



High Intensity Sweeteners & Taste Modification Technologies

While other ingredient companies and consumer packaged goods firms have simply aligned supply streams of stevia, WILD Flavors has taken a bolder step by significantly investing in Sunwin International, one of the top worldwide suppliers of stevia.

In conjunction with our extensive work with stevia sweeteners, WILD has created a vast array of taste modification technologies designed to deliver great taste and sweetness while suppressing disagreeable off-notes. In addition, our taste modification systems can also add value by allowing the use of less expensive ingredients. This paper explores the approaches used in developing specific taste modification systems for high intensity sweeteners.

Types of Sweeteners

Sweetness can be from simple carbohydrates like sucrose, glucose, and fructose, from some amino acids like alanine, glycine, and serine that are mildly sweet, and from high intensity sweeteners that are 100 to 25,000 times sweeter than sucrose. The high intensity sweeteners can be divided into two groups. The first group is the artificial, chemically-synthesized sweeteners. Sucralose, alitame, cyclamate, aspartame, neotame, potassium acesulfame, and saccharin (which was accidentally discovered in 1878), are all examples of commercially available, artificial high intensity sweeteners. The second group is natural high intensity sweeteners extracted from various plant sources. Examples of natural high intensity sweeteners are extracts from *Stevia rebaudiana*, Luo Han Guo, and glycyrrhizin from licorice root. Sweet-tasting proteins from the fruits of African plants are also being commercialized and include thaumatin from *Thaumatococcus daniellii*, monellin from *Dioscoreophyllum cumminsii*, and brazzein from *Pentadiplandra brazzeana* (Kinghorn and Compadre, 2001). Lysozyme, from egg whites, is also a sweet-tasting protein. The difference in the density of charged amino acids on the protein surface may result in varying threshold values for the sweet-tasting proteins thereby resulting in differing levels of perceived sweetness (Masuda et al., 2005).

Formulating Challenges with High Intensity Sweeteners

To a varying degree, the various high intensity sweeteners have inherent flavor issues associated with them. The most common issues are a delay in the onset of the perceived sweetness, a lingering sweetness, bitter aftertaste, metallic aftertaste, a non-linear sweetener concentration to sweetness equivalency ratio, adaptation or desensitizing, and a lack of mouthfeel or body. Additionally, many of the high intensity sweeteners extracted from plants have an herbal or licorice type flavor. The delay in the onset of the perception of sweetness and their lingering sweetness is hypothesized to be caused by two accompanying reactions. One reaction is the

WILD Flavors, Inc.

1261 Pacific Avenue
Erlanger, KY 41018 USA
www.wildflavors.com

Office Number (859)342-3600
Facsimile (859)342-3610
Website www.wildflavors.com

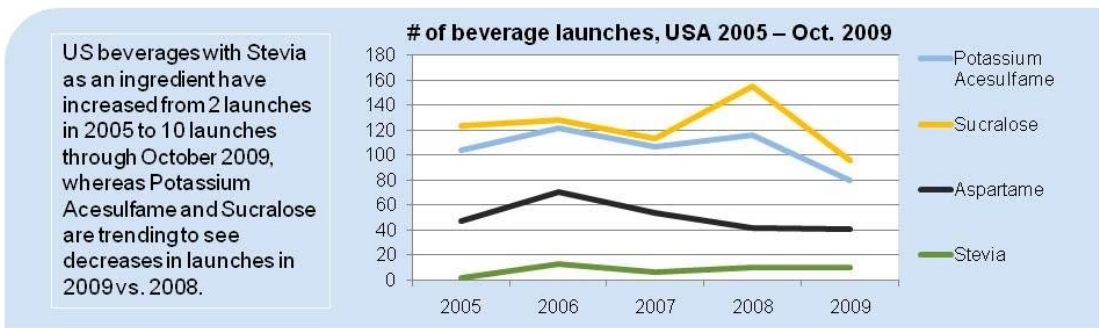
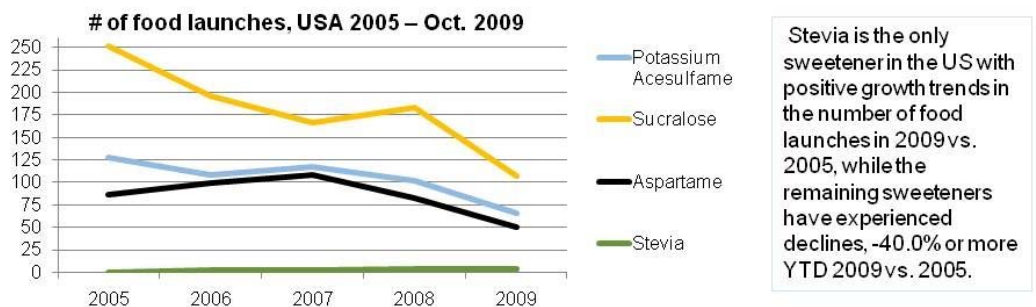


direct interaction of the high intensity sweetener with the G-protein coupled receptor site for sweet taste. The other co-occurring reaction happens once the high intensity sweetener permeates into the taste bud and is past the G-protein coupled receptor site. The sweetener directly activates sites that transport stimuli into the nervous system alerting our brain that we have eaten something sweet (Naim et al., 2002).

