

## Artificial sweeteners: safe or unsafe?

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### Abstract

Artificial sweeteners or intense sweeteners are sugar substitutes that are used as an alternative to table sugar. They are many times sweeter than natural sugar and as they contain no calories, they may be used to control weight and obesity. Extensive scientific research has demonstrated the safety of the six low-calorie sweeteners currently approved for use in foods in the U.S. and Europe (stevia, acesulfame-K, aspartame, neotame, saccharin and sucralose), if taken in acceptable quantities daily.

There is some ongoing debate over whether artificial sweetener usage poses a health threat. This review article aims to cover the health benefits, and risks, of consuming artificial sweeteners, and discusses natural sweeteners which can be used as alternatives.

**Keywords:** Artificial sweeteners, Diabetes mellitus, Natural sweeteners, Reactive hypoglycaemia.

### Introduction

Table sugar has been an essential component of human diet. Its excess can lead to unhealthy effect on the body, most notably diabetes mellitus. Therefore sugar substitutes were introduced as safer alternatives. These are now used by millions of people worldwide without knowing their harmful effects on the body.<sup>1</sup>

Artificial sweeteners (AS) are sugar substitutes used in place of regular sugar. Nowadays, they are found in various products termed "sugar free" or "diet".<sup>2</sup> Their sweetening ability is higher as compared to regular sugar, and they have fewer calories than table sugars.<sup>3</sup> The six Food and Drug Administration (FDA) approved artificial sweeteners regulated as food additives include acesulfame-potassium, aspartame, neotame, saccharin, sucralose and recently approved advantame (derivative of aspartame).<sup>2</sup>

### Benefits of artificial sweeteners

Many health benefits are associated with artificial sweeteners. This is the main reason for their worldwide popularity. According to nutritionist, Phyllis Roxland, "it

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enables people that are carb, sugar or calorie conscious to take in a wider range of foods that they would either not be allowed to eat or could only eat in such tiny amounts that they were not satisfying".<sup>3</sup> They are used in diabetes mellitus, as an alternative to sugar because they do not raise blood glucose levels. As they contain no calories, they can also be appropriately used for weight control.<sup>2</sup> A number of diabetics face difficulty in adapting to non-sugary foods. Artificial sweeteners make this difficult transition easier, allowing people with diabetes to eat their favourite foods.<sup>2</sup>

They can also be used in reactive hypoglycaemia, dental care to avoid caries and help enhancing flavours.<sup>1</sup> A statement from American Heart Association and American Diabetes Association in 2011 spelled out that non-nutritive sweeteners may be good for health by reducing or controlling weight and can have other beneficial metabolic effects too.<sup>4</sup>

### Possible health concerns with artificial sweeteners

Artificial sweeteners may have detrimental effects on the body. They can cause variety of hazards including cancer.<sup>2</sup> In 1970, a research was conducted which showed the association of saccharin with bladder cancer in laboratory rats.<sup>5</sup> They are also associated with malignancies like leukaemia, lymphoma and multiple myeloma (in men).<sup>6</sup> Similarly, another study which assessed the possible effects of five nonnutritive sweeteners on cell proliferation, morphology and cells' DNA by utilizing Caco2, HT-29 (colon) and HEK-293 (renal) cell lines. DNA damage, if any, induced by AS, was studied. Results showed that cells became less well defined and flatter at higher AS concentration. Colon cells were found to be more affected than renal cells. It was also seen that sodium saccharin and sucralose caused more DNA fragmentation in all cell lines than any other ASs.<sup>7</sup>

High fructose intake may cause hypertriglyceridaemia and gastrointestinal (GT) symptoms in susceptible individuals.<sup>8</sup> Bloating is another possible side effect of artificial sweeteners as the body is unable to completely absorb them. Some people also experience laxative effect from these substitutes, mainly from sorbitol and mannitol.<sup>9</sup>

Literature shows that use of artificial sweeteners can increase the risk of type 2 diabetes mellitus. In 2014, an

Israeli research presented experimental evidence that AS may aggravate, rather than put a stop to, metabolic disorders such as type 2 diabetes.<sup>10</sup> Another research conducted in 2013 demonstrated that diets sweetened with either natural or artificial sugars are linked with an increase in type 2 diabetes. However, more research is required.<sup>11</sup>

Artificial sweeteners can also cause increase in weight and obesity. A study was carried out on 3682 individuals examining long term relationship between artificially sweetened drinks and weight. Follow-up period was of 7-8 years in which weight was monitored. Results showed that those who consumed artificially sweetened drinks had a 47% higher increase in BMI than those who did not.<sup>12</sup> Similar hypothesis was proved by a study conducted in Texas University in 2005.<sup>13</sup> Another research in 2008 at Purdue University compared rats eating yogurt sweetened with either sugar or AS. Results showed that rats who consumed zero calorie substitutes had an increase in weight and body fat.<sup>14</sup> Normally, an orosensory stimulus is silently generated by sweet foods, telling the body about intake of calories. This is followed by several GI reflexes that prepare the body for intake. But when sugar substitutes are used alone, the connection between sweet sensation and caloric intake is lost and ability of the body in regulating intake changes. This leads to confusion of the body and ultimately weight gain.<sup>15</sup>

