WEIGHTY issues

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BY **DAVE SAMMUT**

Is a switch to artificial sweeteners a smart alternative to sugar?

In March 2016, Britain introduced a 'Sugar Tax' to be applied to high-sugar drinks (excluding fruit juices and milk-based drinks). The levy will be based on volumes produced in two total sugar categories: >50–80 g/L and >80 g/L. The most popular cola drinks in Australia, for example, contain at least 106 g/L sugar. During the recent federal election, the Greens again raised a sugar tax as policy.

If sugar taxes hit their target, it may be assumed at least some portion of the consumer base will switch to artificial sweeteners, particularly in the soft drink market.

Obesity is a growing problem in Australia. According to the Australian Institute of Health and Welfare, 63% of adults and 25% of children are overweight or obese. These rates are increasing faster than anywhere else in the world (ab.co/2amR6WO), with Australia already ranked as one of the world's most obese countries.

A 2013 study published in *The Lancet* concluded: 'Not only is obesity increasing [globally], but no national success stories have been reported in the past 33 years. Urgent global action and leadership is needed to help countries to more effectively intervene.' (bit.ly/2aK6Khw)

However, obesity is a complex issue. The sugar taxes that have been

introduced or mooted only address one causal factor. And if artificial sweeteners are one logical alternative to sugar, then do artificial sweeteners offer any advantage? Sure, the calorific value of the drinks may be lower, but are we just swapping one problem for another? Questions have been raised about the safety of artificial sweeteners – potential carcinogenic and mutagenic effects, metabolic changes, and the potential to actually trigger weight gain.

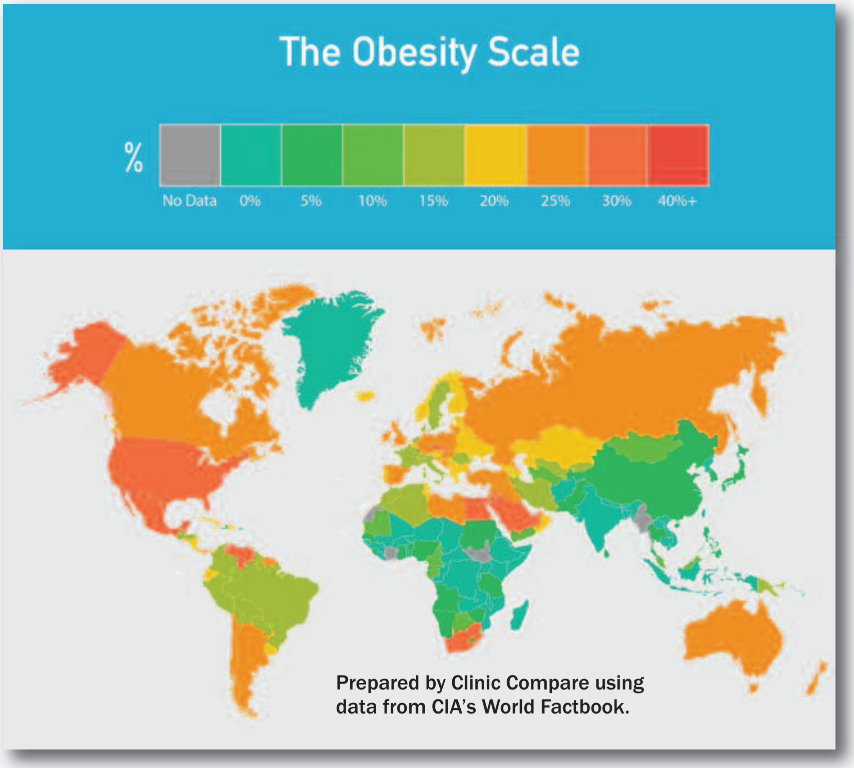
Let's start with the basics. Artificial sweeteners are used as sugar replacements for two reasons. First, they offer the body lower energy on consumption, either by requiring substantially less material to achieve the same sweet taste intensity (see How Taste Works, box, page 25), or by not being metabolised by the body. And second, the most common artificial sweeteners are substantially cheaper than sugar. Aspartame, for example, is typically one-third of the cost of sugar per litre of soft drink.

