CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187
https://doi.org/10.5281/zenodo.17487332

https://www.iajps.com/volumes/volume12-october-2025/137-issue-10-october-25/

Available online at: http://www.iajps.com *Review Article*

ARTIFICIAL SWEETENERS AND FOOD COLORANTS THEIR HAZARDOUS IMPACT ON HUMAN HEALTH

Kalyani S. Mahalle[1*], Shivshankar G.Devkunbi[2], Dr. Swati P. Deshmukh[3]

[1*]Shraddha Institute of Pharmacy, Kondala Zambre, Washim 444505

[2]Lecturer, Shraddha Institute of Pharmacy, Kondala Zambre, Washim 444505

[3]Principal, Department of Pharmacology, Shraddha Institute of Pharmacy, Kondala Zambre, Washim 444505

Abstract:

This review article comprehensively explores the overview of artificial sweeteners and food colorants, examining their safety, regulatory status, and potential health effects. It explores the historical background of artificial sweeteners, covering key compounds like saccharin, aspartame and cyclamate, while also highlighting emerging alternatives such as rare sugars. The discussion extends to the physiological impacts of artificial sweeteners including their potential ill effects on blood glucose levels, obesity, gut microbiome, cardiovascular health, and cancer risk.

Additionally, the review evaluates the safety and adverse effects of food colorants, emphasizing regulatory frameworks and potential health risks associated with synthetic food colorants like tartrazine and rhodamine B. Now a days sugar free food are very much popular because of their less calorie content. So food industry uses various artificial sweeteners which are low in calorie content instead of high calorie sugar. U.S. Food and Drug Administration has approved aspartame, acesulfame-k, neotame, cyclamate and alitame for use as per acceptable daily intake (ADI) value. It concludes by underlining the importance of cautious consumption, particularly among vulnerable populations like children and pregnant women, and advocates for ongoing research to inform evidence-based dietary guidelines and regulatory policies.

Keywords:

Artificial Sweeteners, Food Colorants, Rare Sugar, Diabetes, Obesity, Cancer.

Corresponding author:

Kalyani S. Mahalle,

Shraddha Institute of Pharmacy,

Kondala Zambre, Washim 444505

E-mail:- kalyanimahalle567@gmail.com

QR CODE

Please cite this article in press Kalyani S. Mahalle et al., ***Artificial Sweeteners And Food Colorants Their Hazardous Impact On Human Health****, Indo Am. J. P. Sci, 2025; 12(10).*

INTRODUCTION:

In recent trends, it has been observed that increase in the incidence of diabetes mellitus and cardiovascular diseases. Intake of added sugars is directly related to higher energy consumption and is thought important contributor to the rise in obesity worldwide.[1] In 2016, the number of overweight adults exceeded 1.9 billion while over 650 million were classified as obese, reflecting a global prevalence of 13% It is inherent nature of humans to like sweet food. Previously published studies have reported the inclination of new-borns towards sweet-tasting nutrition. Therefore, sweetening agents has always been popular in man-made food preparations.[3]In view of customer satisfaction, the pressure to meet dietary requirements with caloric restrictions and competition between factors like taste and appearance, the food industries are continuously in search of low calorie and intense artificial sweeteners. A number of marketed low calorie products are now available as healthier food choices. Artificial sweeteners also classified as food additives for man indispensable part of modern food industry. In the European Union, the following artificial sweeteners are allowed to be used: acesulfame-K, aspartame, cyclamates, saccharins, sucralose, neohesperidine DC, neotame and salt of aspartame-acesulfame (2)

Artificial sweeteners, also known as high-intensity sweeteners, are sugar alternatives that provide intense sweetness with few or no calories.Six sweeteners, including aspartame, acesulfame potassium (Ace-K), neotame, saccharin, and others, were approved by the FDA as food additives in the 1970s. Additionally, natural sweeteners such as steviol glycosides from the stevia plant and monk fruit extract are also generally considered safe. The World Health Organization recommends reducing free sugar intake to less than 10% of total energy intake, ideally less than 5%.artificial Sweeteners are divided into low-caloric and non-caloric. Aspartame contains the same amount of calories per gram As sugar; however, it is 400 times sweeter, which means that The energy intake from aspartame sweetened products is Negligible. Acesulfame-K, saccharin, sucralose, neotame are Not metabolized by the human organism, consequently too They have no energy value. (3)

2. Commonly Used Artificial Sweeteners:

Saccharin:

Saccharin is an artificial sweetener with zero food energy and no calories. This is the earliest and one of the oldest sugar used for about a century in processed food and beverages industries. Saccharin is 300 times more sweetener than Sucrose.

