, 2025, 33(02), 354–362

Publication history: Received on 11 October 2025; revised on 17 November 2025; accepted on 19 November 2025

Article DOI: <https://doi.org/10.30574/gscbps.2025.33.2.0456>

Abstract

This review article closely looks at the safety, regulations, and potential health impacts of artificial sweeteners and food colorings. It covers the history of artificial sweeteners, including newer options like unusual sugars and key substances such as saccharin, aspartame, and cyclamate. The article also explores how these sweeteners might affect the body, such as their possible influence on blood sugar levels, weight gain, gut bacteria, heart health, and cancer risk.

The assessment also looks at the safety and possible harmful effects of food colorants, paying special attention to the rules that govern their use and the health risks linked to synthetic colorants like rhodamine B and tartrazine. Because they have fewer calories, sugar-free foods are quite popular now. For that reason, the food industry often uses low-calorie artificial sweeteners instead of regular sugar. Aspartame, acesulfame-K, neotame, cyclamate, and alitame have all been approved by the US Food and Drug Administration for use, as long as they are consumed within the recommended daily intake level. The conclusion highlights the importance of being careful with how much of these sweeteners people consume, especially for children and pregnant women. It also encourages ongoing research to back up dietary guidelines and food safety regulations. (1)

Keywords: Artificial Sweeteners; Food Colorants; Rare Sugar; Diabetes; Obesity; Cancer

1. Introduction

It has been noted in recent trends that there has been a rise in the prevalence of diabetes mellitus and cardiovascular diseases. There is a direct correlation between sugar consumption and this increase. It is considered a major factor in the increase in obesity globally, leading to increased energy use. (1) Over 1.9 billion adults were overweight in 2016. Despite the fact that over 650 million people were classified as obese, representing a 13% worldwide prevalence, humans are naturally drawn to sweets. The preference of newborns for sweet-tasting foods has been documented in several published studies. Consequently, sweeteners have always been well liked in artificial food recipes. (3) The food businesses are always looking for satisfaction, the strain of meeting dietary needs with calorie limits, and competition between variables like flavor and appearance. Of potent artificial sweeteners with few calories. As healthier food options, many low-calorie items are currently on the market. Artificial sweeteners are also categorized. An essential component of the contemporary food business as a food addition for humans. The use of the following artificial sweeteners is permitted in the European Union: acesulfame-K, Examples of these include aspartame, cyclamates, saccharin's, sucralose, neohesperidine DC, neotame, and the salt of aspartame-acesulfame. (2)

* Corresponding author: Kalyani S. Mahalle



Figure 1 Artificial Sweeteners

Artificial sweeteners, also known as high-intensity sweeteners, are sugar substitutes that offer a strong taste. Sweetness that has few or no calories. The FDA has authorized six sweeteners, including aspartame, acesulfame potassium (Ace-K), neotame, saccharine, and others, for use as food additives in the United States. The 1970s. Furthermore, natural sweeteners like monk fruit extract and steviol glycosides from the stevia plant are also often thought to be safe. The World Health The organization advises limiting free sugar consumption to less than 10% of total energy intake, preferably less than 5%. There are two categories of artificial sweeteners: low-calorie and non-calorie. The caloric content of aspartame is the same as that of sugar, but because it is 400 times sweeter, it follows that aspartame provides the same amount of energy. Negligible is the number of sweetened foods. Acesulfame-K, saccharin, sucralose, neotame are all non-metabolized by the human body, and as a result, they have no nutritional value either. (3)

2. Commonly Used Artificial Sweeteners

2.1. Saccharin

Saccharin is a man-made sweetener that has no calories or energy value. For nearly a hundred years, it has been used in processed foods and drinks, making it one of the oldest artificial sweeteners. It is much sweeter than regular sugar, being about 300 times sweeter.

2.2. Acesulfame potassium (Ace-k)

A common sweetener is acesulfame potassium. This white, crystalline substance stays stable even at very high temperatures, up to 250 degrees Celsius. It is often used in many baked goods because it remains stable when exposed to high heat.

