

Artificial Sweeteners – Pros & Cons

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Abstract

Majority of human population has a craving and fondness for sensation of sweet taste but means or modes of sweetness put a very strong impact on human health. Refined sugar has been proven as a culprit for various disorders ranging from mild symptoms of migraine to as severe as cancer. Nowadays there are many alternative sources of refined sugar including both natural as well as artificial or these can also be classified as nutritive and non nutritive sweeteners. Present review is based on different researches on impact of artificial sweeteners on various aspects of body. Some studies recommend the use of artificial sweeteners for weight loss and diabetes control as these are helpful in cut down excess calorie intake. On the other hand many research and review articles depict the harmful effect of sugar substitutes specially artificial sweeteners including acesulfame K and sapartame. Therefore, it's very important to counsel a patient properly about the judicious use and pros and cons of an artificial sweetener.

Keywords

Artificial sweeteners, Nutritive and Non nutritive sweeteners, sugar, calories, weight, diabetes

Introduction

Sweet sensation of taste is liked by majority of people. This property of food can be used to enhance food intake thus enough energy can be provided to fulfil metabolic needs and need to maintain person physically active. Natural sweet foods lead to good health, e.g. fruits and breast milk. Food becomes a pleasure when a pinch of sweet taste is added in one or other part of a meal. It also makes a food more palatable by masking unpleasant taste or fragrance of a food or medicine. Sweetness can be incorporated in a product with the help of sugar, sugar alcohols or dipeptides. These compounds can be affected by other flavours, physical state and temperature of the food product. These sweetening

agents interact with taste buds in mouth and the throat (Chattopadhyay et al., 2014). Sugar, one of the sweetening agent, is an indispensable part of our diet that may prove harmful for our teeth and waistline if consumed in uncontrolled manner. Excess sugar is very harmful that may cause teeth decay and abdominal obesity. As it provides empty calories without any nutrient, it can lead to Obesity (Tandel, 2011). Unfortunately, consumption of sugar has been linked to obesity and diabetes mellitus (DM) due to its empty calories, therefore a need was felt to invent its substitute without its ill effects (Sharma et al., 2016b). Adverse effects of refined sugars range from promoting heart disease (atherosclerosis), diabetes and prediabetes, obesity, metabolic syndrome, worsen mental behaviours, accelerates skin aging and decrease skin elasticity, impairs absorption of calcium and magnesium in kidneys, it weakens immune system, it weakens eyesight, lung and respiratory problems and tends to increase risk for all types of cancer.

Artificial sweeteners may prove a strong tool in reduction of excess energy intake although it is debatable since long (Debras et al., 2022).

What are artificial sweeteners?

It is a sugar substitute used as a food additive that contains multiple times sweetness than sugar but contains generally negligible amount of calories (Tandel, 2011).

Mechanism of action

Generally different types of artificial sweeteners have different structural and chemical properties that decide their fate of metabolism in the body. It may be one of the causes of enhancing belly fat/ insulin resistance by one type of sweetener than other (Debras et al., 2022).

Types of sweeteners

Sweeteners can be classified as natural or manmade (synthetic). Natural sweeteners are found directly or in bound form in many natural foods, e.g. sugar cane, fruits, beetroot, milk etc. Some more examples of natural sugar substitutes in form of sugar alcohols are xylitol, erythritol, tagatose and trehalose. These are obtained directly from nature, while some of the sugar substitutes are made by men, therefore known as artificial sweeteners e.g., saccharin, acesulfame potassium, aspartame, sucralose and acesulfame potassium

(Sharma et al., 2016). Chattopadhyay et al. (2014) described sweeteners as nutritive and non-nutritive. Food and Drug Administration (FDA) has recommended nutritive sweeteners (sucrose, fructose) safe. FDA has also approved five non nutritive sweeteners like saccharin, neotame, acesulfame-K, aspartame and sucralose and acceptable daily intake was determined for safe level of consumption. Usage of non nutritive sweeteners (NNS) has been popularised greatly today in many types of products including food and medicines. Six NNS obtained GRAS (Generally recognised as safe) status by United States Food and Drug Administration including aspartame, stevia, sucralose, saccharine, acesulfame-K and neotame. Later on Swingle fruit extract and advantame were also added to this list (Suez et al., 2014). Although natural sweeteners seem healthier, yet the minute amount consumed doesn't make any significant difference when it comes to vitamin, mineral and antioxidant intake. Some of the common natural and artificial sweeteners are as following -

Natural sweeteners	Artificial sweeteners
Honey, jaggery, dates, stevia, coconut sugar, maple syrup, molasses, agave nectar etc.	Aspartame, sucralose, acesulfame K, Saccharin, xylitol etc.

