SWEETABULARY™ sweetness language: Bridging the gap between consumer and food scientists

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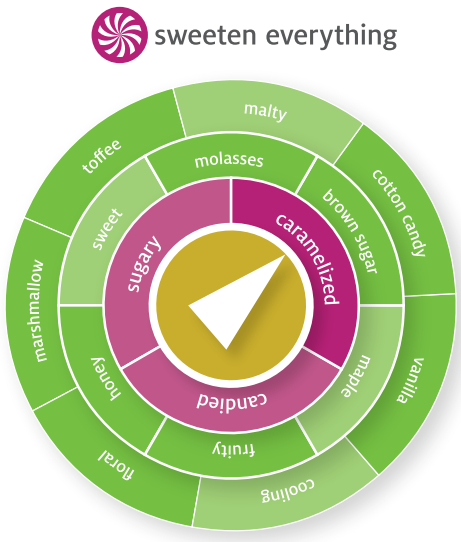
The typical consumer can quickly tell you whether something is too sweet or not sweet enough. But can the consumer describe sweetness character? Does that sweet taste remind them of a caramel candy or cotton candy? Is it too sweet on the first sip or sweet long after they swallow the food or beverage? Understanding the difference between sweet on the tongue and sweet aromatic may not be important to the consumer but those details can help the product developer realize what drives consumer likes or dislikes. To bridge the gap, the innovators of Ingredion have developed a new sweetness language. SWEETABULARY sweetness language is the proprietary vocabulary that connects the consumer experience of sweetness with scientific terms that lead to perfectly sweetened products. With Ingredion and SWEETABULARY translations, you'll be speaking the language of innovation and new product success.

Sensory analysis

Sensory analysis is a scientific discipline that uses human assessors (sensory panelists) to measure and evaluate food products and ingredients using their five senses of sight, smell, taste, touch and hearing. Sensory analysis can mainly be broken down into three sub-sections:

Discrimination/Difference testing: This testing is done to determine if there is any perceptible difference in the product or ingredient. Panelists are trained on the test method and may be tested for sensory acuity. They do not have to be highly trained to participate in the test.

FIGURE 1: SWEETABULARY™



Consumer Testing: Another name for this category of sensory testing is "Affective." This test is run to determine how well the product is liked or preferred. Panelists are not trained but may be selected based on demographics important to the product being tested.

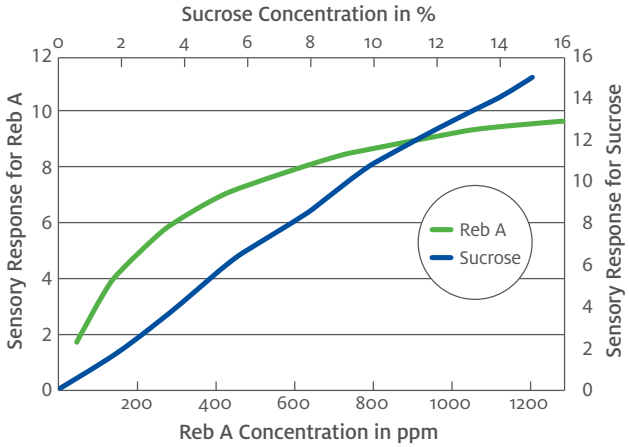
Descriptive testing: This form of sensory testing measures how products differ in specific sensory attributes. Sensory panelists are selected after going through full sensory acuity testing. Training for descriptive testing is in-depth and the outcome is a highly trained expert panel.

Differentiating sweeteners using sensory analysis

Descriptive analysis can be designed to accurately measure the sensory characteristics required to answer the objective of the product being tested. In descriptive analysis all the sensory attributes are measured on a 15 point scale by an expert trained sensory panel. Areas of descriptive analysis that differentiate sweeteners and can be used as a tool to help product developers formulate consumer preferred products are 1) concentration response, 2) time-intensity, and 3) descriptive flavor profile analysis.

Concentration response measures the desired sensory attributes across a range of solution concentrations. It is especially helpful when formulating with high potency sweeteners since they are not linear when the sweetness response is measured across a concentration curve. Nutritive sweeteners tend to be linear across the curve. This can be illustrated when comparing Rebaudioside A (Reb A) to sucrose (Figure 2, page 3).