2.3. Aspartame

The sugar substitute that people talk about the most because it tastes like sugar is aspartame. It dissolves somewhat well in water and remains stable when exposed to high heat. The speed at which aspartame dissolves depends on how hot the water.

2.4. Sucralose

One of the most commonly used sugar substitutes is sucralose. It is safe to use, very stable, and can even be used in baked items even when exposed to high heat. Sucralose is twice as sweet as saccharin, three times as sweet as aspartame and acesulfame potassium, and up to 1000 times sweeter than regular sugar.

2.5. Neotame

Neotame is the best option if you're looking for a powerful sweetener. Even though it comes from aspartame, it's much sweeter—about 7,000 to 13,000 times sweeter than sugar. Because of this, only a small amount is needed to make things sweet. Neotame is great for making products with low sugar content because it can withstand high heat and helps enhance the taste of food. (4)

Table 1 Characteristic features of artificial sweeteners (5)

General Name or Common Name	Most Popular Brand Name	Intensity of sweetness compared to table sugar	Killing calories per gram (kcal/gm)	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
Aspartame	NutraSweet, Intrastate, sugar twin, Equal	200	4	Tabletop sweetener (in packets), chewing gums, instant coffee and tea, gelatines, puddings, soft drinks, Yoghurt, Pharmaceuticals
Neotame	Same as common name (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, gelatines, gelatines

3. Therapeutic use

Replacing regular table sugar with little or no calorie sweeteners in food helps the body take in fewer calories, which can support weight loss. However, diets with a lot of sugar can lead to tooth decay. It's recommended to use sugar substitutes. When people with diabetes choose artificial sweeteners or sugar alternatives instead of regular sugar, their blood sugar levels tend to stay more balanced. (6)

4. Non-Therapeutic use

Aspartame, a sugar substitute used in many processed foods, has the same sweet taste as regular sugar. It is commonly used in the beverage and food industries as a sugar substitute. Not only does it provide a sweet taste, but it also enhances and even boosts the overall flavor. (7)

5. Health benefits

Artificial sweeteners don't increase blood sugar levels, which is a key factor in developing diabetes. These sugar substitutes have no calories. Because they don't add calories, they can help with weight control. They also promote good dental health. (8)

6. Hazardous impact of Artificial sweeteners on human health

People are still arguing about the long-term effects of artificial sweeteners on health. Some research says they might help with weight control, but other studies warn about possible problems like an unhealthy balance of gut bacteria, issues with metabolism, effects on the brain and how people think, and even cancer. These sweeteners can affect several parts of the body, including blood sugar levels, weight gain, gut health, heart health, and cancer risk. (9)

