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#### REFERENCES

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## SWEETENERS: FRIEND OR FOE?

**There can be a lot of confusion about the role and safety of sweeteners. This article will explore the evidence related to artificial sweeteners and bulk sweeteners. The term 'sweeteners' will be used to encompass both types of sweetener during this article.**

Sugars (also called 'nutritive sweeteners' or 'caloric sweeteners'), such as sucrose and fructose, contain carbohydrates and provide 3.75 calories per-gram.<sup>1</sup> Nutritive sweeteners are found in table sugar, honey and syrups. Artificial sweeteners are used to provide sweetness while containing little to no calories.<sup>1</sup> These are used in a variety of products such as diet soft drinks, jellies, yoghurts, desserts, chewing gum, sweets and table-top sweeteners.<sup>2</sup> Artificial sweeteners can also be referred to as sugar substitutes, non-nutritive sweeteners, intense sweeteners and high-potency sweeteners.<sup>1</sup> Polyols, like sorbitol, xylitol and mannitol, are sugar alcohols (also called 'bulk' sweeteners) which are technically nutritive sweeteners, but they are lower in sugar and calories than other sugars (2.4 calories per gram).<sup>1</sup>

The sweeteners listed in Tables 1 and 2 are licensed for use in the UK; each has a corresponding E number, which means that it has passed the safety tests for approved use in the EU and the UK.<sup>3</sup> Artificial sweeteners range from 30 times sweeter than table sugar (or 'sucrose'), to 37,000 times sweeter, whereas bulk sweeteners often have the same level of sweetness as sucrose, but can also be up to 50% less sweet. These are often used as fillers to improve the consistency of products, as well as their role as sweeteners.<sup>4</sup>

As part of the safety evaluation process by the European Food Safety Authority (EFSA), artificial sweeteners are given an acceptable daily intake (ADI)

value. This ADI, which applies to all food additives, is an estimate of the amount that is considered to be safe to consume everyday over a lifetime. It is measured as milligrams per kilogram of body weight per day.<sup>5</sup> For example, aspartame has an ADI of 40mg per kg body weight per day; in order to reach this, a 70kg adult would have to consume over five litres of Diet Coke everyday over a lifetime.<sup>1,6</sup> Rather than allocating an ADI, bulk sweeteners (which are licensed for use in the EU) are classified as 'acceptable', meaning that the expected exposure to these is considered safe.<sup>4</sup> An excess intake of bulk sweeteners is not advised as this can cause gastrointestinal issues such as, cramping, bloating, flatulence and diarrhoea.<sup>7</sup>

#### DENTAL HEALTH

There is an EFSA approved health claim that replacing sugar with intense sweeteners (i.e. artificial sweeteners), certain sugar alcohols (xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt and erythritol) and other nutritive sweeteners (D-tagatose, isomaltulose and polydextrose) is good for dental health.<sup>2</sup> This is because these sweeteners don't ferment and cause demineralisation of teeth; instead, they help to maintain tooth mineralisation.

#### DIABETES

Using artificial sweeteners in place of sugary options can be a useful strategy for managing blood glucose levels for some people with diabetes and also for

Table 1: ADI value of artificial sweeteners<sup>1,4,6,8-11</sup>

Artificial sweetener	E number	Approximate sweetness compared to sucrose	ADI value (per kg of body weight per day)
Acesulfame K	E950	200 times sweeter	9mg
Advantame	E969	37,000 times sweeter	5mg
Aspartame	E951	200 times sweeter	40mg
Sodium cyclamate	E952	30-40 times sweeter	7mg
Neohesperidin dihydrochalcone	E959	1000-1800 times sweeter	5mg
Neotame	E961	7000-13,000 sweeter	2mg
Saccharin	E954	300-500 sweeter	5mg
Steviol glycosides (or 'stevia')	E960	200-300 times sweeter	4mg
Sucralose	E955	600-650 times sweeter	15mg
Thaumatococin	E957	2000-3000 times sweeter	1.03-1.10mg
Aspartame-acesulfame salt	E962	350 times sweeter	15mg

those with reactive hypoglycaemia.<sup>1,12</sup> There is some evidence that saccharin and sucralose may increase insulin levels, but, overall, the research is conflicting, so more well-designed human studies are needed to investigate this.<sup>13-16</sup>

EFSA approved the health claim that replacing sugar with the same sweeteners outlined earlier (i.e. xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt, erythritol, D-tagatose, isomaltulose and polydextrose) reduces the increase in blood sugars which occurs after a meal.<sup>2</sup> However, EFSA could find no clear relationship between using artificial sweeteners to replace sugar and maintaining normal blood sugar levels overall.<sup>2</sup>