Acesulfame potassium (Ace-k):

Acesulfame potassium is used as general sweetener. This is a white crystalline material which is stable up to high temperatures (250 °C). Because of its high stability under high temperature it is used in many bakery products.

Aspartame:

Aspartame is the most discussed sugar substitute which tastes like sugar. This is highly stable to hot temperatures and has modest solubility in water. This rate of solubility of aspartame is directly proportional temperature.

Sucralose:

Sucralose is one of the largely consumed sugar substitute. Sucralose is highly stable, safe and even used at higher temperatures (baked food products). Sucralose is up to 1000 times more sweeter than sucrose, thrice sweet as aspartame and acesulfame potassium and sucralose is twice sweet as saccharin.

Neotame:

If you are looking for high sweetening power, neotame is the best option. This compound is a

derivative of aspartame, but its sweetening power is between 7,000 and 13,000 times that of sugar. For this reason, only a very small amount is needed to sweeten products. Its high heat resistance and ability to enhance food flavors make neotame an attractive option for producing products with low doses.(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, Natrataste, sugar twin, Equal	200	4	Tabletop sweetener (in packets), chewing gums, instant coffee and tea, gelatins, 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, gelatins, gelatins

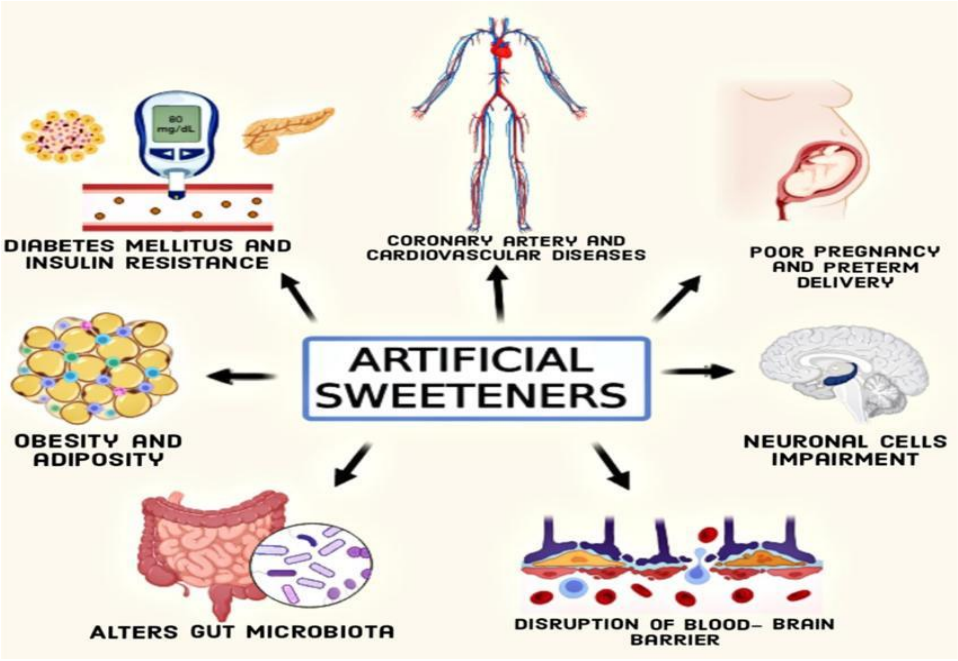
3.Therapeutic use:
Replacement of common table sugar with less or no calorie sugar in food products allows less calories intake into the body which in turn helps in reducing weight. High sucrose containing foods may cause dental decay, in order to reduce this problem. prescribe to use sugar substitutes. People suffering from diabetes have fluctuations in blood sugar use of sugar substitutes or artificial sweeteners in diet instead of table sugar allows more stability in blood sugar levels. (6)

4.Non Therapeutic use:
Aspartame taste same as common sugar which is used as sugar substitute in various processed foods. In few beverage and food industries aspartame is used as a sugar substitute which not only gives sugar taste but also enhances and even intensifies the flavors. (7)