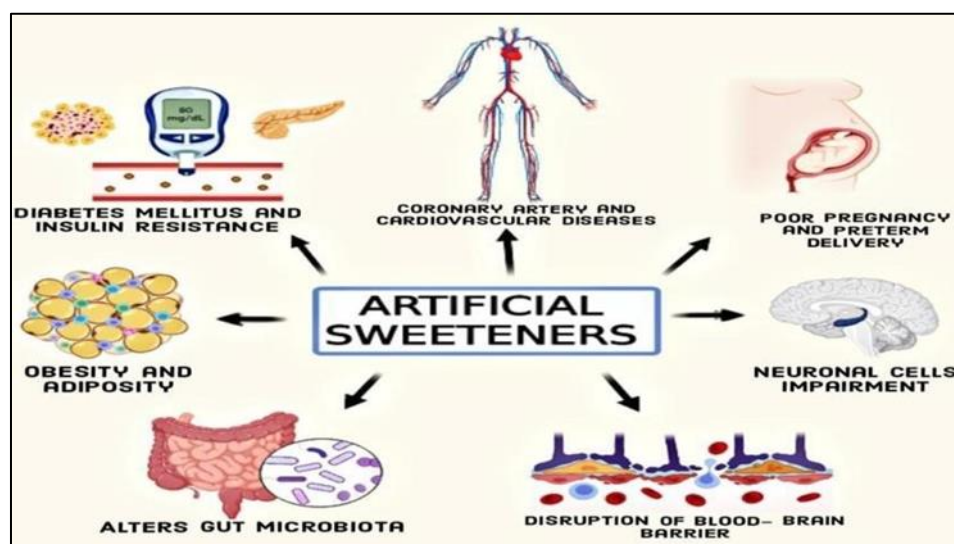


Figure 2 Hazardous Impacts of Artificial Sweeteners on Human Health

6.1. Blood Glucose Concentration and Diabetes Mellitus

When people ate artificial sweeteners, their blood sugar levels went up, but not as much as when they ate glucose. The four artificial sweeteners—aspartame, saccharine, sucralose, and stevia—didn't cause much of a difference in blood sugar levels. Additionally, a study on animals showed that after eating saccharin, they developed a higher intolerance for glucose. In humans, four out of seven healthy people had changes in their gut bacteria and developed glucose intolerance when they consumed more saccharin than the recommended limit. Other studies on both healthy and diabetic people found that artificial sweeteners don't really affect how the body keeps glucose levels steady. (10)

6.2. Obesity and Weight Gain

A positive energy balance leads to more body weight and obesity. Artificial sweeteners can affect body weight and energy balance in a different way compared to natural sugar. A review of six long-term studies involving 26,551 people found that for every 250 mL of sugary drinks with artificial sweeteners consumed daily, the risk of obesity went up by 21%. This connection between artificial sweetener use and obesity might be because of several possible reasons, both in lab tests and in real-life situations.

6.3. Cardiovascular Disease

Many studies, including meta-analyses, have looked at how added sugars affect health, especially heart and metabolic conditions. Public health experts now agree that these sugars are a major risk factor. Research also shows that eating a lot of artificial sweeteners may raise the risk of heart problems. While aspartame wasn't linked to heart disease, other sweeteners like ACEK and sucralose were. A 2022 WHO report found that drinking sugary drinks that use artificial sweeteners as a substitute is connected to some early signs of heart disease. (11)

6.4. Carcinogenic Effect

The market for artificial sweeteners faced challenges when cyclamate was banned in 1970 because of worries that it might cause cancer. However, studies on humans haven't shown clear evidence supporting those cancer concerns. Aspartame breaks down into a chemical called diketopiperazine, which has also been linked to cancer in some discussions. Another important point is that aspartame or its breakdown product can create nitrosated compounds when they mix with nitrates found in food. (12)

6.5. Impact on Gut Health

Some early studies suggest that using artificial sweeteners for a long time might affect the gut microbiota, which are the good bacteria in the digestive system. However, more research is needed in this area. These changes could possibly influence how the body processes metabolism and overall digestion. Two common artificial sweeteners, saccharin and sucralose, may disrupt the balance of gut bacteria. This imbalance has been linked to issues like a weakened immune system, increased inflammation throughout the body, and metabolic disorders.

6.6. Neurological symptoms

In some individuals, artificial sweeteners have been associated with neurological symptoms such as headaches and changes in taste. Also, mood disorders, feelings of sadness, and mental stress have been connected to the sweetener aspartame.

6.7. Addictive behavior

Sugar can be much less sweet than artificial sweeteners, sometimes even hundreds of times less sweet. The brain's reward areas might become too excited by this intense sweetness, leading to a desire for more sugary foods and drinks. (13)

6.8. Children and pregnant women

Studies on specific groups like young children and pregnant women have not been done very often. The World Health Organization's analysis shows that the evidence in this area is of moderate to low quality because there isn't enough data and the results from different studies often disagree. A study that involved randomly assigning people to different groups found that replacing sugary drinks with artificially sweetened ones might help normal-weight children avoid gaining weight. However, according to the WHO's guidelines, using artificial sweeteners to control body weight does not offer any benefits. This advice also applies to children. Some studies suggest that using artificial sweeteners might be linked to preterm birth in pregnant women. But the researchers say more studies are needed to confirm these results.