Bramlet (2017)

As per Purohit and Mishra (2018), there are different commonly consumed foodstuffs like sugarless cookies, diet coke, diet pepsi, chocolate syrup, sugar-free traditional Indian sweets, chewing gum, pan masala, supari, candies etc. that have abundant artificial sweeteners including acesulfame K, sucralose, stevia, cyclamate, saccharine etc.

Sugar free foods are gaining very much popularity in food processing units as they are calorie less or contain very less calories, therefore production of sugarfree foods using artificial sweeteners is very much in demand nowadays. U.S. Food and Drug Administration has been approved different artificial sweeteners like alitame, aspartame, acesulfame-k, neotame and cyclamate within acceptable daily intake (ADI) (Pang et al., 2021). These sugar substitutes provide sweetness without calories thereby producing low glycemic response. Sharma et al. (2016a) studied about different types of artificial sweeteners, their uses, chemistry and their impact on health. It was documented that

artificial sweeteners may be beneficial to health in terms of low calories intake but these may prove fatal if consumed at high concentrations for long term. Their side effects can be observed ranging from headaches to fatal brain damage (Sharma et al., 2016a).

As per Nagar (2020), there are many natural sugar substitutes that can be used in place of refined sugar. These will not only prevent the harm of artificial sweeteners but also have their own positive antioxidant effects with good quality mineral and vitamin profile. These include

- **Dates:** Being rich in fibre and protective nutrients, dates are not only digested easily but also reduce blood cholesterol levels very well
- **Stevia:** It is a plant based sweetener that is 200 times sweeter than sugar
- **Coconut sugar:** It can be used as a natural sugar substitute for non diabetics only as it is higher in glycemic index
- **Jaggery:** It is easily digested and is known to have protective role in various ailments as well including cold, cough, asthma etc.
- **Raw honey:** It is a natural antioxidant rich natural sugar substitute

Benefits of consuming artificial sweeteners are highlighted by various food industries as following -

- Tooth friendly (prevent dental carries)
- Help in increasing the quality of life of diabetics by providing sweetness without calories
- Helpful in weight control with enjoying sweet taste

However, it's a matter of deeply concern by many consumers and purely economic reasons have been found for the use of artificial sweeteners by food industry (Zygler et al., 2009).

Review of Literature

A lot of researches have been carried out on this very interesting and important subject. Many researchers found artificial sweeteners very useful in shedding weight and maintaining diabetes. On the other hand, many studies reported harmful health outcomes as well.

Therefore it's a much debatable topic. Some of the research work has been documented under following subheads -

Artificial sweeteners & weight

Poshala (2020) studied about both natural (xylitol and trehalose) as well as artificial sweeteners (aspartame and saccharin) and reported that these sugar substitutes are helpful in losing weight and management of diabetes, but this strategy is successful only with restricted calorie intake and exercise. On the contrary, it may lead to obesity and uncontrolled diabetes if not used correctly. Thus judicious consumption is the key. Therefore proper counselling is very much important for type and amount of sweetener. Similar results were found by Wilk et al. (2022) who evidenced weight loss and weight maintenance after consumption of NNS including neohesperidin dihydrochalcone, aspartame, saccharin, acesulfame-K, sucralose, neotame, cyclamate, advantame and taumatin, although role of NNS on appetite and regulation and perception of taste was not identified.

On the contrary, Brown et al. (2009) demonstrated a link between consumption of artificially sweetened beverage with weight gain in children, although randomized controlled trials in this area are scarce and evidence of artificial sweetener on metabolic health effects is yet to be studied more. It was also reported in their study that some animal experiments demonstrate a direct role of artificial sweeteners in metabolism. Till now, no clinical evidence of causality due to artificial sweeteners has been reported, still it is really very important to study pediatric obesity and diabetes in association with irrational usage of artificial sweeteners.

Pearlman et al. (2017) reported in their study that although artificial sweeteners have become healthy alternative of calorie dense sugar and a strong strategy for reduction in weight, yet clinical data does not correlate well with it. New innovations are required with focus on microbiome in plant based sweeteners, as this is the main attributing factor for absorption of nutrients as well as for glucose metabolism.

Artificial sweeteners & diabetes

A compositional and functional variation was noted in the intestinal microbiome after consumption of artificial sweeteners that was linked to increased susceptibility to metabolic disease and glucose intolerance (Weihrauch and Diehl, 2004). These artificial sweeteners were promoted for weight loss and established as safe for diabetics, but evidences from many studies oppose this propaganda (Suez et al., 2014). In an another study done by Sanyaolu et al. (2018) it was showed that obesity and diabetes continued to rise in obese and diabetic individuals inspite of similar level of consumption by lean, obese and diabetic individuals.