5.Health benefits:
Arificial sweeteners do not increase the sugar levels in blood which is responsible for diabetes. These sugar substitutes have no calories. As these artificial sweeteners do not increase calories, they help people to control their weight. They provide good oral health.(8)

6.Hazardous impact of Artificial sweeteners on human health:
The long-term health effects of artificial sweeteners are still being discussed, with some Studies showing possible benefits and others pointing to harmful effects. While some research Says they can help with weight control, other findings suggest they might cause problems like An unbalanced gut

bacteria, issues with metabolism, effects on the brain and thinking, aanEven cancer. The major physiological impacts of artificial sweeteners include which affects blood glucose levels, obesity, gut microbiome, cardiovascular health, and cancer. (9)



Blood Glucose Concentration and Diabetes Mellitus

Consuming artificial sweeteners led to a rise in blood glucose levels but the rising level is lesser when compared to the glucose consumption. However, there is no noticeable change in the values between the four artificial sweeteners such as aspartame, saccharine, sucralose, and stevia.18 Furthermore, an animal study demonstrated the development of glucose intolerance following saccharin consumption. In humans, when saccharin consumed above the upper limit recommended by the ADI, also induced glucose intolerance and altered gut microbiota in four out of seven healthy individuals. Other intervention studies experimented on healthy individuals and diabetic individuals have shown no significant impact of artificial sweeteners on glucose homeostasis. (10)

Obesity and Weight Gain

Increased body weight and adiposity arise from a positive energy balance. Artificial sweeteners will impact energy balance and body weight differently when compared to natural sugar through physiological processes. In a metaanalysis including six prospective cohort studies of 26,551 subjects, established that the risk of obesity increased by 21% for every 250 mL/day rise in artificial sweetener-containing soft drink consumption.24 Several proposed mechanisms, both in vitro and in vivo, may elucidate the association between artificial sweetener intake and obesity.

Cardiovascular Disease

The negative consequences of added sugars on numerous health outcomes, including cardiometabolic disorders, have been extensively investigated and analysed in meta-analyses and are now widely acknowledged as major risk factors by public health authorities. The total artificial sweetener consumption was accompanied by a greater risk of cardiovascular system dysfunction. ACEK and sucralose were linked to an increased risk of coronary artery disease, whereas aspartame was not associated with such risk. The WHO's 2022 report on artificial sweeteners highlighted connections between the intake of beverages containing artificial sweeteners (used as a proxy) and certain intermediate indicators of CVD. (11)

Carcinogenic Effect:

The banning of cyclamate in 1970 due to suspicions of its carcinogenicity damaged the artificial sweetener market. However, these concerns regarding carcinogenicity have not been shown in human epidemiological studies. The diketopiperazine compound formed when aspartame decomposes has also been proposed as a potential cause of cancer. Another important discovery was the generation of nitrosated compounds through the interaction of aspartame or its diketopiperazine breakdown product with nitrates in the diet. (12)

Impact on Gut Health:

Although research in this area is still incomplete, some preliminary studies suggest that long-term consumption of artificial sweeteners may affect the gut microbiome (beneficial gut bacteria). These potential changes can affect the body's metabolic processes and impact overall digestive health. Some artificial sweeteners, such as saccharin and sucralose, can disrupt the balance of gut bacteria. This imbalance is linked to metabolic disorders, systemic inflammation, and impaired immune function.

Neurological symptoms:

Artificial sweeteners have been linked to neurological symptoms in some individuals, including headaches and altered taste perception. The sweetener aspartame has also been associated with mood disorders, mental stress, and depression.

Addictive behavior:

Artificial sweeteners can be hundreds of times sweeter than sugar. This intense sweetness can overstimulate the brain's reward centers, potentially leading to cravings for more sweet foods and drinks. (13)

Children and pregnant women:

Comparatively fewer studies have been conducted on specific groups of the population, such as children and pregnant woman. The World Health Organization's meta-analysis emphasizes that the certainty of evidence in that topic is moderate to low due to lack of data, and the fact that the conclusions of conducted studies are often contradictory . One of the randomized controlled trial suggests that replacing sugar sweetened beverages with artificially sweetened beverages contributes to reducing weight gain in normal-weight children. However, the afore-mentioned WHO guideline claims that there is no benefit in consuming artificial sweeteners in order to control body mass. This recommendation also applies to children. Studies conducted on pregnant women suggest that there might be a link between usage of artificial sweeteners and preterm birth. Nevertheless, the authors claim that further investigation is needed to confirm their finding.