6.9. Long-Term Health Concerns

The long-term effects of using artificial sweeteners regularly are not fully understood yet, even though major health groups say it's safe to consume them in reasonable amounts. Because of this, many experts recommend not replacing real, whole foods with artificial sweeteners, but instead using them as part of a varied and balanced diet. (14)

7. Applications and Necessity of Artificial Sweeteners in the Food Industry

The use of artificial sweeteners in the food industry isn't by chance. These substances are a good alternative to sugar because they offer manufacturers both technical and cost advantages. This goes beyond just changing the recipe and shows a smart way of adapting to what the market and customers want.

8. Application in the Production of Diet and Low-Calorie Products

People are starting to care more about their health, especially when it comes to problems like diabetes and obesity. This has led to a big increase in the need for food and drinks that are diet friendly or low in calories. Since artificial sweeteners give a sweet taste without adding extra calories, companies can make delicious packaged snacks, sugar-free candies, and diet sodas that also help keep blood sugar levels steady and support weight management. The main reason these sweeteners are used by food makers is because of this ability. (15)

9. Food Colors

The FDA must approve color additives before they can be used in food, medications, cosmetics, or medical devices that touch the human or animal body for a long time, as stated in the Federal Food, Drug, and Cosmetic Act. This rule doesn't apply to coal tar hair dyes. It's important to limit how much dye is used to keep people healthy. To make sure products are safe after they're used, the highest allowed amount of color in any food is 0.1 grams per kilogram. The acceptable amounts of synthetic colors in food are decided by food and drug regulatory agencies.

According to FSSAI standards, the total amount of colorants in synthetic foods and drinks should not be more than 100 parts per million. On average, an Indian person consumes about 220 milligrams of food coloring each year. The FSSAI has approved 48 synthetic colorants, such as Red (including Ponceau 4R, Carmoisine, and Erythrosine), Yellow (like Tartrazine and Sunset Yellow FCF), Green (Fast Green FCF), and Blue (Indigo Carmine and Brilliant Blue FCF). Additionally, FSSAI has approved several natural colorants, including carotenes and carotenoids, chlorophyll, caramel, riboflavin, annatto, curcumin, and saffron. (16)

10. Natural Colors

Color is important in making people accept food products. This is because people often link the color of food with qualities like how fresh it is, how ripe it is, and whether it's safe to eat. There are many different colors available from artificial food dyes. However, there have been many reports about the harmful effects of synthetic colors. Even some synthetic colors that are approved can be dangerous and may lead to cancer. Using a lot of synthetic colors also causes pollution, messes up the natural balance, and can harm people's health. Natural colors, on the other hand, come from natural sources such as minerals, plants, animals, and insects. Colors from plants can also provide health benefits. The natural colors used in raw materials and processed foods usually come from pigments found in plants. (17)

11. Plant Natural Color

Table 2 Plant Natural Color (17)

Class	Colour	E-number
Chlorophyll	Olive green	E 140
Anthocyanin	Red, purple, blue, pink, magenta	E 163
Carotenoids	Red, orange, yellow	E 160
Betacaine	Red, yellow	E 162

12. Health benefits of Natural Food colorants

- The colors are extracted from vegetables, fruits and elements
- Natural food colorants are good for health.
- Doesn't contain harmful elements that effects humans and animals

13. Purpose of Food coloring

- Enhancing the appearance of food
- For artistic or decorative uses, like cake frosting
- Giving food its own individuality
- Enhances flavor

14. Synthetic Food Colors

Synthetic food color, also called artificial color, is a substance made in a lab and added to food to make it look better. These colorings come in different forms like liquid or powder and are often cheaper, more stable, and brighter than natural options. Examples include Tartrazine (Yellow 5), Allura Red (Red 40), and Brilliant Blue (Blue 1). However,

some people are unsure about the safety of certain synthetic colors, which has resulted In laws and warning labels in some places. (18)