FIGURE 2: CONCENTRATION RESPONSE CURVES FOR REB A VS. SUCROSE



When comparing the two sweeteners in Figure 2 you can determine the sucrose sweetness equivalence of Reb A at different concentration levels. For example, 6% sucrose (upper x-axis) gives approximately a 7 sweetness response (right y-axis) using the 15 point scale the panelist has been calibrated on. On the left y- axis find the 7 for the Reb A sweetness response, draw a perpendicular line to where it intersects the Reb A curve and drop the line to the lower x-axis. It shows that approximately 375 ppm of Reb A is needed to match a 6% sucrose solution. This can be useful information for the product developer when substituting one sweetener for another in food formulations.

Temporal or time intensity sensory measurements are also important to distinguish sweetener differences. Time intensity is the measurement of sensory stimuli over a continuous or set time interval. Often a product developer can match the maximum perceived sweetness, but the time of sweetness onset and sweetness linger can vary. This can cause the overall flavor perception of the food to be different and not meet consumer expectations.

FIGURE 3: TIME INTENSITY MEASUREMENT OF SWEET AFTERTASTE OF VARIOUS SWEETENERS

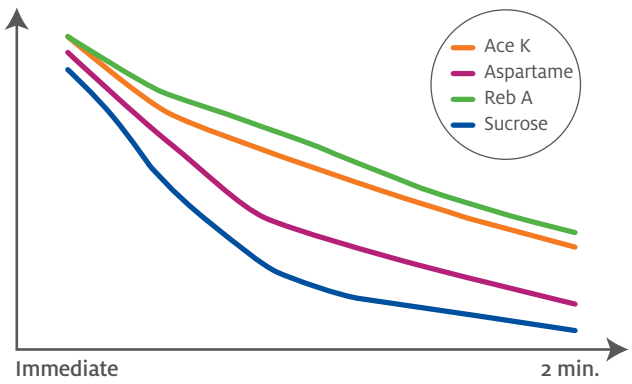


Figure 3 shows the sweet aftertaste of four different sweeteners. Panelists measure the sweet taste immediately after swallowing and then each successive 20 seconds for two minutes. All samples were tested at a sucrose sweetness equivalence of 6%. Results show that Reb A and Ace-K stay sweeter longer (or linger longer) than sucrose and aspartame. If the product developer wants to substitute Reb A or Ace-K for sucrose, they will have to compensate the flavor system to address the lingering sweetness.

Figure 4 shows a time intensity curve for multiple attributes for Reb A. In this case the testing starts when the panelists ingest the sample. Using a computer program designed for time intensity measurements, panelists continuously track the various flavor attribute responses after swallowing for a total of 2 minutes. Results show that sweet intensity decreases steadily to a point where the intensity matches the astringent attribute. This may show why some consumers feel Reb A has a particular aftertaste they do not like. Depending on the application, a product developer may be able to mask bitter and astringent taste with a sweet modulator.

