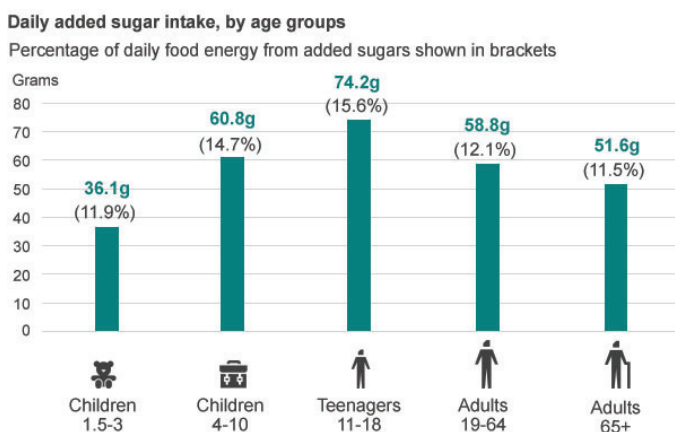


SUNETT® ACESULFAME POTASSIUM

A SUPERIOR SWEETENER FOR ACHIEVING SUGAR REDUCTION GOALS.

Current challenges to the sweetener industry extend beyond the chemistry. Currently, more than 1.4 billion adults and more than 40 million children are overweight. Worldwide, more people die of illnesses related to obesity (heart disease, type-2 diabetes, stroke, and even some cancers) than starvation. Medical research and public opinion has focused on the prevalence of refined sugars in our diet as a main factor responsible for this situation.

The Scientific Advisory Committee on Nutrition (SACN) recommends that free sugars should account for no more than 5% of daily dietary intake. Figure 1 illustrates the estimated average daily sugar intake by age group over the four-year period between 2008 - 2012.



Source: National Diet & Nutrition Survey, rolling programme 2008-12

Figure 1. Daily sugar intake.

In response to the health risks associated with excessive sugar consumption, there has been a growing movement among consumers and public

health professionals alike to decrease dietary sugar. Around the world, government agencies have responded with public policy interventions ranging from funded studies, to simple dietary guidelines, to more aggressive school nutrition policies, to reduction of food and beverage marketing activities to children, to levying punitive excise taxes on sugary drinks and foods with additional sugar content. Taxation, particularly of sugary drinks, is a popular, high-profile response, and to date a number of countries have introduced taxes, including Mexico, France, Hungary, the UK, at least 35 of the United States, Denmark, Finland, and Norway. Taxation is being considered or pending approval in a number of other countries.

While this range of responses has had a depressing effect on the sugar industry, it represents an opportunity for the low calorie sweetener industry. When it comes to addressing healthcare and consumer sentiment, your task as product developers is to remove sugar but still retain a taste that will ensure that consumers keep purchasing your products.

Human taste buds evolved over millions of years to detect five basic tastes: salt, sweet, bitter, sour, and savory (umami). When it comes to sweet,

the gold standard has always been sucrose, so the challenge has been to reproduce the taste of sucrose as closely as possible. It hasn't been easy. All low-calorie sweeteners have different flavor characteristics (sweetness, flavor, mouthfeel, and aftertaste), both individually and in combination. Their characteristics as food additives also vary: some break down when heated, which makes them unsuitable for baked goods, others are stable to relatively high temperatures. Some have longer shelf lives or greater synergistic qualities than others. Still, taste continues to be the most important driver in the purchase of reduced-sugar foods and beverages.

Given all the choices available, choosing the appropriate sweetening system can be challenging. The focus of this paper is to inform you about Sunett® Acesulfame-K brand sweetener and how it could be used to make your next sugar-reduced product a success.

WHY USE ACESULFAME-K?

Of all high potency sweeteners tested, no single sweetener tastes exactly like sugar, but blending sweeteners has a lot of potential to approximate the taste of Sucrose. Figure 2 shows how blends of Acesulfame-K fit into the sweetness aftertaste/bitterness landscape in a carbonated lemon-lime soda. While not a perfect match to sugar, these Acesulfame-K blends can significantly improve the sweetness quality of a zero calorie product compared to an individual sweetener.

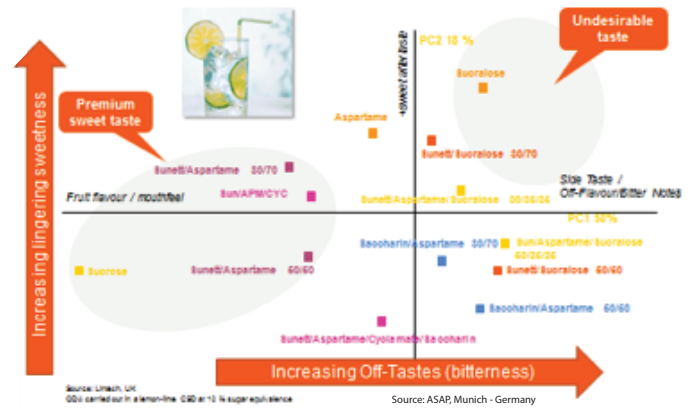


Figure 2. Sensory panel results show that Sunett® Ace-K blends provide a taste that is more similar to sugar. Bitter and bitter aftertaste principal component 1 (bitter, bitter-AT, bitter-AT2).

