The role of low calorie sweeteners in weight management: Evidence and practicalities

Debbie Cook, David Haslam, Carol Weir

Consumption of low calorie sweeteners (LCSs) is increasing (Mattes and Popkin, 2009), but questions remain around their role as a potential tool for weight management. A roundtable meeting of representatives from the National Obesity Forum was convened to discuss these issues. We reviewed the existing evidence regarding the effect of LCSs on energy balance, appetite, food intake and glycaemic response, and their role in weight management. This document summarises our conclusions and provides practical tips for healthcare professionals on the effective use of LCSs in weight management while also addressing some of the common misunderstandings surrounding their use. In summary, the evidence reviewed suggests that LCSs are an appropriate tool for weight management with few, if any, discernable negative effects and some potential benefits.

What are low calorie sweeteners and how are they used?

Low calorie sweeteners (LCSs) are intensely sweet sugar substitutes that are up to several hundreds of times sweeter than sucrose, commonly known as table sugar. LCSs are added to many foods and beverages, but their impact on beverages is potentially the most significant as they can reduce the energy content to zero, while maintaining palatability. Aspartame, for example, is a LCS that is 180 times sweeter than sucrose, but has the same energy value (4 kcal/g) (Weibe et al, 2011). Owing to its high sweetening power, aspartame is used only in small amounts accounting for fewer, or no, calories compared with equivalent standard products (Table 1). Saccharin was the first LCS to be developed during the late 1800s (Academy of Nutrition and Dietetics, 2012), but the market for LCSs has only begun to develop over the past 30 years or so, concomitant with the increase in obesity and type 2 diabetes, which led to an increased interest in methods of losing weight or maintaining weight loss (Mattes and Popkin, 2009).

In the literature, LCSs are also often referred to as “non-nutritive sweeteners”, “low energy sweeteners” or “intense sweeteners”. The LCSs currently licensed for use in
the UK include: saccharin, aspartame, acesulfame potassium, sucralose, cyclamate (Diabetes UK, 2012a) and, most recently, steviol glycosides, which were granted authorisation in the EU in December 2011 (Food Standards Agency, 2012). The varying chemical properties of each LCS means they are suited to diverse uses e.g., acesulfame potassium is stable at oven temperatures and therefore is suitable for use in baked goods whereas some other LCSs degrade under such conditions (Academy of Nutrition and Dietetics, 2012).

It has been widely postulated that one of the causative factors for the current obesity epidemic is our innate preference for sweet taste combined with an abundance of sweet tasting foods (Drewnowski et al, 2012). The prevalence of type 2 diabetes has risen in tandem with the increase in obesity, with 3 million people now diagnosed with the condition in the UK, a prevalence of 4.6% of the adult population (Diabetes UK, 2012b). Overweight and obesity are also associated with a number of other morbidities, and, as such, there is intense interest in tools such as LCSs for assisting with weight management for people with, or at risk of, obesity.

Typically, the energy difference between regular and LCS-sweetened products is more pronounced in beverages than foods (Bellisle and Drewnowski, 2007; Table 1). Therefore, this document will focus mainly on use of LCSs in beverages. For clarity, the term “caloric beverage” will be used throughout to denote non-diet carbonated soft drinks, naturally sweet drinks such as fruit juices and other sugar-sweetened beverages. (Despite being caloric, it should also be noted that fruit juices provide the benefit of certain vitamins and minerals [British Soft Drinks Association, 2013]).

In the UK, the safety of all licensed LCSs has been assessed by the European Food Safety Authority (EFSA), which assigns acceptable daily intake levels (ADIs – that is, the safe level of intake over the lifetime of an individual). There are several national and international bodies that have also assessed the safety of LCSs and approved them as safe for use. For example, EFSA (2013) has recently published draft guidelines to re-state the safety of aspartame at its current ADI, and the US National Cancer Institute (2009) has stated that “There is no clear evidence that the artificial sweeteners available commercially in the United States are associated with cancer risk in humans”. We are satisfied with the safety data for LCSs, and therefore this topic will not be discussed further in this document.

**LCSs in weight management: What does the evidence say?**

We reviewed and discussed 64 papers (44 original research papers and 20 reviews). The search criteria for selection of these papers were as follows (PubMed search terms are provided on page 4):

- Available literature from the early 1980s up until 2012.
- Only human studies considered.
- Papers were published in peer-reviewed journals and excluded anecdotal findings or unsubstantiated case reports.

