INTERNATIONAL STEVIA COUNCIL

Effective, Nature-based Sugar Management:

Overview of the Safety and Benefits of Modern Stevia-based Sweeteners

Summary

Global experts acknowledge the range of serious health risks associated with excessive sugar consumption, including cardiometabolic disease, diabetes, metabolic syndrome, obesity, and even depression.[1] The recent COVID-19 pandemic has amplified consumers' consciousness of excessive sugar intake's negative health effects, catalyzing a more proactive and holistic approach to wellness. As the public increasingly recognizes the need for healthier lifestyles, the food and beverage industry has expanded programs and projects to reduce the level of calories and added sugars in their products. Replacing sugar-based sweeteners in foods and beverages with plant-based, nonnutritive sweeteners, such as sweeteners derived from the stevia leaf, consumers today have access to an array of food and beverage options that satisfy their desire for sweetness while supporting improved public health. A wealth of scientific evidence exists that supports the use of nonnutritive sweeteners, like stevia-based sweeteners, to help reduce the risk of chronic diseases and improve quality of life.

Need for a Sugar-Reduced Diet

In recent decades, countries across the globe have become increasingly aware of the negative impact of excessive calories and added sugar consumption.[2-4] According to the World Health Organization (WHO), noncommunicable (or chronic) diseases are the world's leading cause of deaths, killing 41 million people each year, equivalent to 74% of all deaths globally.[5] Although causal relationships have not been established, observational studies do show correlations between excessive sugar intakes, largely through sugar sweetened beverages, and increased non-communicable disease risks.[1]

The serious health risks of obesity and related illnesses underscore the great importance of changing the lifestyle-related risk factors of these conditions, including sedentary behavior and unhealthy diets. Added sugars in the diet both can contribute to overall caloric density and impact the nutritional quality of the diet by providing energy without nutrients; this can lead to weight gain and increased risk of chronic diseases.

Though researchers acknowledged the relationship between sugar and insulin eighty years ago, the health profession only began to take heed in the 1950s and 60s[6,7]. In 2015, a formal guideline was finally established by the WHO recommending the reduction of added sugar intake to less than 10% of total energy intake, with added guidance that reductions to below 5% of total energy intake would provide additional health benefits.[5] Public interest thereafter showed a heightened awareness of the health risks of poor diets, resulting in greater interest in healthier, reduced-sugar diets and concurrent interest in plant-based foods.

The Case for Nature-Based Zero Calorie Sweeteners

The recent COVID-19 pandemic sparked a global trend toward health and wellness, not only for increased immune health, but also mental wellbeing and reduced waistlines, with 66% of consumers reporting the pandemic made them more conscious of their 'overall health'.[8] Many people gained unwanted weight during the pandemic from comfort eating but have now recognized the long-term health problems associated with increased weight and obesity.[8] With over 43% of US consumers stating that they are limiting sugar in their diets, control over sugar intake is being recognized as an essential tool for a healthier lifestyle.[9]

Despite a desire to reduce sugar, taste and pleasure remain strong motivators for consumers toward specific foods. Thus, consumers are increasingly seeking products to satisfy their cravings for taste and nutrition with no tradeoffs.[10] These demands provide the medical and nutrition community with unique opportunities to introduce patients and consumers to a wide variety of plant-based, reduced-energy and reduced-sugar offerings. Stevia-based sweeteners, in particular, offer consumers a great range of options when it comes to nutrition, a desire for nature-based ingredients, and taste. In comparison, calorie-dense sweeteners like sucrose, corn syrup, agave, and honey, while plant-based and nature-derived, are prime sources of unwanted added sugars.

Nonnutritive sweeteners, as a class, have little to no caloric impact. These sweeteners are hundreds to thousands of times sweeter than sugar and are often used to reduce or eliminate added sugar and calories from foods and beverages. They can be divided into two groups: artificial sweeteners, such as sucralose and aspartame, which are not found in nature, and nature-derived sweeteners such as stevia-based sweeteners and monk fruit extracts. This latter group is set apart by their natural origin, providing the best of both worlds for consumers seeking a zero calorie, nature-based sweetness.