Over the years, Celanese Food Ingredients (CFI) has generated this kind of sensory data for many food and beverage applications. This innovative research uncovered the benefits of combining sweeteners and optimizing blends and types of sweeteners to achieve the taste goals of the individual product. CFI also linked the optimized blend to the flavor system of the beverage. In every case, Acesulfame-K blends were evaluated as being more similar to sugar than any individual sweetener.

The reason that Acesulfame-K blends provide such a sugar-like taste is linked to Acesulfame-K's 'temporal' profile. Many high potency sweeteners, such as aspartame, sucralose, and stevia, have a delayed onset of sweetness or the sort of lingering sweetness that consumers associate with an "artificial" or diet taste because it does not taste like sugar. To the contrary, Acesulfame-K has a fast onset of sweetness, which fades quickly (also unlike sugar). However, when Acesulfame-K is used in combination with these lingering sweeteners the resulting taste profile is much more like sugar. Figure 3 illustrates this by presenting the temporal profile of sugar and individual sweeteners as well as an Acesulfame-K and aspartame blend.

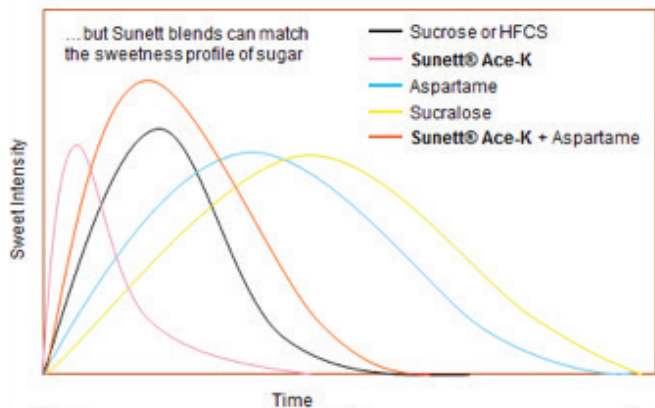


Figure 3. No single sweetener tastes like sugar but Sunett® Ace-K blends can match the sweetener profile of sugar. Individual sweetener and Sunett® blends sweetness profiles.

While the taste benefit of an Acesulfame-K blend drives its use in foods and beverage, its physical and chemical versatility ensures that it can be used without issues. The table below lists some of these properties and the benefits they would have for food and beverage manufacturers.

ACESULFAME-K FEATURES AND BENEFITS

Feature	Benefit
Excellent heat stability – up to 230oF	Ace-K can be used in a wide variety of thermally-processed products (baked goods, boiled confections, hot filled beverages, canned goods).
Broad pH stability from 3.0 to 9.0	Ace-K can be used successfully in essentially all food, beverage and pharmaceutical products.
200 times sweeter than sugar	High potency of Ace-K means that usage levels are low, making it a very cost-effective sweetener.
Does not react/interact with other food ingredients	Ace-K can be used in all food, beverage, and pharmaceutical formulations without concern about quality changes over time due to ingredient interactions.
Excellent water solubility – up to 27% soluble at room temperature	Ace-K quickly and fully dissolves in water for ease of production. It is easily incorporated into concentrates and beverage bases.
Zero calories	Ace-K is not metabolized and doesn't contribute any calories to your formula.

Table 1. Acesulfame-K features and benefits.

These characteristics clearly indicate that Acesulfame-K is an excellent sweetener choice when removing sugar from foods and beverages. In addition to that, the following section provides a brief history of the sweetener and illustrates that not all brands of Acesulfame-K are the same.

SUNETT® ACE-K DISCOVERY AND DEVELOPMENT

Like other high-potency sweeteners, Acesulfame potassium was discovered by accident. In 1967, Hoechst researcher Karl Claus was conducting research on oxathiazinondioxides and found that they tasted sweet. A subsequent research program evaluated structurally-related compounds until a great-tasting, safe, stable, and commercially viable compound was selected — now known as Acesulfame-potassium. Since that discovery, Hoechst has generated an abundance of safety data to satisfy the requirements of global regulatory approvals, bolstered its production know-how with a robust patent portfolio, broadened its expertise in the usage

of Acesulfame-K in foods and beverage, and trademarked the name Sunett® Ace-K for the sweetener. Through a series of mergers and divestitures, the name of the owner of the production, intellectual property, and know-how have changed from Hoechst to Nutrinova® to the current name, Celanese. The Food Ingredients division of Celanese still supports the Hoechst patent portfolio and continues to support the use of Sunett® Ace-K in the market. The amount of time and resources that Celanese invested in bringing Sunett® Ace-K to market has made them experts in the production and usage of this unique sweetener. This expertise has led to an extensive production and application patent portfolio, which Celanese continues to build and enforce.