Long-Term Health Concerns

While reputable health organizations consider the consumption of artificial sweeteners safe in permissible amounts, the long-term effects of their daily consumption on health are not yet fully understood. For this reason, some experts recommend that these sweeteners be consumed as part of a balanced and varied diet, rather than as a substitute for whole, natural foods.(14)

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

The food industry's inclination to use artificial sweeteners is no accident. These compounds offer numerous economic and technical advantages to manufacturers, making them an attractive alternative to sugar. These reasons, beyond a simple change in formulation, represent an intelligent response to the evolving needs of the market and consumers.

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

Today, health concerns such as obesity and diabetes have increased among consumers. This has significantly boosted the demand for low-calorie and diet products. Artificial sweeteners, by providing perfect sweetness without calories, enable manufacturers to produce products such as diet sodas, sugar-free desserts, and packaged foods that are both delicious and help control weight and blood sugar. This feature is the main driver for industries to use these sweeteners.(15)

9.Food Colors

According to the Federal Food, Drug and Cosmetic Act, color additives, with the exception of coal tar hair dyes, must Receive approval from the FDA before they can be used in food, drugs, cosmetics, or medical devices that have Prolonged contact with the bodies of humans or animals. For the sake of Human health, it's crucial to set limits on the concentration of dyes used. The maximum allowable limit for permitted Color in any food product is set at 0.1 g per kg to ensure safety after consumption.Food and drug regulatory agencies establish permissible levels of synthetic dyes for inclusion in food products.

According to FSSAI regulations, the total concentration in synthetic food, the colorants must not fall above 100 ppm In food and beverage. Currently, it's estimated that the average Indian citizen consumes around 220 mg of food Colorants per year.48 FSSAI-approved synthetic colorants such as Red (Ponceau 4R, Carmoisine, Erythrosine), Yellow (Tartrazine, Sunset Yellow FCF), Green (Fast green FCF), Blue (Indigo Carmine, Brilliant Blue FCF). FSSAI Approved natural colours are Carotenes and carotenoids, Chlorophyll, Caramel, Riboflavin, Annatto, Curcumin,Saffron.(16)

10.Natural Colors:

Color is an important factor increasing consumer's acceptability to food products. This is due to consumers always links food color with other qualities such as ripeness, freshness, and food safety. . The synthetic food colors are available in different color shades. There are many reports on the toxicity of synthetic colors. Approved synthetic colors are proved to be toxic and carcinogenic. The usage of large synthetic colors causes pollution, disturbs the ecological balance and causes health hazards to human. Natural colors are obtained from naturally occurring sources such as plants, animals, insects, and minerals. Amongst the colors, plant-based pigments have wide range of medicinal benefits.Plant natural colors:The natural colorants in natural plants have been the source of the

traditional colorants of raw as well as the processed food. (17)

11.Plant Natural Color:

Table 2: Plant Natural Color (17)

Class	Color	E-number
Chlorophyll	Olive green	E 140
Anthocyanin	Red, purple, blue, pink, magenta	E 163
Carotenoids	Red, orange, yellow	E 160
Betalains	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 known as artificial color, is an artificially manufactured compound used to add or enhance color in food products to make them more visually appealing. These colorants are often cheaper, more stable, and more vibrant than natural alternatives, and they are available in various forms like powder or liquid. Examples include Tartrazine (Yellow 5), Allura Red (Red 40), and Brilliant Blue (Blue 1), though the safety of some synthetic colors is debated, leading to regulations and warning labels in certain regions. (18)

Table3: Artificial food colors are classified: As per PFA (18)

Sr. No	color	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

15.Adverse Effects of Food Colorants:

The Food Advisory Committee under the Food and Drug Administration held a hearing on certified color additives And their potential link to hyperactivity in children. A research has indicated that young children exhibit strong Responses to synthetic colorants, manifesting symptoms such as irritability, sleep problems, lack of attention, Impulsivity, hyperactivity, and a clinical condition known as attention deficit hyperactivity disorder Tartrazine appears To trigger the most allergic and intolerant reactions in all azo dyes, especially among asthmatics and individuals with Aspirin intolerance.(19)