Market Insight on High Intensity Sweeteners

The increased demand for the use of high intensity sweeteners is driven by consumers' concern for weight management. The World Health Organization estimates that there are over a billion people globally who are overweight, 400 million of which are obese. Unfortunately, these numbers are expected to almost double by 2015 (WHO, 2006). Launches of new products containing stevia have risen while those of artificial sweeteners have decreased as consumers want no calorie, yet natural, sweetening alternatives

FOOD & BEVERAGE: Stevia vs. Potassium Acesulfame vs. Sucralose vs. Aspartame



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Solutions to Meet These Challenges

As previously mentioned, flavor enhancers and taste modifiers have been used to improve the taste of foods for centuries. Flavor enhancers contribute a flavor to the product and are used to round out the sweetness profile or to mask off-flavors. The mechanism deployed by taste modifiers can be adaption, cross-adaption, taste blocking, and taste modifying.

Adaptation and cross-adaptation are forms of fatigue. Adaptation is achieved by continuously exposing the taste receptors to a particular taste stimuli resulting in the flavor perception fading rapidly. Cross-adaptation is when adaptation of one taste may increase or lower the taste threshold of perception for another taste. An example of this is the use of sweeteners in medicines to suppress their bitter flavor.

Taste modification occurs when consumption of a compound creates a new perception of the taste of a food. Tart foods will taste sweet if miraculin, the protein from the Miracle Fruit, is first consumed. Taste blockers are compounds that prevent the perception of some or all of the flavors. The classic example of this mechanism is the utilization of cloves for an oral analgesic (Foster, 2007). Another example of a taste blocker is gymnemic acid, from the leaves of an Indian vine, that suppresses the sweet taste.

Bitterness reduction is an important need for many of the high intensity sweeteners to improve their consumer appeal. Organic acids such as aspartic and glutamic acids are known to reduce bitterness (Noguchi et al., 1975). Some of the amino acid such as glutamic acid and taurine have been shown to reduce bitterness of some, but not all, of the common bitter compounds. The bitter taste of potassium acesulfame was reduced by the addition of DL-alanine and glycine. These amino acids, as mentioned, contribute a slightly sweet taste. Sclareolide, a natural flavor chemical, has been shown to reduce the bitterness in potassium chloride-based salt substitutes, in coffee, and in citrus fruits. Mouthwashes typically employ flavors with a cooling effect to mask bitterness and this approach may also be a benefit in some foods and beverages. Menthol, mint oils, or the aroma chemicals fenchone, borneol, or isoborneol have all been commercially used to reduce bitterness in oral pharmaceuticals.

In addition, increasing the viscosity of a food product made with high intensity sweeteners can decrease the rate of diffusion of the bitter compounds from the food to the taste buds thereby decreasing the bitterness (Roy, 1997). WILD Flavors, Inc. offers a natural, botanical extract to reduce bitterness of high intensity sweeteners as well as other bitter compounds. This extract is hypothesized to block the bitter compounds from the receptor site (Gray, 2002). Most bitter blockers used in the food industry have little flavor or odor at their typical use level but help suppress off-flavors in food.

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Flavor enhancers are used to make the high intensity sweeteners taste more like sucrose. Common flavor ingredients used to increase the upfront sweetness and provide more sugar-like notes are strawberry furanone, maltol, ethyl maltol, and vanillyls such as vanillin and ethyl vanillin. Caution must be used in selecting the use level of such ingredients due to the fact the product may taste like pancake syrup, cotton-candy, or develop burnt sugar notes at high levels. Also, not all of the chemical listed are considered natural. The addition of aconitic acid or gluconic acid is reported to improve the flavor and provide a slight umami effect resulting in a fuller mouthfeel (Roy, 1997).

Glycyrrhizin and other glucuronide-saponins of licorice root, have a sweet taste and can be used to augment the flavor profiles of other high intensity sweeteners (Kitagawa, 2002). Ammoniated salts of glycyrrhizic acid are commercially produced flavoring agents that are approximately 50 times sweeter than sucrose. The addition of other plant constituents such as cynarin, chlorogenic acid, and caffeic acid, can provide a more sugar-like flavor profile (Kinghorn and Compadre, 2001). Neohesperidan dihydrochalcone, considered an artificial flavoring agent at restricted levels, can also be added to high intensity sweeteners to modify the sweetness profile and reduce bitterness.