SUNETT® ACE-K QUALITY

Sunett® Ace-K is manufactured in a modern, single-purpose facility in Frankfurt Germany. This centralized manufacturing approach allows Celanese to bring its considerable production expertise to bear to ensure the high quality of Sunett® Ace-K when compared to other Acesulfame-K products on the market. The advantages of this product include:

- Seamless system processing that minimizes defects and risk through the entire supply chain. Every step in the production of Sunett® acesulfame potassium is monitored for quality control and documented (safety and security).
- Industry certification as best-in-class by AIB, HACCP, BRC, and NFPA/GMA-SAFE as well as compliance with the Food Safety and Modernization Act (FSMA).
- A vertically-integrated supply chain with critical raw materials on the manufacturing site so there is no exposure to possible contamination during shipping.
- Certification as Kosher and Halal.
- A customer support line is staffed 24/7.
- A continuous review and a comprehensive crisis management system is in place to reduce risk to our customer's brands.

Since the appearance of generic Acesulfame-K on the market, Celanese has found some marked differences that they have brought to the attention of the food and beverage industry. Specifically, these differences are:

- **Insoluble Impurities.** Impurities of unknown sources found in generic Acesulfame-K samples are generally black or brown particulates that can clog filters. Figure 4 illustrates the impact of these insoluble impurities on a simple filter test.



Figure 4. Insoluble impurities test results. Predictable purity for your product quality and brand protection.

- **Particle Size Consistency.** This may be an indicator of process stability and process control. The particle size distribution of Sunett® Ace-K exhibits low batch-to-batch variables compared to that of generic Acesulfame-K manufacturers. This might have implications during food and beverage production where particle size is critical. Figure 5 provides some further detail on the benefits associated with Sunett®'s Ace-K consistent particle size.

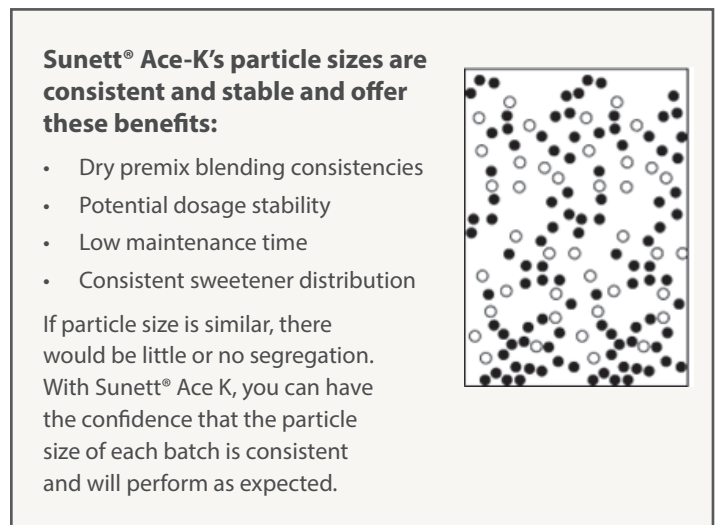


Figure 5. Sunett® Ace-K has a very stable and narrow window of particle sizes.

CONCLUSION

The tests and studies referenced in this paper show that Acesulfame-K, when blended with Aspartame, delivers a flavor profile that is very similar to sucrose and that the chemical characteristics of Acesulfame-K make it suitable for a wide range of formulations and applications. Because of our long history with the product, from its invention to today, and our stringent quality control and dedicated manufacturing facility, Celanese believes that Sunett® Ace-K is superior to generic Acesulfame-K

formulations. That qualitative edge ensures that your products will be the best formulations on the market and the stability of supply and lack of impurities will minimize risks to your brands.

To find out more about how to take advantage of the extreme versatility of Sunett® Ace-K in your formulations, follow these links for more detailed information celanese.com/food-ingredients/products/Sunett.aspx or contact your Celanese representative.



FOOD INGREDIENTS

celanese.com/food-ingredients

Contact Information

Europe, Middle East and Africa
(Germany)

t: +49 69 45009 1663

e: foodingredients-emea@celanese.com

Americas (United States)

t: +1 800 786 3883

e: foodingredients-AM@celanese.com

Asia (Japan)

t: +81 3 3436 3203

e: foodingredients-AP@celanese.com

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