Although there is now a considerable database of investigations, many of which are double-blinded and placebo-controlled, to provide a basis for assessing possible effects of LCSs on hunger, food intake, weight control, insulin release, blood glucose concentrations and dietary compliance by meeting recommended dietary goals, the limitations of the data as noted by some of the review articles were:

- Typically small study populations.
- A paucity of studies in children owing to the attendant ethical issues.
- LCSs are ubiquitous, meaning that randomised controlled trials are difficult to execute and have limited applications for use in clinical practice.
- Many studies relied on recall of dietary intake, which has been shown to be generally unreliable (Medical Research Council, 2012).

**Key conclusions**

Overall, the evidence reviewed suggests that LCSs are an appropriate tool for use in weight management because they offer a means of creating a calorie deficit while maintaining the palatability of food and beverages (Mattes and Popkin, 2009). In 2012, the Academy of Nutrition and Dietetics published a position paper in which dietetic practice-related questions around LCSs were identified and a conclusion statement was developed for each following a systematic review of the literature. The conclusions were scored according to the quality of the evidence base, with “good” meaning that the evidence is clinically important, and the results are consistent and free of serious doubt. On the other hand, “limited” means that the evidence base is limited and the studies are inconclusive. For a full explanation of the criteria please see: www.andevidecephalibrary.com/grades. The decisions are too numerous to list here, but some of the key conclusions were (Academy of Nutrition and Dietetics, 2012):

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<th>Table 1. Energy differences between regular and diet consumables (Bellisle and Drewnowski, 2007).</th>
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• There is good evidence that use of aspartame as part of a comprehensive weight management programme may be associated with weight loss and assist with weight management.
• There is good evidence that aspartame does not affect appetite or food intake.
• There is fair evidence that steviol glycosides (commonly known as stevia) have minimal, if any, effects on blood glucose and insulin levels, hypertension, and weight.
• There is limited evidence that sucralose does not increase food intake or appetite, and has no metabolic effects.

As already noted, there are limitations to the available data in this field, but one noteworthy trial that provided evidence to support a role for LCSs in weight management was the DRINK (Double-blind Randomised Intervention Study in Kids) study (de Ruyter et al, 2012). DRINK demonstrated reduced weight gain among children consuming LCS-sweetened beverages as opposed to a caloric beverage over an 18-month period. More than 600 normal-weight children aged between 4 and 11 years were recruited to the study and randomly assigned to receive the same volume of either a LCS-sweetened beverage or a similar-tasting caloric beverage. Masked replacement of a caloric beverage with a low-calorie beverage led to reduced weight gain and reduced body fat gain of approximately 1 kg over the study period. By blinding the trial and ensuring that both beverages tasted similar, the potential effects of some psychological cues were eliminated.

Clarifying the facts
Media interpretation of some of the data surrounding LCSs may have impacted upon their perception by the public and led to propagation of some misconceptions. However, the results of some of the studies that have seeded these misconceptions have not been reproducible. Some examples of questions commonly faced by healthcare professionals, in our experience, are presented in the boxes that follow, along with our responses:

Q: Do all LCSs leave a bitter aftertaste?
A: Saccharin is commonly regarded as having a bitter aftertaste, but saccharin is no longer extensively used to sweeten food or beverages in the UK, following the emergence of alternative sweeteners with different taste profiles.

Q: Do LCSs increase appetite?
A: The “paradox” that consumption of LCSs could cause increased appetite was first raised in a study by Blundell and Hill (1986). They reported increased hunger in participants who had consumed an aspartame-sweetened beverage compared with water. Others have since tried to recreate these results, but have not succeeded and, in fact, many studies have found the opposite effect (Anton et al, 2010).

Q: Will consumption of LCSs lead to addiction to sweet tasting foods?
A: There has been some concern that consumption of LCSs could train the palette to prefer sweet-tasting items (Mattes and Popkin, 2009). However, there is no convincing evidence to suggest that it is problematic to dissociate sweetness from energy intake. The subject of food addiction is currently a contentious topic and a full review is beyond the scope of this document. However, in the evidence reviewed here, there were no data to suggest that LCSs are addictive. Furthermore, as reviewed by Drewnowski and Bellisle (2007), sweetness does not fulfill the criteria for substance dependence as detailed in the Diagnostics and Statistics Manual of Mental Disorders, 4th Edition.