For those who carb count, it is not clear how bulk sweeteners should be counted, as the carbohydrate levels absorbed from these can vary.<sup>17</sup> Bulk sweeteners are also used in products labelled as 'diabetic food'. However, these products are not usually recommended as they can still be high in fat and calories and may cause gastrointestinal problems if consumed in large amounts.<sup>17</sup>

## WEIGHT MANAGEMENT

Although swapping sugars for sweeteners reduces calorie intake, there are concerns that sweeteners may interfere with our metabolism and increase our appetite.<sup>1,18</sup> Some studies have found that using artificial sweeteners as part of a weight-loss program can help participants to improve

weight loss;<sup>1,19-22</sup> however, a review by EFSA in 2011 found no clear relationship between using sweeteners and weight management.<sup>2</sup> A recent systematic review by Azad et al found evidence from cohort studies that consuming artificial sweeteners was associated with a slight increase in BMI, weight and waist circumference, but there was no association found from randomised-controlled trials.<sup>23</sup> There is a small amount of research that suggests that those who consume sweeteners may have a lower overall diet quality and this may also play a role in terms of weight management.<sup>24</sup> There is limited information about the effect of polyols on weight management.<sup>25</sup>

Furthermore, it has been found that sweeteners can alter gut bacteria which may be harmful. This has mainly been found in animal studies and the results of human studies have been mixed.<sup>26-28</sup> Other studies have found that changes in our gut bacteria can be linked to our weight and overall health,<sup>29-30</sup> so it is possible that sweeteners may promote weight gain via changes to our gut bacteria, but more human trials are needed to test this.

Overall, more research is needed to clarify the role that sweeteners play in weight management. The BDA acknowledges this, but also highlights that sweeteners can be helpful in some cases, as they 'allow patients and (or)

Table 2: Bulk sweeteners compared to sucrose<sup>3,4</sup>

Bulk sweetener	E number	Approximate sweetness compared to sucrose
Erythritol	E968	20-40% less sweet
Isomalt	E953	50% less sweet
Lactitol	E966	50% less sweet
Maltitol	E965	Same level of sweetness
Mannitol	E421	30% less sweet
Sorbitol	E420	40% less sweet
Xylitol	E967	Same level of sweetness

clients to alter their calorie intake without making significant dietary changes'.<sup>1</sup>

### CANCER

Some studies in the 80s and 90s found an association between aspartame, saccharin and cancer development in rats. However, more recent large studies carried out in humans provide strong evidence that artificial sweeteners do not increase cancer risk.<sup>6,31</sup> As discussed above, both types of sweeteners have undergone rigorous evaluation by EFSA and are licensed as safe to use in the EU within their respective ADI levels.<sup>1,6</sup>

### PHENYLKETONURIA (PKU)

This rare genetic condition is a deficiency of the enzyme phenylalanine hydroxylase, which means that the amino acid phenylalanine (Phe) cannot be metabolised and can build up to dangerous levels if not carefully excluded from the diet. As aspartame contains Phe, it is a legal requirement in the UK to clearly label that a food product contains a source of Phe if it contains aspartame.<sup>1,32</sup>

### PREGNANCY

ADI levels are very conservative, as they are calculated at one hundredth of the amount that is safe to consume. Therefore, sweeteners are considered safe to use during pregnancy, as long as consumption remains below the ADI. However, low calorie options shouldn't replace nourishing options during pregnancy; for example diet pop shouldn't replace milky drinks.<sup>1</sup>

### INFANTS AND YOUNG CHILDREN

In the EU, artificial sweeteners are not allowed to be used in any food which is designed for

infants or young children (up to three years old), including baby food.<sup>1,33</sup> An important reason for this is because infants and children have high energy needs to support growth and development.<sup>1,33</sup> There is also a lack of safety data in relation to the use of artificial sweeteners in this age group.<sup>1,33-35</sup>

A recent study found that breastfeeding mothers who drank diet drinks which contained sucralose and acesulfame K, resulted in these sweeteners transferring to their breast milk.<sup>36</sup> However, this was a small study and more research is needed to investigate whether this might have any negative health effects for a baby consuming this breast milk.

### CONCLUSION

The evidence base shows that artificial sweeteners and bulk sweeteners are safe for the general public to consume, including pregnant women (up to the advised ADI in the case of artificial sweeteners).

However, artificial sweeteners are not recommended for infants and children under three years old. People with PKU need to avoid aspartame.

There is no strong evidence that sweeteners increase the risk of cancer in humans; but there is good evidence that they are good for our teeth and can help to manage blood sugar levels. Sweeteners can also be useful as part of weight management interventions, especially for those with a sweet tooth.

Overall, sweeteners can be used as part of dietetic interventions, but, as with most aspects of nutrition, this should be assessed on a case-by-case basis.