In principle, it would seem logical that artificial sweeteners should be a viable replacement for sugar. Not only should lower energy intake reduce obesity, particularly if this is balanced with lifestyle improvements such as increasing exercise, but reduced sugar intake should also improve dental health.

However, for decades artificial sweeteners have been subject to an evolving series of serious health concerns and complaints. There do appear to be some genuine causes for concern – certainly worthy of serious study.

International regulatory agencies have engaged in in-depth considerations of the available information, but the field is complex. The science is tarnished with claim and counter-claim, duelling studies with mutual criticism, selective study design and/or data selection. All of this is underlaid with the distorting influences of vested interests/science for sale, politics and the hysterical non-science of the antifluoride/antivaccination variety. Throw in a solid dose of media sensationalism, and the truth is incredibly difficult to discern.

Aspartame is a good example. It has been anecdotally blamed for a huge range of health problems, from headaches and seizures, to chronic fatigue syndrome and multiple sclerosis, Alzheimer's disease and cancer. Of these, the cancer threat grabs many of the headlines. This may be linked to the legacy of cancer studies associated with saccharin (no longer widely used), which may have 'bled over' in the public perception to the wider range of sweeteners. Yet regardless of how the concerns arose, and despite aspartame's long-standing use, its safety remains a current issue and an ongoing area of active investigation for health authorities worldwide.



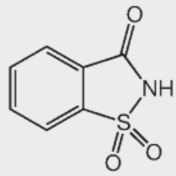
Prepared by Clinic Compare using data from CIA's World Factbook.

Aspartame is unusual among artificial sweeteners in that it fully breaks down during digestion, into phenylalanine, aspartate and methanol. While these are normal compounds as part of our diets, it has been argued in a 2011 study at Gujarat's Government Medical College in India that at high levels, they can cause problems to the central nervous system, and/or that their negative effects are increased in the absence of the other amino acids that would normally be ingested at the same time (bit.ly/2auPMmD). Similarly, the methanol produced as a breakdown product of aspartame has been argued to significantly exceed recommended daily allowances.

In response to the concerns, regulatory authorities globally have conducted multiple studies and reviews, including of large populations. The consensus appears to be that aspartame is safe at reasonable consumption levels (bit.ly/2auPMmD) (the European Food Safety Authority acceptable daily intake is 40 mg/day per kilogram of body mass; an average can of diet soft drink in Australia contains less than 200 mg of

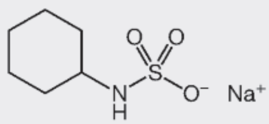
The sweetest things

Saccharin: Accidentally discovered in 1879 by Constantin Fahlberg, who failed to wash his hands before eating after working in the lab, the name is derived from the Latin word for 'sugary'. Roughly 300 times sweeter than sugar, saccharin isn't used extensively any more but can still be found with aspartame in some soft drinks and in Sweet 'N Low®. In the 1970s, it was found to potentially cause bladder cancer in rats, and it carried a warning label until the 1990s. However, it was later concluded that the cancer mechanism was different in rats, and saccharin was removed from the US NIH's list of carcinogens in 2000.



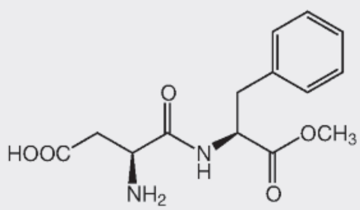
saccharin

Cyclamate: Accidentally discovered in 1937 by student Michael Sveda while smoking in the lab, sodium cyclamate is 30–50 times sweeter than sugar. It was banned by the US FDA in 1970 because of reports that it causes cancer in animals, but is still used widely worldwide (such as Canadian Sweet 'N Low®), usually in combination with other sweeteners. It is cheap, and stable under heating.



