



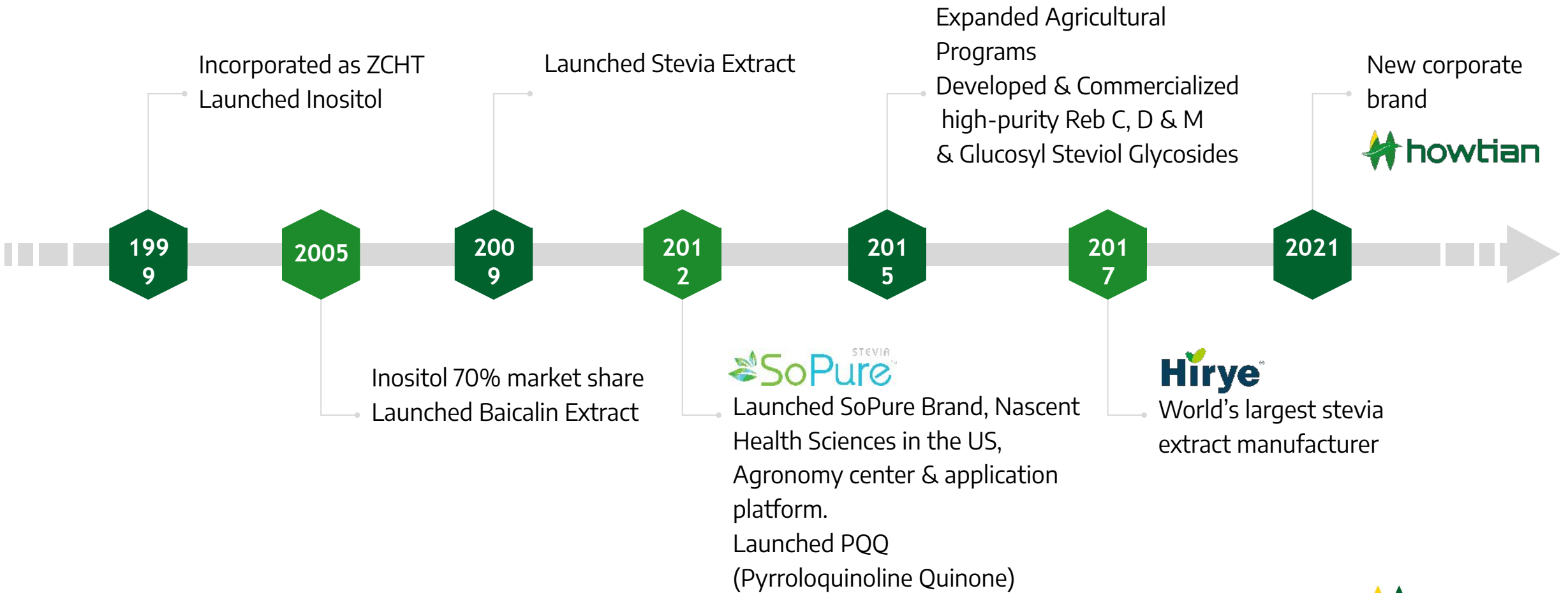
How to Reduce Sugar with Natural Sweeteners