Table 3 Artificial food colors are classified: As per PFA (18)

Sr. No	colours	Common Name	Colour shade	Colour index
1	Red	Carnosine	Red	14720
		Erythrosine	Bright pink/Red	45430
		Ponceau 4R	Strawberry Red	16225
2	Yellow	Tartrazine Sunset yellow	Lemon yellow	19140
			Orange	15985
3	Blue	Indigo carmine	Royal Blue	73015
		Brilliant blue FCF	Turquoise Blue	42090
4	Green	Fast green FCF	Sea Green	42053

15. Adverse Effects of Food Colorants

The Food and Drug Administration's Food Advisory Committee had a meeting to discuss approved color additives and whether they might be linked to hyperactivity in children. A study found that young children can have strong reactions to artificial coloring, showing symptoms such as irritation, trouble sleeping, impulsiveness, hyperactivity, and attention deficit hyperactivity disorder. Among all the azo colors, tartrazine appears to cause the most allergic and intolerant reactions, especially in people who have asthma or are sensitive to aspirin. Tartrazine appears to cause the most allergic and intolerance issues among all azo dyes, especially in people with asthma or those who are sensitive to aspirin. Studies suggest that high levels of Brilliant Blue FCF might lead to problems with the kidneys and lymphatic vessels. Some azo dyes that contain Benzedrine rings can break down into aromatic amines, which are linked to cancer and could contribute to intestinal cancer when processed by the body's gut bacteria. Exposure to rhodamine and auramine, which are yellow-colored dyes, has been associated with liver and kidney diseases in humans. (19)

16. Health Hazards Of Food Colorants

16.1. Hyperactivity In Children

In the 1970s, people started talking about whether artificial food coloring might cause hyperactivity and learning issues in children. At that time, there wasn't strong scientific proof to support these claims. However, many parents still chose to be careful with artificial colors, which kept the topic in the news and led to more studies. Newer research has found a small but meaningful connection between artificial food coloring and hyperactivity in kids. Health worries about artificial colors are more harmful to children because these substances can more easily affect their growing bodies and brains.

16.2. Allergic Reactions

Some people may have reactions to artificial food coloring. Symptoms like skin rashes, itching, asthma attacks, and swelling can happen. Common types of food coloring that cause these issues are Red 40 and Yellow 5. People who are sensitive to aspirin are more likely to have a reaction to these colorings. Artificial food dyes have been known to trigger allergic reactions, particularly in children. Yellow Dye 5 and Yellow Dye 6 are known to cause hypersensitivity and allergic reactions.

16.3. Carcinogenicity

Animal testing has caused concern, even though there isn't much evidence yet. Red 3 has been linked to thyroid cancer in rats. High levels of Blue 2 have been connected to brain cancer. Many health professionals believe the harmful effects of artificial food dyes are real, even though more research is needed. Some research suggests that certain artificial food dyes may be associated with an increased risk of cancer. (20)

17. Conclusion

The use of certain food ingredients, like added sugars, artificial sweeteners, and food colorings, has become a topic of concern because of the increasing rates of chronic illnesses such as diabetes and heart disease. Artificial sweeteners are often used as a sugar alternative that is lower in calories, but there are concerns about their possible effects on blood sugar levels, weight gain, gut health, and even cancer. Similarly, both natural and artificial food colorings have been connected to health issues, including allergies and possible cancer risks. More studies are needed to understand the long-term impacts of these sweeteners and colorings on health. In the meantime, it's important to focus on reducing added sugars in our diets and looking for healthier alternatives like stevia and rare sugars. Also, stronger rules for food coloring could help lower the risks. Many sweeteners can be good, neutral, or even harmful for health. Special care should be taken, especially for groups that are more vulnerable, such as children, pregnant women, and people with certain health conditions. Overall, navigating the complex world of food additives and their health effects needs a balanced approach that puts consumer safety and public health first. Therefore, we conclude that the food marketing company behind the campaign shouldn't have a big influence on what we eat.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