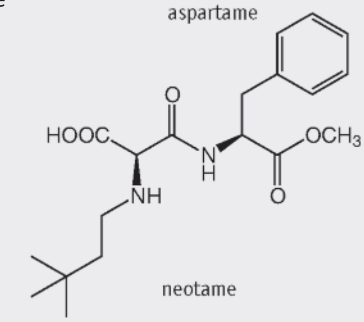
sodium cyclamate

Aspartame: Accidentally discovered in 1965 (seriously folks, take some *care* in the lab, this isn't safe) by Jim Schlatter, who licked a finger before picking up a piece of paper from a bench, aspartame is roughly 200 times sweeter than sugar. It is the most commonly used artificial sweetener, in most diet soft drinks and in Equal®, NutraSweet® and NatraTaste®. Aspartame breaks down in heat, so it isn't used in baked or heated foods.



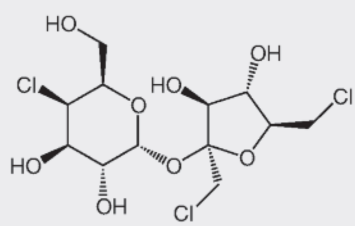
aspartame

Neotame: Similar to aspartame, neotame is derived from a combination of aspartic acid and phenylalanine. It is 8000 times sweeter than sugar, but being the newest artificial sweetener approved for general use in the US, it is not yet widely used.



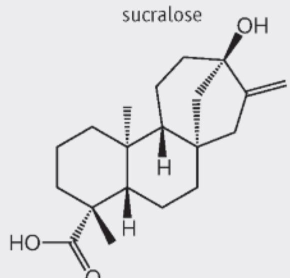
neotame

Sucralose: Produced from sugar via the replacement of three hydroxyl groups with chlorides, sucralose becomes 600 times sweeter than sugar in processing. It is used in Splenda®, and is the most heat-stable of the artificial sweeteners. This has seen its introduction into a broad range of foods and beverages as a substitute for other artificial sweeteners.



sucralose

Stevia: A natural plant extract, Stevia has been used as a sweetener in Paraguay and Brazil for centuries. It is roughly 300 times sweeter than sugar, and is not metabolised by the body. However, studies have suggested that it may be linked to lower sperm production and smaller offspring. Stevia is currently not approved for food use by the FDA. Steviol (pictured) is the basic building block of Stevia's sweet glycosides.



steviol

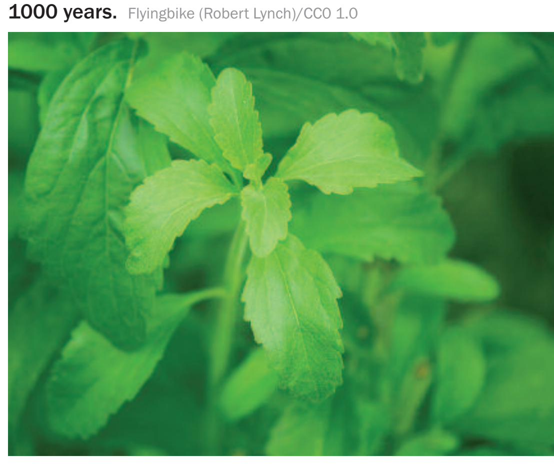
aspartame)

Even if artificial sweeteners are not directly toxic, there is still the important concern as to whether they are actually effective in combating obesity. In this, there does seem to be a growing consensus that the artificial sweeteners may actually have the opposite effect to that intended, via one or more mechanisms.

