better sweetener strategies.” In speaking about the chemistry and application of high-potency sweetener ingredients for foods and beverages, Woo pointed out in his characteristic trademark clarity and wit, that the big drive today is to develop “natural” sources for high-potency sweeteners that offer superior performance.

Factors that affect the function of various steviol glycosides include purity and chemical structure, which affect taste, solubility and sweetness intensity. “Natural stevia leaf contains anywhere from 40 to 70 identified steviol glycosides,” said Woo, “of which 11 have thus far been food-approved.” Each of the 11 may bind to different locations within the Venus Fly Trap part of the sweet-taste receptor, which “helps explain why they all taste different from one another.” It also explains why they can also taste better together in unique combinations.

Steviol glycosides (i.e., stevioside and rebaudiosides) consist of a central “steviol” alcohol ring structure to which multiple and different types of sugars are attached. These sugar side chains determine the taste and solubility properties of the different steviol glycosides—the more soluble the molecule, the more rapid the sweetness onset and clearance.

Highly water-soluble erythritol has quick onset which, together with steviol glycosides’ slow onset, delivers an overall sugar-like quick sweetness onset perception. An osmolyte, such as table salt, decreases steviol glycosides’ sweetness lingering via osmotic pressure change, said Woo.

Rebaudioside A (REBA), the most common steviol glycoside in commercial use, consists of four glucose units and is about 200x sweeter than sucrose. Its available purity in the marketplace ranges from 40% (REBA40) to 100% (REBA100).

Second-generation stevia is all about REBA. The higher the purity, the better the taste. However, REBA itself at high usage is still bitter, because it triggers two out of the 25 bitterness receptors: TAS2R4 and TAS2R14. REBB, with one less glucose side chain, is less sweet but also less bitter than REBA. Combinations of A and B have complementary (but not proven synergistic) effects on sweetness. At the far end of spectrum is “the famous REBM, the biggest steviol glycoside,” with six attached glucose units. “It is the best-tasting and the sweetest of the steviol glycosides, so far,” explained Woo. Farm-based third-generation stevia extracts are the newer 2-way and 3-way blends of REBA, B, C, D and/or M for even more sugar-like taste but at higher cost, he added.

How can steviol glycosides be improved? One approach underway is to breed stevia varieties with elevated levels of REBM (for the optimum profile) or REBC (for increased sweetness). Another is to use “natural” enzymatic glycosylation (“bioconversion”) of REBA to generate REBM. A third approach is to use “natural” microbial fermentation to convert corn glucose or sugarcane sucrose to REBM. Fermentation and bioconversion-based stevia already co-exist with farm-based stevia in 2018.

“The acceptable cost of high-potency sweeteners will vary according to their application and consumer expectations,” said Woo. He presented a matrix that cross-compares different stevia purity and moiety combinations whereby to achieve acceptable cost benchmarks, depending upon the food and beverage applications.

Another factor is the use of flavor compounds to enhance the performance of high-potency sweeteners. Woo explained how enzymatic glycosylation of REBA can be used to transform stevia extract into a sweetness-enhancing natural flavor with modifying properties (FMP) called glucosyl steviol glycosides (GSG). Using a GSG FEMA 4728 at up to 175ppm in a beverage would qualify it as a flavor, according to Flavor Extract Manufacturers Association (FEMA) criteria. Native stevia extracts, such as REBA60 and REBA80, also qualify as natural flavors, when used below 30ppm and 35ppm, respectively.

Woo is a big advocate of using stacking strategies to achieve desirable sweetness profiles. Stacking is a sugar-reduction strategy for building up to the required sweetness intensity and profile,