Overview of Stevia-Based Sweeteners

Origin Story

Stevia is one of the world's most popular nature-based sweeteners. The sweetness of stevia comes from molecules called steviol glycosides, which are found in the leaves of the stevia plant Stevia rebaudiana, a small shrub native to South America.[11] The sweet-tasting steviol glycoside molecules were identified in the stevia leaf in 1931, and were first commercially prepared in Japan in the early 1970s.[12] Stevia is easy to grow and cultivate on a large scale and is now grown in many countries. Stevia leaf extracts were acknowledged to be GRAS (generally recognized as safe) in the United States in 2008 when the US Food and Drug Administration issued a letter stating it had no questions regarding the safety of the ingredient for use in food and beverages.[13] The first generation of stevia extracts satisfied many consumers' cravings for a nature-based, zero calorie sweetener, but some consumers detected some bitter and licorice tastes in products sweetened with the ingredient.

Technological Advances

The primary component of the original stevia sweeteners launched into the marketplace was the sweet molecule Rebaudioside A (or Reb A). Since then, the stevia leaf extraction process has advanced, igniting research studies into the stevia leaf. Over forty great-tasting steviol glycosides were discovered, each with a different taste and sweetness profile. Since then, the stevia leaf extraction process has advanced over the years, first with the isolation of the molecule Rebaudioside A (or Reb A), then with the as researchers isolated other sweeter and better tasting steviol glycosides such as Rebaudiosides M and D, among many more.

Several technological advances have improved the taste of stevia-based sweeteners. Innovative new production technologies like bioconversion and fermentation have greatly improved stevia taste and consumer satisfaction. These "next generation" steviol glycosides, such as Reb M and D, are now widely available and deliver a taste much more comparable to nutritive sugars.

Health and Safety

High quality scientific studies support the benefits of steviol glycosides for health. Steviol glycosides have been found to be safe and have no adverse effects on blood glucose management, appetite or food intake when used to reduce or substitute sugar and calories in a meal, food, or beverage.[14-16] Randomized controlled trials noted a significant reduction in post-meal blood glucose levels with purified steviol glycosides used in reduced-sugar/calorie meals[17,18] or in supplement