Following a 2005 study of more than 1500 adults in the US, Sharon Fowler of the University of Texas Health Science Center stated that: 'There was a 41% increase in risk of being overweight for every can or bottle of diet soft drink a person consumes each day' (wb.md/2auQ7pe). Fowler was careful to note that this is not necessarily a causal link, but is exemplary of wider observations. One possibility is that psychology comes into play. A person may say something along the lines of 'I've been good with this diet soft drink, so I can afford to have a little extra treat.' Alternatively, the extra ingestion might not be a conscious choice.

In a 2004 study at Purdue University in the US, two groups of rats were offered sugar-sweetened food after having been first primed with either artificial sweeteners or standard sugared food. The rats who ate sugar all the way through controlled or reduced their intake, while the rats fed with artificial sweeteners did not (go.nature.com/2b4g133).

Leaves of *Stevia rebaudiana* have been used as a natural sweetener for more than 1000 years. Flyingbike (Robert Lynch)/CC0 1.0



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A 2013 review of multiple similar studies at Purdue University argued that our taste receptors play an important function in regulating our energy intake (bit.ly/2amWcCC). Under this hypothesis, our taste receptors detect the total sweetness of our food intake, giving an indication of when we have 'had enough'. By using artificial sweeteners, it is argued that the 'calibration' of the learned behavioural link is thrown off, so that we no longer receive accurate signals on when to stop ingesting other sugary foods. 'This somewhat counterintuitive result may reflect negative consequences of interfering with learned relationships between sweet tastes and typical post-ingestive outcomes, which may result in impaired ability to compensate for energy provided when caloric sweeteners are consumed.'

The review was emphatically attacked by various people and organisations with apparent links to the vested interests in the beverage industries, such as the Calorie Control Council. This potential conflict of interest may not eliminate the criticisms, but it leaves room for doubt.

There is also some evidence to suggest that artificial sweeteners may be addictive. In a 2007 study at the University of Bordeaux in France, rats were given a choice of water sweetened with saccharin or intravenous cocaine; 94% of the animals selected the saccharin, with specific indicators of addiction observed through variations in the methodology (bit.ly/2azhEI0).

Emerging studies also point to the importance of the balance of our digestive flora to the extraction of energy from food. For example, a 2014 study at the Weizmann Institute of Science in Israel found that even short-term ingestion of artificial sweeteners may favour the growth of bacteria that maximise the energy extracted from our food (bit.ly/2aOQm0y). High levels of these bacteria have been associated with obesity in rats, and also potentially in humans, but again it is not yet certain whether this is a causal link.

What is indisputable among the various viewpoints is that with obesity as a growing public health issue, it is critical not only that action is taken to induce behavioural change (including decreasing sugar consumption), but that the direction of that change doesn't lead us down the wrong path. There is an urgent need for independent, consensus science to determine whether artificial sweeteners are effective in reducing obesity, or are actually worsening the problem.

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How taste works

How does our body actually perceive flavour? What we see on our tongue are three forms of taste papillae. These structures host the much smaller taste buds, and perform various specific functions to enhance our perception of taste, temperature and touch. The taste buds themselves (2000–4000 in total, spread throughout the oral and nasal cavities) each contain 10–50 sensory cells, which are in turn connected to nerve fibres. When the chemicals in our food come in contact with proteins on the surface of the 'taste pore' at the outer reservoir of the taste bud, the cell is activated and produces messenger chemicals to inner nerve cells. These, in turn, pass the information for a particular perception of flavour to the brain.

About half of the sensory cells are 'coded' to react to just one taste, and transmit the intensity of the stimulus. The other half have varying sensitivity profiles for all of the five basic tastes: sweet, sour, salty, bitter and umami (savoury). One cell might be particularly sensitive to salty, then sour and bitter, while another might have a completely different profile. The combined signals give the full experience of flavour.

Most artificial sweeteners are said to be 'sweeter' than sugar. The intensity of the sweet response is much greater than for the equivalent amount of sugar. For example, saccharin is 300–500 times sweeter than sugar. However, such measurements are empirical, relying on statistical analysis of perceptions from trained panellists, typically compared to 0.1 M sucrose solutions.