FIGURE 4: CONTINUOUS TIME INTENSITY MEASUREMENT OF DIFFERENT REB A ATTRIBUTES

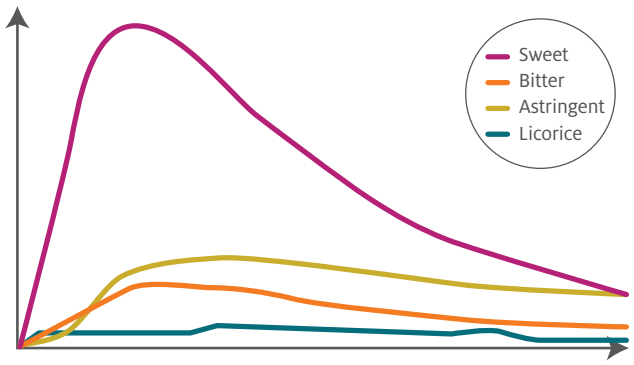


TABLE 1: SWEETABULARY™ SWEETNESS LANGUAGE — SET SENSORY TARGETS

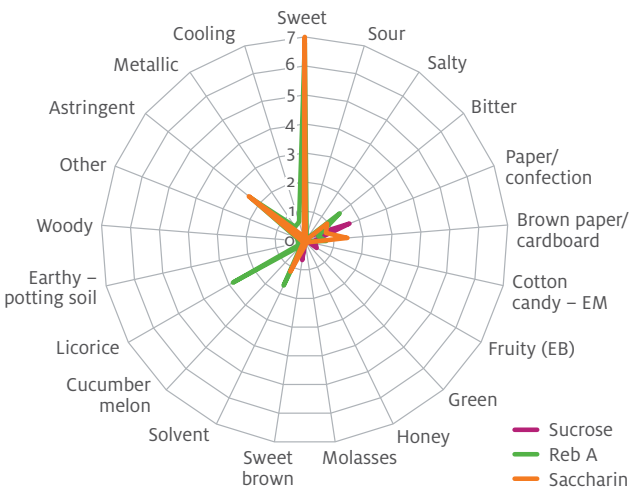
FLORAL	Lily flower, brown soap
EARTHY WOODY	Potting soil, popsicle stick
GREEN	Green twigs, green grass, cucumber skin, cis-3-hexanol
PAPERY CONFECTIONERY	Sugar bag, brown paper bag, white paper, brown cardboard, confectionery sugar
SWEET BROWN	Caramelized sugar, raisin paste, molasses, clover, honey
FRUITY	Ethyl maltol, cotton candy, ethyl butyrate, Juicy Fruit gum
MINERAL	Gravel/stones, calcium carbonate
SOLVENT	Sharpie marker
SAVORY & SPICE	Cured meat, nutmeg, smokey, licorice

Descriptive flavor profile analysis using SWEETABULARY™ sweetness language

Sweeteners add more to food than just a sweet taste. Each sweetener can contribute distinct flavors to the food or beverage. Through screening and tasting dozens of different sweeteners by trained sensory experts, Ingredion has developed a new sweetness language which is being used by its teams globally. SWEETABULARY characterizes diverse sweetener profiles using flavor references such as 'earthy/woody,' 'green,' 'floral,' 'papery confectionery,' 'sweet brown,' 'fruity,' 'mineral,' 'solvent' and 'savory and spice.' These highly specific attributes (Table 1) translate into the precise scientific terms that we can formulate to — for consumer-pleasing results.

Figure 5 shows how sucrose, Reb A and saccharin differ beyond the sweet taste. These differences can potentially influence other flavors when formulating for a customer. This is demonstrated in Figure 6. The data in the spider

FIGURE 5: DESCRIPTIVE PROFILE USING SWEETABULARY

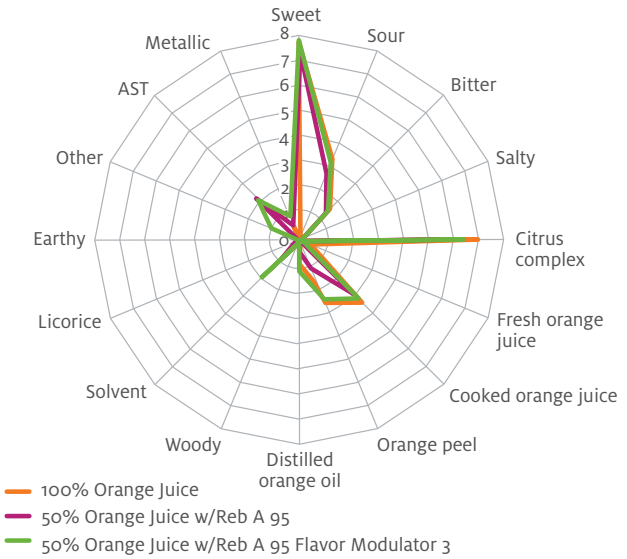


graph shows how replacing Reb A in a reduced calorie orange juice can add back the sweetness but can alter the orange flavor. When combined with a sweet modulator, Reb A give the sweetness along with the expected orange flavor found in 100% orange juice.

Formulating using SWEETABULARY and DIAL-IN® Sweetness Technology

SWEETABULARY and DIAL-IN Sweetness Technology will help you find the best functional solution for your desired sweetness profile, taking into account your processing requirements. We'll help you select from our broad portfolio of nutritive, non-nutritive, naturally based or high potency sweetness options — and share our in-depth baseline analyses of our sweetener portfolio and comparative studies. SWEETABULARY sweetness language represents one more way in which Ingredion is driving market-shaping innovations to help you achieve your sweetness goals. We update our sweetness database daily and conduct regular sensory evaluations to map ingredient and product attributes. And with 24 R&D facilities around the world, we're ready to support your sweetness success no matter where you are.

FIGURE 6: FORMULATING ORANGE JUICE USING SWEETABULARY SWEETNESS LANGUAGE AND DIAL-IN SWEETENER TECHNOLOGY



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