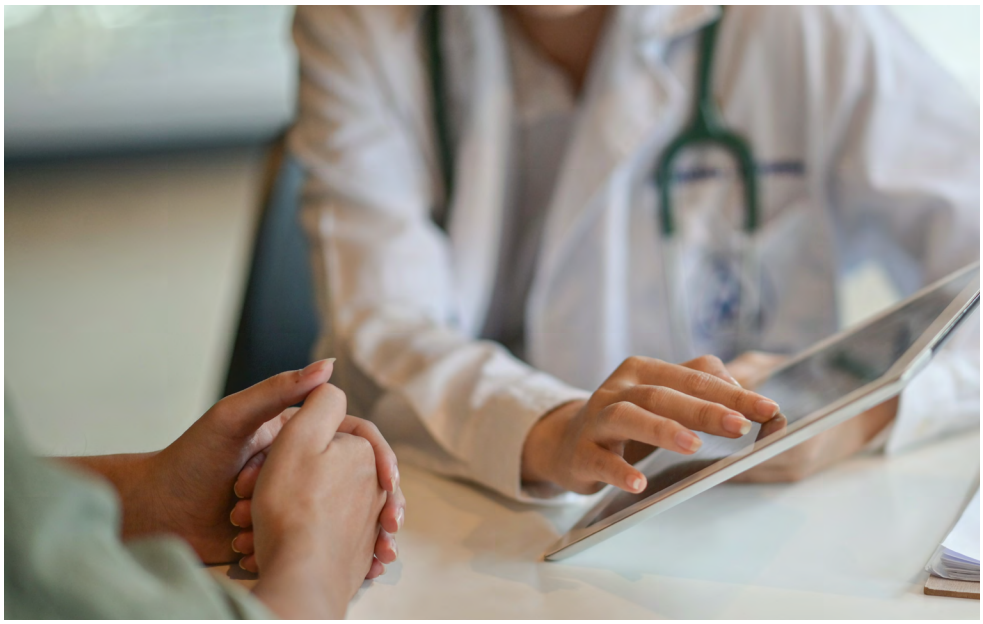
The technology of great taste

Stevia-based sweeteners are incredibly diverse in taste and sweetness because each sweet molecule (steviol glycoside) in the stevia plant has unique qualities. For example, Rebaudioside A, the first high purity stevia-based ingredient to be recognized as safe in the US, has a sweet taste as well as some light licorice and bitter notes. Many consumers like this taste, but some prefer less bitterness and aftertastes. New sweet steviol glycosides like Reb M, which occur only in small quantities in the stevia leaf, provide a cleaner sweet taste, with no bitterness, licorice and very little in terms of lingering sweet notes. Advanced production technologies called bioconversion and fermentation that mimic the aging process of stevia leaves, have enabled the production of these newer, improved tasting stevia-based ingredients. These fermentation and bioconversion production processes are similar to the production of beer, wine and cheese, and are the key to delivering the great tasting, zero calorie stevia-based sweetness consumers want in their sugar-reduced products.

form, in people with diabetes and healthy controls.[19] In one study involving lean and obese subjects, a significant reduction in post-meal blood glucose and insulin occurred when stevia was consumed in a mid-morning meal compared to sucrose.[17] In addition, longer-term studies – ranging from 3 months to 1 year – in healthy individuals and people with diabetes indicate that steviol glycosides are safe and have a neutral effect on fasting blood glucose, insulin, and hemoglobin A1C at doses of equal to and less than 1500 mg per day.[12,18] Stevia is an optimal sweetener to satisfy the taste cravings of many individuals for whom high-sugar consumption has drastic consequences.

Although some have raised concerns that nonnutritive sweeteners may contribute to obesity, a critical review of the literature has found no supportive evidence for mechanisms contributing to weight gain. In fact, most of the studies exploring the use and effect of nonnutritive sweeteners on weight in adults have shown that they reduce caloric intake, resulting in moderate weight loss, and prevent unwanted weight gain.[19,20] Regarding other health parameters, research on steviol glycosides has observed a modest but positive effect on blood pressure[21], and other studies have reported no negative gastrointestinal side effects from steviol glycosides.[12] Furthermore, stevia-based sweeteners are not cariogenic and may be beneficial for the prevention of dental caries.[12] Food and drinks containing stevia-based sweeteners in approved amounts are safe for all consumers, including children and pregnant and nursing women, as well as those with diabetes.[12]

Regulatory approvals for high purity steviol glycosides are based on safety studies with high-purity (>95%) steviol glycosides that have addressed any adverse effects that have been historically noted with unpurified and crude stevia extracts, which are not approved.[22, 23] In humans, steviol glycosides remain intact until the large intestine, where they are broken down by intestinal bacteria to the core molecule, steviol. Steviol is absorbed by the liver where it forms steviol glucuronide, which then enters the blood stream and is primarily eliminated in the urine.[24, 25] Rats are the ideal animal model to measure stevia toxicology due to similar exposure of the extracts to organs after consumption. When rats were fed high purity steviol glycosides, they showed no detrimental effects on development or reproduction.[12] Furthermore, these assessments dosed rats with far greater levels of steviol glycosides than humans consume.[12] Today's "next-generation" stevia-based products contain only the high purity glycosides, such as Reb M.



As stated previously, these ingredients have been submitted to the U.S. Food and Drug Administration (FDA) since 2008 and are Generally Recognized as Safe (GRAS).[13] These ingredients have also been reviewed and determined to be safe globally by food safety authorities such as the European Food Safety Authority (EFSA), the Joint WHO/FAO Expert Committee on Food Additives (JECFA) [26, 27], Food Standards Australia New Zealand (FSANZ) and Health Canada. The data are solid and conclusive: high purity stevia-based sweeteners are safe to use and enjoy.