Q: What advantages do LCSs have over other means of achieving weight loss?
A: Substituting caloric beverages for their low-calorie equivalents is a small-scale change that is often achievable in individuals seeking to lose weight. However, this approach only has potential for success in an individual who typically consumes caloric beverages as part of his or her diet.

LCSs in diabetes
It has been well established that weight loss in overweight people with type 2 diabetes is associated with benefits such as reductions in both blood glucose levels and cardiovascular risk (Look Ahead Research Group et al, 2007). Thus, control of body weight is of the utmost importance in those with type 2 diabetes. Prior to approval, LCSs are scrutinised to ensure they are safe for consumption, including for use by those people with diabetes (American Diabetes Association, 2008). Studies have highlighted that further research is required around LCSs and the glycaemic response (Weibe et al, 2011). One interesting study concerning LCS use in diabetes was conducted by Brown et al (2012). Glucagon-like peptide-1 (GLP-1) secretion in response to either carbonated water or soda sweetened with sucralose and acesulfame potassium followed by a glucose load was assessed in participants aged 12–25 years with either type 1 or type 2 diabetes. The researchers found that GLP-1 secretion was increased by 43% with the LCS-sweetened beverage compared with the carbonated water in those with type 1, but not type 2 diabetes. The clinical significance of this finding is yet to be determined, but it has been hypothesised by the study authors that the LCSs increased GLP-1 secretion by binding to sweet taste receptors on gastrointestinal L cells. In addition, GLP-1 is known to delay gastric emptying, so LCSs may have a role in suppressing appetite (Foreyt et al, 2012).

Further to this, there are currently limited data suggesting a beneficial effect of steviol glycosides on glucose metabolism in
type 2 diabetes. Steviol glycosides have been found to increase insulin sensitivity and stimulate insulin release only in type 2 diabetes (Chatsudthipong and Muanprasat, 2008). However, this is a potentially interesting effect, and further research in humans is needed to substantiate this.

Conclusions and practical implications

The available evidence suggests that LCSs can play an important role in helping people to lose weight or maintain weight loss. Our key “practice points” for healthcare professionals supporting overweight and obese individuals are summarised in Box 1. However, ideally it would be helpful for there to be more long-term, high quality, adequately powered randomised controlled trials to confirm the exact role of LCSs in weight management (Weibe et al, 2011).

Box 1. The authors’ key “practice points” regarding the use of low calorie sweeteners.

1. In order to lose weight, the amount of calories expended must be greater than calories consumed.
2. Low calorie sweeteners should always be used in the context of a healthy, balanced diet with regular exercise to assist with weight management. This can be achieved by decreasing calorie intake, e.g. through switching to low calorie sweeteners, and/or through increasing calorie expenditure through increased exercise.
3. When recommending low calorie sweeteners for weight loss, it is important to draw attention to the psychological effect of compensation for reduced consumption of calories by raising calorie intake at subsequent meals. That is, someone who achieves calorie savings, for example, through replacing their usual two teaspoons of sugar in their cup of tea with a low calorie sweetener, may use this as justification to consume an extra snack or to consume a larger portion at their next meal.
4. Low calorie sweeteners can be recommended for use in people with diabetes as a means of reducing or maintaining body weight as part of their overall diabetes management strategy. Low calorie sweeteners do not contain carbohydrate and therefore have no adverse effects on glycaemic control.

N.B. Fruit drinks and other acidic soft drinks, regardless of whether or not they are calorific, should be consumed with meals to minimise damage to teeth.

References

Diabetes UK (2012b) Number of people diagnosed with diabetes reaches three million Available at: http://bit.ly/XkpXKp (accessed 05.03.2013)

*The complete list of papers reviewed for the purpose of this supplement can be accessed at: www.nationalobesityforum.org.uk/index.php/publications

PubMed search terms

- Aspartame and weight control/management
- Aspartame and food intake
- Sweeteners/low calorie sweeteners and appetite
- Low calorie sweeteners
- Non-nutritive sweeteners
- Low calorie sweeteners and diabetes, blood glucose
- Sucralose and diabetes
- Sweeteners and diet quality/dietary recommendations
- Sweetness
- Sweet taste perception

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