Tartrazine appears to trigger the most allergic and intolerant reactions in all azo dyes, especially among asthmatics and individuals with aspirin intolerance. Research on Brilliant Blue FCF has reported potential side effects on human health, noting that high doses could lead to settlement in the kidneys and lymphatic vessels. Azo dyes containing Benzedrine rings, when metabolized by anaerobic intestinal microflora in the body, can produce aromatic amines, which are known to be carcinogenic and may contribute to the development of intestinal cancer. Exposure to auramine, a dye known for producing a yellow color, and rhodamine can cause damage and dysfunction to the liver and kidney in humans.

16. Health Hazards Of Food Colorants:

1. Hyperactivity In Children:

In the 1970s, people started talking about how artificial food coloring might cause hyperactivity and learning issues in kids. At that time, there wasn't much solid scientificproof to support these claims. However, many parents were still careful about using artificial colors, which kept the topic in the public eye and led to more research. Newer studies have found a small but meaningful connection between artificial food coloring and increased hyperactivity in children.Children are more likely to be affected by the health risks

connected to artificial food coloring. Their bodies and brains, which are still growing, can be more easily harmed by these substances. The American Academy of Pediatrics suggests that parents should try to reduce their children's contact with artificial food dyes, especially those that have been shown to be harmful.

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.

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. (20)

CONCLUSION:

The increasing prevalence of chronic diseases like diabetes mellitus and cardiovascular diseases has brought attention To the role of dietary factors including added sugars and artificial sweeteners, as well as food colorants. While artificial Sweeteners offer a low-calorie alternative to sugar, their potential health effects including impacts on blood glucose Levels, obesity, gut microbiome and even cancer raise concerns. Similarly, food colorants both synthetic and natural, Have been associated with adverse health effects including allergic reactions and potential carcinogenicity. In light of These concerns, there's a need for more research to better understand the long-term health implications of artificial Sweeteners and food colorants. Meanwhile, emphasizing the importance of reducing added sugars in the diet, in search Of healthier alternatives like rare sugars and stevia and advocating for stricter regulations on the use of food colorants Could help mitigate potential risks.Many sweeteners on health is beneficial, neutral, or negative. Additionally, caution should be exercised especially among vulnerable populations Such as pregnant women, children and individuals with specific health conditions. Overall, a balanced approach that Prioritizes consumer safety and public health is essential in navigating the complex landscape of dietary additives and Their potential impacts on health. Hence, we conclude that our diet should not be influenced by the campaign's food Marketing company.(21).

REFERENCE:

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 Durazzoa, Márcio Carocho 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
9. Normal Flora and Yeast, International journal of Health Scienced and Research 2017;7(8)110-114.
10. Tejashree Anil More, Zoya Shaikh and Ahmad Ali et.al., A Review on Artificial sweeteners and their Health
11. Implications, Biosciences Biotechnology Research Asia, 2021;18(2):227-237.
12. 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.
13. 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.
14. Rycerz K, Jaworska-Adamu JE. Effects of aspartame metabolites on astrocytes and neurons. Folia Neuropathol 2013; 51: 10-7.
15. 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.
16. Clauss, K. and Jensen, H. 1970. Cycloadditionen von

halogensulfonylisocyanaten an acetylene. Tetrahedron Letters 11(2): 119-122
17. 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.
18. 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.
19. Chattopadhyay S, Raychaudhuri U, Chakraborty R. Artificial sweeteners-a review. J Food Sci Technol. 2014;51(4):611-21.
20. 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.
21. Han Y, Park H, Choi BR, Ji Y, Kwon EY, Choi MS. Alteration of Microbiome Profile by D-Allulose in Amelioration of High-Fat-Diet-Induced Obesity in Mice. Nutrients. 2020;12(2):352.
22. Saraswathy S, Mishra S. Effect of Artificial Sweeteners on the Blood Glucose Concentration. J of Med Acad. 2018;1(2):81-5.
23. Purohit V, Mishra S. The truth about artificial sweeteners – Are they good for diabetics? Indian Heart J. 2018;70(1):197-9.