Find Stevia-Sweetened Products

Many companies and food manufacturers today incorporate next-generation stevia ingredients into their products. These foods and beverages are sold across the globe. Stevia-based sweeteners can be found in reduced and zero sugar beverages like teas, juice drinks, flavored waters, sodas, coffees, etc., and in foods from sweet condiments to bars, cereals, candies and desserts. When looking for products that contain stevia ingredients, consumers can look for the following names on the ingredient list: stevia leaf extract, stevia sweetener, stevia-based sweetener, stevia extract, steviol glycosides, Reb A, and Reb M. Consumers can enjoy sweet-tasting food and beverages guilt free, because stevia-based sweeteners contribute zero calories and deliver an enjoyable sweet taste.[27]

Summary

The serious health risks imposed by excessive energy and sugar consumption continue to negatively impact public health. Prevalent chronic disorders such as diabetes and obesity highlight the importance of dramatic dietary changes to improve public health outcomes and lower mortality. National and global dietary guidelines encourage the reduction of added sugar intake, so replacing traditional caloric sweeteners with high purity stevia-based sweeteners meets changing health needs and the consumer's desire for healthy, nature-based, and tasty zero-calorie sweetness options. High purity stevia-based sweeteners have a proven safety record for consumers of all ages and stages of life, making it an ideal option for consumers looking to reduce their sugar intake in a variety of beverages and foods. Furthermore, innovative technologies have produced next-generation stevia products to replicate the sweet taste that consumers crave.

Medical and dietetic professionals interested in helping their patients transition to reduced or no-sugar-added products sweetened with stevia-based sweeteners should feel confident that these products offer a safe and delicious taste experience that will promote and support healthier lifestyles and meet consumer demand for elevated nature-based taste experiences in their holistic approach to wellness.

References

1. Huang Y, Chen Z, Chen B, Li J, Yuan X, Li J, Wang W, Dai T, Chen H, Wang Y, Wang R, Wang P, Guo J, Dong Q, Liu C, Wei Q, Cao D, Liu L. Dietary sugar consumption and health: umbrella review. BMJ. 2023 Apr 5;381:e071609. doi: 10.1136/bmj-2022-071609. PMID: 37019448; PMCID: PMC10074550.

2. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. The Lancet. Diabetes & Endocrinology. 2016;4(2):174-186.

3. Ng SW, Ni Mhurchu C, Jebb SA, Popkin BM. Patterns and trends of beverage consumption among children and adults in Great Britain, 1986-2009. The British Journal of Nutrition. 2012;108(3):536-551.

4. Sanigorski AM, Bell AC, Swinburn BA. Association of key foods and beverages with obesity in Australian schoolchildren. Public Health Nutrition. 2007;10(2):152-157.

5. World Health Organization (WHO) Noncommunicable diseases, September 2022 **https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases**

6. Vecchio I, Tornali C, Bragazzi NL, Martini M. The discovery of insulin: An important milestone in the history of medicine. Frontiers in Endocrinology. 2018;9:613.

References

7. O'Connor A. How the sugar industry shifted the blame to fat. New York Times 2016.

8. "Health and Wellness: Prevention Over Cure in 2022." FMCG Gurus.

9. "Plant-Based Eating and Alternative Proteins: June 2021." Euromonitor International.

10. "Health and Wellness: Conscious Indulgence in 2022." FMCG Gurus.

11. International Stevia Council website, "History of Stevia", **https://internationalsteviacouncil.org/about-stevia/history-of-stevia/**. Accessed on April 24, 2023.

12. Samuel P, Ayoob KT, Magnuson BA, et al. Stevia Leaf to Stevia Sweetener: Exploring Its Science, Benefits, and Future Potential. The Journal of Nutrition. 2018;148(7):1186S-1205S.