- [1] Kranthi Kumar Poshala, A Review on Artificial sweeteners, International Journal of Engineering Science and computing. 2020; 10(10):27461-27421.
- [2] Shalini Saxena, A Review on Hazardous effects of synthetic food colors, Journal of Plant Archives. 2023;23(1):218-222.
- [3] Alessandra Durazzo, Márcio Carochio et.al., A Review on Food dyes and health: Literature quantitative research analysis, Journal of Measurement Food. 2022;(7)1-7.
- [4] Rudrajit Paul, Dipanjan Bandyopadhyay, A Review on Are Artificial Sweeteners Safe and Useful: What does the Evidence Suggest, Journal of Indian association of clinical Medicine, 2020;21(3-4): 159-65.
- [5] Satish Kumar Basattikoppalu Puttegowda, Mohith Shivaramu et.al., A Review on Understanding Artificial Sweeteners and Food Colorants-their Impact on Human Health, Indian Journal of Pharmacy Practice., 2025; 18(1):8-15.
- [6] Reshma V. Jadhav, Santosh S. Bhujbal, A Review on Natural food colors, Journal of pharmaceutical Resonance 2020; 2(2):1-20.
- [7] Lydia Kossiva, Kostas Kakleas et.al., Chronic Use of Artificial Sweeteners: Pros and Cons, journal of Nutrients, 2024; (16):1-16.
- [8] Prithviraj Sadar, Pooja Dande et.al., A Review on Evaluation of Toxicity of Synthetic Food Colors on Human Normal Flora and Yeast, International journal of Health Scienced and Research 2017;7(8)110114.
- [9] Saraswathy S, Mishra S. Effect of Artificial Sweeteners on the Blood Glucose Concentration. J of Med Acad. 2018;1(2):81-5.
- [10] Tejashree Anil More, Zoya Shaikh and Ahmad Ali et.al., A Review on Artificial sweeteners and their Health Implications, Biosciences Biotechnology Research Asia, 2021;18(2):227-237.
- [11] Petra Amchova, Hana Kotolova et.al., A Review on Health safety issues of synthetic food colorants Journal of Regulatory Toxicology and Pharmacology 2015;73(3):1-9.
- [12] Wissam Ghusn, Roopa Naik et.al., A Review on The Impact of Artificial Sweeteners on Human Health and Cancer Association, Journal of Cureus, 2023;15(12):1-8.
- [13] Rycerz K, Jaworska-Adamu JE. Effects of aspartame metabolites on astrocytes and neurons. Folia Neuropathol 2013; 51: 10-7.

- [14] Kavey, R.E.W. 2010. How sweet it is: sugar-sweetened beverage consumption, obesity and cardiovascular risk in childhood. *Journal of the Academy of Nutrition and Dietetics*. 110(10): 1456-146.
- [15] Clauss, K. and Jensen, H. 1970. Cycloadditionen von halogensulfonylisocyanaten an acetylene. *Tetrahedron Letters* 11(2): 119-122
- [16] Singh S, Kohli A, Trivedi S, Kanagala SG, Anamika FNU, Garg N, et al. The contentious relationship between artificial sweeteners and cardiovascular health. *Egypt J Intern Med*. 2023;35(1):43.
- [17] Sharma A, Amarnath S, Thulasimani M, Ramaswamy S. Artificial sweeteners as a sugar substitute: Are they really safe? *Indian J Pharmacol*. 2016;48(3):237.
- [18] Chattopadhyay S, Raychaudhuri U, Chakraborty R. Artificial sweeteners-a review. *J Food Sci Technol*. 2014;51(4):611-21.
- [19] Smith A, Avery A, Ford R, Yang Q, Goux A, Mukherjee I, et al. rare sugars: metabolic impacts and mechanisms of action: a scoping review. *Br J of Nutr*. 2022;128(3):389-406.
- [20] Purohit V, Mishra S. The truth about artificial sweeteners – Are they good for diabetics? *Indian Heart J*. 2018;70(1):197-9.