Apart from weight gain and body confusion, AS also cause chemical imbalances in the human body. Their frequent use can impair body's metabolic response normally generated due to food intake. This leads to decline in metabolic boost seen after a high calorie diet. This makes it difficult for the body to use those calories leading to decreased energy production.<sup>15</sup>

Although many AS are considered safe during pregnancy, women with any form of diabetes (gestational or diabetes mellitus) and insulin resistance must limit their use of these substitutes.<sup>16</sup> According to Garland et al (1993) saccharin has been shown to cause effects as anaemia, iron and vitamin A deficiency, depressed growth and elevated vitamin E in rats.<sup>17</sup> They are also linked with premature deliveries prompted by two observational studies published in 2010 and 2012. Therefore pregnant women must be advised to avoid these sweeteners.<sup>18,19</sup>

Artificial sweeteners, unlike, natural table sugar, provide no nutritional value. They have phosphoric acid which can cause increase in bone loss in later life. Some ASs are believed to cause side effects in patients suffering from conditions like cancer, depression, multiple sclerosis and systemic lupus. These include headache, fatigue, mood swings, and dizziness.<sup>2</sup> A study was conducted in the University of San Diego, California on volunteers who

were given small sips of water sweetened with either sugar or sucralose. MRI scans of the brain were then taken. Results showed that sugar activated areas of the brain were involved in food reward whereas sucralose did not have the same effect. These results proved that ASs may not be effective in managing cravings for sweets.<sup>20</sup>

### Alternatives to artificial sweeteners

Various natural sweeteners, which are safer, can be used instead of artificial sweeteners. Many of these include added benefits of being rich in minerals and vitamins. These include honey, coconut nectar, fruits, coconut sugar, maple syrup, molasses, sugar alcohols, stevia, dates, agave nectar, apple sauce and others.

Honey is considered as the best alternative to table sugar and artificial sweeteners. Apart from natural sugar, it also contains probiotics which aid in improving the health of the digestive system. Fruits are another source of healthy and naturally available sugar as they contain fructose which is packed with fiber and minerals. Coconut nectar is derived from the coconut tree blossoms and is rich in vitamin C and amino acids. Maple syrup, molasses and agave nectar are liquid sweeteners containing concentrated sugars. They also hold some quantity of calcium, magnesium, iron, potassium and zinc. Agave nectar also contains high amount of fructose making it unacceptable for some people with diabetes. Sugar alcohols like sorbitol, xylitol, mannitol, erythritol, isomalt occur naturally in many fruits and vegetables. Basically they are carbohydrates that are not calorie free but enclose fewer calories than white sugar and due to this fact they offer no nutritional benefit. They can cause bloating, gas and diarrhoea so should not be taken in large amounts. Lastly, stevia is a naturally occurring calorie free sweet plant that has been used for hundreds of years in parts of the world. It is widely considered safe for people with diabetes. Stevia rebaudiana is considered to be between 50 to 400 times sweeter than cane sugar.<sup>21-23</sup>

### Summary

Artificial sweeteners are a ubiquitous part of modern life, especially of diabetes care. Artificial sweeteners are added to a wide variety of foods, drinks, drugs and hygiene products. Their chief advantages are that they don't raise blood glucose levels, can be used to control weight and to treat hypoglycaemia. If used excessively, they can increase weight, promote obesity, and impairment of normal metabolic responses. These findings have now led to increase in importance of natural sweeteners in place of ASs as alternative to natural sugar. We conclude that artificial sweeteners should be used in a limited amount. Moreover, use of natural sweeteners should be increased.

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**Table-1:** Benefits limitations and potential risks of artificial sweeteners.**Benefits**

- ◆ In diabetes mellitus
- ◆ In reducing/ controlling weight
- ◆ In dental caries
- ◆ For flavour enhancement
- ◆ In reactive hypoglycaemia

**Limitations**

- ◆ No nutritional value
- ◆ May not manage craving for sweets
- ◆ Inability to boost metabolic response after high calorie intake
- ◆ Avoid in pregnancy

**Potential Risks**

- ◆ Malignancy (at very high dose)
- ◆ Hypertriglyceridaemia (fructose)
- ◆ Gastrointestinal symptoms
- ◆ Aggravation of diabetes (not proven)
- ◆ Weight gain
- ◆ Osteoporosis (due to phosphoric acid)

**Table-2:** Seven commandments for safe sweetener use.

1. Discuss AS use with your physician
2. Use an FDA approved AS
3. Use AS in moderate amount
4. Prefer natural sweeteners, wherever possible
5. Limit use of AS in pregnancy and lactation
6. Limit use of AS in children
7. Remember AS may lead to weight gain

AS: artificial sweeteners FDA: Federal Drug Agency.

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