Similar results were quoted in another study done by Bukhamseen and Novotny (2014) who showed possibility of catastrophic ripple effects of consumption of artificial sweeteners above the recommended FDA guidelines. It may lead to obesity and diabetes. Role of artificial sweeteners has been popularized in control of obesity and diabetes mellitus due to reduced caloric intake but as per Purohit and Mishra (2018) these may not have any beneficial effect as they may alter the insulin sensitivity as well as other safety issues linked to cancer.

Artificial sweeteners & cancer

Many times artificial sweeteners have been propagated as carcinogenic by mass media since their launch in the market. This propagation has bothered population a lot about the usage of artificial sweeteners. Most of the Western world's population is consuming artificial sweeteners intentionally or unintentionally. Therefore, carcinogenic activity of one or other type of artificial sweeteners may put entire population at risk. ADA (2004) performed research work on old generation (saccharin, aspartame and cyclate) as well as new generation (acesulfame-K, neotame, sucralose and alitame) artificial sweeteners. It was reported that artificial sweeteners like saccharine and cyclamate didn't show any bladder cancer inducing activity in human subjects as was observed in rats. Similarly aspartme also didn't showed any cancer inducing activity. It was reported that risk may be seen in case of drastically heavy intake (>1.7 g/day). No conclusion was made for new generation sweeteners in scarcity of required evidences. Besides this as many sweeteners have been used in combination, therefore carcinogenic effect of single substance couldn't be determined.

Another study done by Tandel (2011) reported direct link of artificial sweeteners with increase in weight, gliomas, bladder cancer etc. Investigators are not unanimous on this issue. Present study took into account the consumption of artificial sweetener from all types of foods (including type of sweetener) and its association with risk of cancer (including site of cancer). Most commonly consumed synthetic sugar substitutes (aspartame and acesulfame-K) were related to higher risk of cancer. These results proved very beneficial and helpful in the re-evaluation process of artificial sugar substitutes by various health agencies worldwide including the European Food Safety Authority.

Artificial sweeteners and metabolic syndrome

Swithers (2013) evidenced that drastic usage of artificial sweeteners may result in obesity, metabolic syndrome, diabetes and cardiovascular disorders. It was documented that these compounds interfere with normal glucose and energy homeostasis and this interference is directly responsible for different types of metabolic derangements. Lohner (2017) also reported adverse health consequences in response to irrational consumption of artificial sweeteners. This may be precipitated as neurological problems, kidney changes, depression, preterm delivery or heart risk. Inconsistent use of artificial sweeteners was observed in diabetic and hypertensive patients.

Artificial sweeteners & GI disorders

Many a times, usage of artificial sweeteners seems safe, still some people may face gastric symptoms including diarrhoea specially paediatric age group after high doses consumption (Food & the Nutrition Care Process, 15th Edition).

Beneficial role of artificial sweeteners

Anti-inflammatory properties of aspartame were reported by Pradhan et al. (2010) in two different experimental models although its anti-inflammatory properties were not visible in experimental arthritis. Conclusion drawn that aspartame has therapeutic potential as an analgesic and antipyretic agent although more researches are needed in this direction.

Toews et al., (2019) demonstrated in their research an spike in body mass index z score of paediatric age group who consumed artificial sweeteners although remarkable weight difference was not found at the time of completion of this study.

As per ADA (2018), all FDA approved sweeteners can be consumed by diabetics and even in pregnancy also within recommended daily intake levels. It directly reduces sugar intake that is linked with reduction in calorie intake as well.

New inventions

Artificial sugar substitutes like Advantame and extract from swingle fruit are new inventions in this ever growing list of non nutritive sweeteners, which are abundantly used in various food as well as drug industry including dairy, confectionary and therapeutic purposes (Wilk et al., 2022).

Conclusion

Scarcity of randomized controlled trials still persist to derive any clear cut conclusion for artificial sweeteners. Majorly there is need to avoid artificial sweeteners like acesulfame K, Monosodium glutamate (MSG), sucralose, aspartame, sodium benzoate. It is really very important to find out their benefits in various physiologic and clinical conditions including pregnancy, lactation, paediatric age group, diabetics, neurological problems and cancer with their adverse outcomes as well. Certain dose of different types of sweeteners in different conditions yet to be determined after research trials on a big population group. As impact of artificial sweeteners is not clear and vary in different conditions, therefore patients or consumers need to be counselled well at the time of prescription. In fact, to be on a safer side, one should avoid prescribing these until positive or negative role becomes clear, as harms outweigh benefits. Therefore, it is recommended to follow evidence-based guidelines only.

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