13. US. Food and Drug Administration, GRAS Inventory:

GRN No. 252
https://www.cfsanappsexternal.fda.gov/scripts/fdcc/?set=GRASNotices&id=252&sort=GRN_No&order=DESC&startrow=1&type=basic&search=stevia

GRN No. 253
https://www.cfsanappsexternal.fda.gov/scripts/fdcc/?set=GRASNotices&id=253&sort=GRN_No&order=DESC&startrow=1&type=basic&search=stevia

14. Stamataki NS, Scott C, Elliott R, McKie S, Bosscher D, McLaughlin JT. Stevia Beverage Consumption prior to Lunch Reduces Appetite and Total Energy Intake without Affecting Glycemia or Attentional Bias to Food Cues: A Double-Blind Randomized Controlled Trial in Healthy Adults. J Nutr. 2020 May 1;150(5):1126-1134. doi: 10.1093/jn/nxaa038. PMID: 32125421.

15. Farhat G, Berset V, Moore L. Effects of Stevia Extract on Postprandial Glucose Response, Satiety and Energy Intake: A Three-Arm Crossover Trial. Nutrients. 2019 Dec 12;11(12):3036. doi: 10.3390/nu11123036. PMID: 31842388; PMCID: PMC6950708.

16. Stamataki NS, Crooks B, Ahmed A, McLaughlin JT. Effects of the Daily Consumption of Stevia on Glucose Homeostasis, Body Weight, and Energy Intake: A Randomised Open-Label 12-Week Trial in Healthy Adults. Nutrients. 2020 Oct 6;12(10):3049. doi: 10.3390/nu12103049. PMID: 33036155; PMCID: PMC7600789.

17. Anton SD, Martin CK, Han H, et al. Effects of stevia, aspartame, and sucrose on food intake, satiety, and postprandial glucose and insulin levels. Appetite. 2010;55(1):37-43.

18. Jeppesen PB BL, Meyer MT, Palacios M, et al. Efficacy and tolerability of oral stevioside in patients with type 2 diabetes: a long-term, randomized, double-blinded, placebo-controlled study. Diabetologia. 2006;49:511-512 (abstr 0843).

19. Ceunen S, Geuns JM. Steviol glycosides: chemical diversity, metabolism, and function. Journal of Natural Products. 2013;76(6):1201-1228.

20. Rogers PJ, Hogenkamp PS, de Graaf C, et al. Does low-energy sweetener consumption affect energy intake and body weight? A systematic review, including meta-analyses, of the evidence from human and animal studies. International Journal of Obesity (2005). 2016;40(3):381-394.

21. Rogers PJ, Appleton KM. The effects of low-calorie sweeteners on energy intake and body weight: a systematic review and meta-analyses of sustained intervention studies. Int J Obes (Lond). 2021 Mar;45(3):464-478. doi: 10.1038/s41366-020-00704-2. Epub 2020 Nov 9. Erratum in: Int J Obes (Lond). 2021 May 27;: PMID: 33168917.

22. Onakpoya IJ, Heneghan CJ. Effect of the natural sweetener, steviol glycoside, on cardiovascular risk factors: a systematic review and meta-analysis of randomised clinical trials. European Journal of Preventive Cardiology. 2015;22(12):1575-1587.

23. Planas G, Kuc J. Contraceptive properties of Stevia rebaudiana. Science. 1968;162:1007.

24. Melis M. Effects of chronic administration of Stevia rebaudiana on fertility in rats. Journal of Ethnopharmacology. 1999;167:157–61.

25. Roberts, A, Renwick AG, Comparative toxicokinetics and metabolism of rebaudioside A, Stevioside, and Steviol in rats. Food and chemical toxicology: an international journal published for the British Industrial Biological Research Association. July 2008; 46 Suppl 7(7); S31-9.

26. Commission Regulation (EU) 2021/1156 of 13 July 2021 amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council and the Annex to Commission Regulation (EU) No 231/2012 as regards steviol glycosides (E 960) and rebaudioside M produced via enzyme modification of steviol glycosides from Stevia. https://eur-lex.europa.eu/eli/reg/2021/1156/oj.

27. Specification Monograph prepared by the meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), 91st Meeting 2021. https://www.fao. org/3/cb8031en/cb8031en.pdf.