Sugar alcohols and other polyols are used to provide sweetness and mouthfeel to products made with high intensity sweeteners. Glycerol can increase the sweetness, and at higher levels, can increase the perceived viscosity (Noble and Bursick, 1984). Sugar alcohols, such as erythritol, mannitol, xylitol, and sorbitol, effectively add back mouthfeel and body to foods made with high intensity sweeteners. Also, these sugar alcohols have varying degrees of sweetness and cooling effect. Except for erythritol, the sugar alcohols can cause gastrointestinal distress when consumed at high levels, making them inappropriate for use in beverages because of the large serving sizes.

A unique approach to modifying the sweetness perception is by taking into account the role of water in sweet taste perception. The addition of solutes will interact with the water structure. Salts, such as sodium gluconate, decrease the apparent specific volume of the high intensity sweetener. This will then alter the taste perception and decrease the possibility of tasting bitter. This role of the water structure may also explain the observed synergistic effect of salt-structured, high intensity sweeteners, such as sodium saccharin, potassium acesulfame, and sodium cyclamates, with bulk sweeteners. A 50:50% mixture of sodium cyclamate with maltitol had a 27% synergy level (Birch, 2002).

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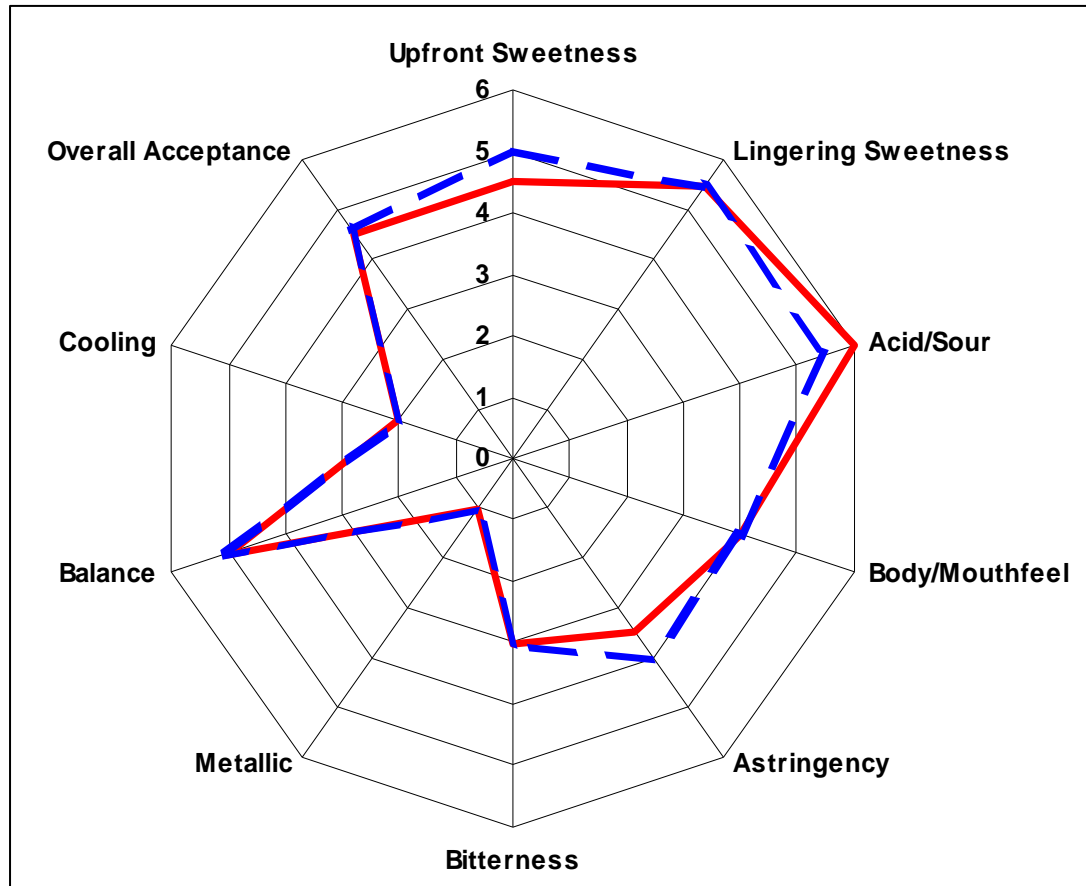
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Improving the Taste of Stevia with Taste Modifiers

Reb A 95 ——— Reb A 60 + Taste Modifiers - - -



A large consumer panel demonstrated the tremendous value that WILD's taste modifiers brings to the food industry. A more cost effective stevia grade combined with our taste modifiers was equally preferred by consumers when compared to a sports drink made with Reb A 95. Same preference, great taste, at a much lower cost.

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WILD Flavors, Inc.

WILD delivers innovative flavor, color, and ingredient technology solutions to the food and beverage industries. We solve our customers' challenges through creative chemists, excellent applications personnel, and a complete supply chain of services and manufacturing capabilities. WILD Flavors, Inc. encompasses many of the following for the food and beverage industries including, but not limited to:

- Flavors
- Colors
- Health/Functional Ingredients
- Taste Modification Systems
- Concept to Market Development
- Turn-key Solutions

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