Hank Wang
Technical Director



howtian®

Company History



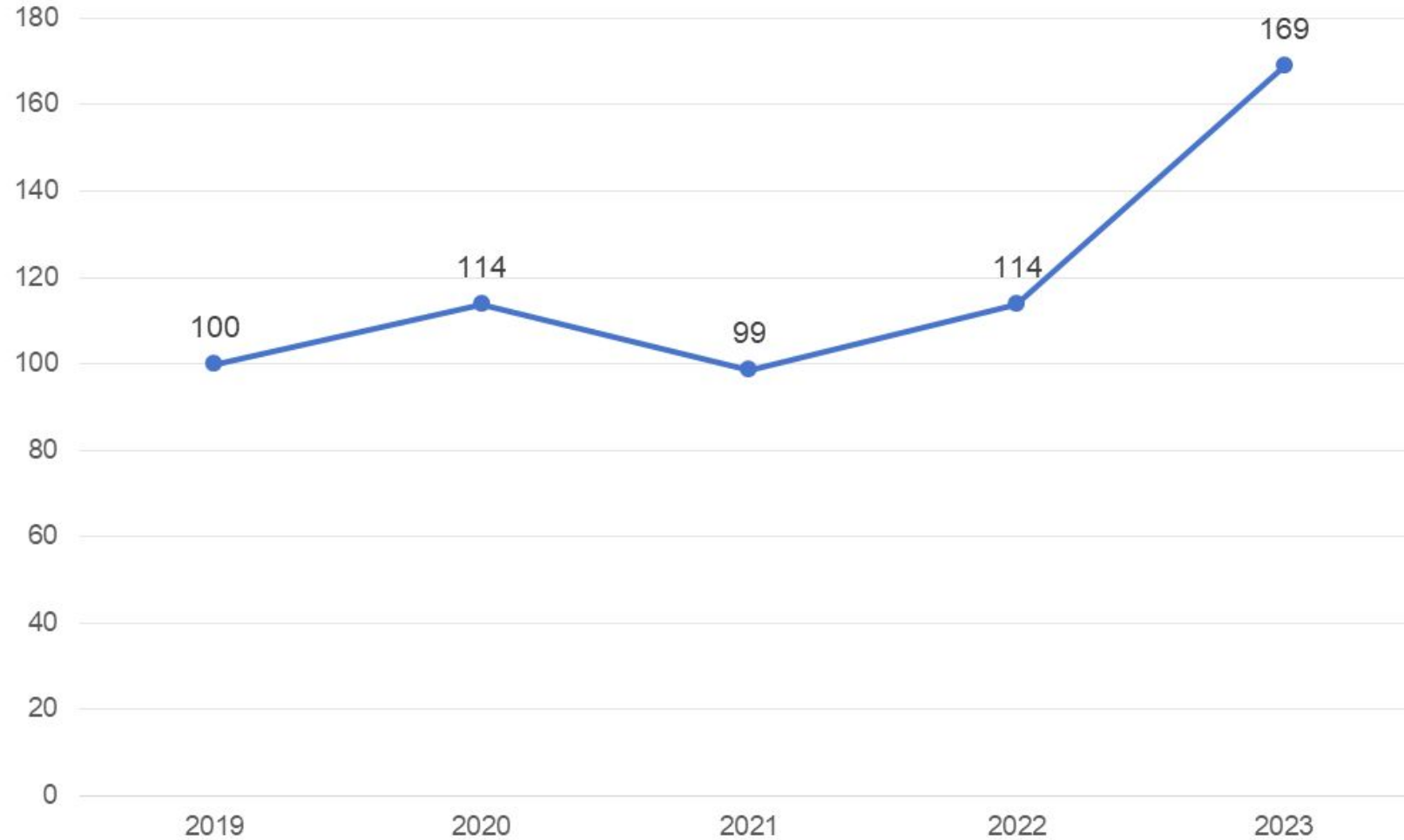
Agenda

- Consumer Insights
- Comparison of Natural Sweeteners
- Cost Comparison
- Stevia Properties and Grades
- Developing with Monkfruit
- Erythritol to Bulk
- Long-term Outlook

Product Launches in Canada



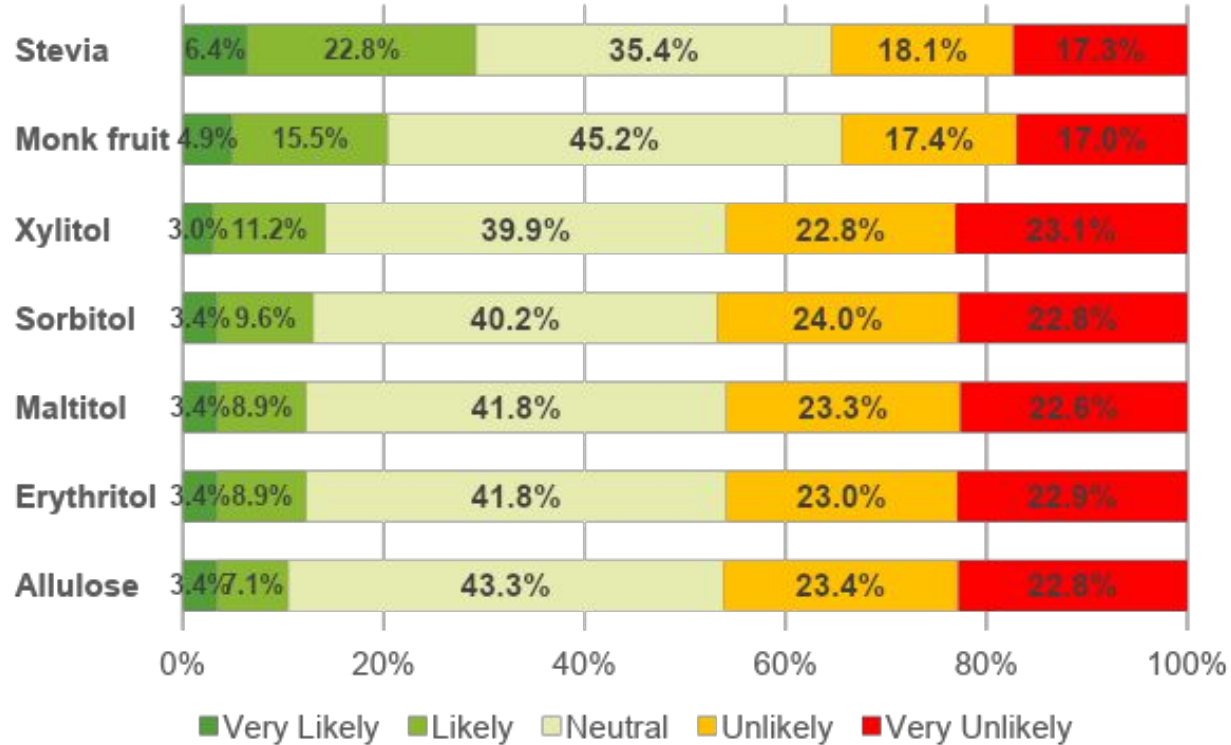
New Product Launch with Natural Non-Nutritive Sweeteners
(Canada, 2019-2023, Index 2019 = 100)



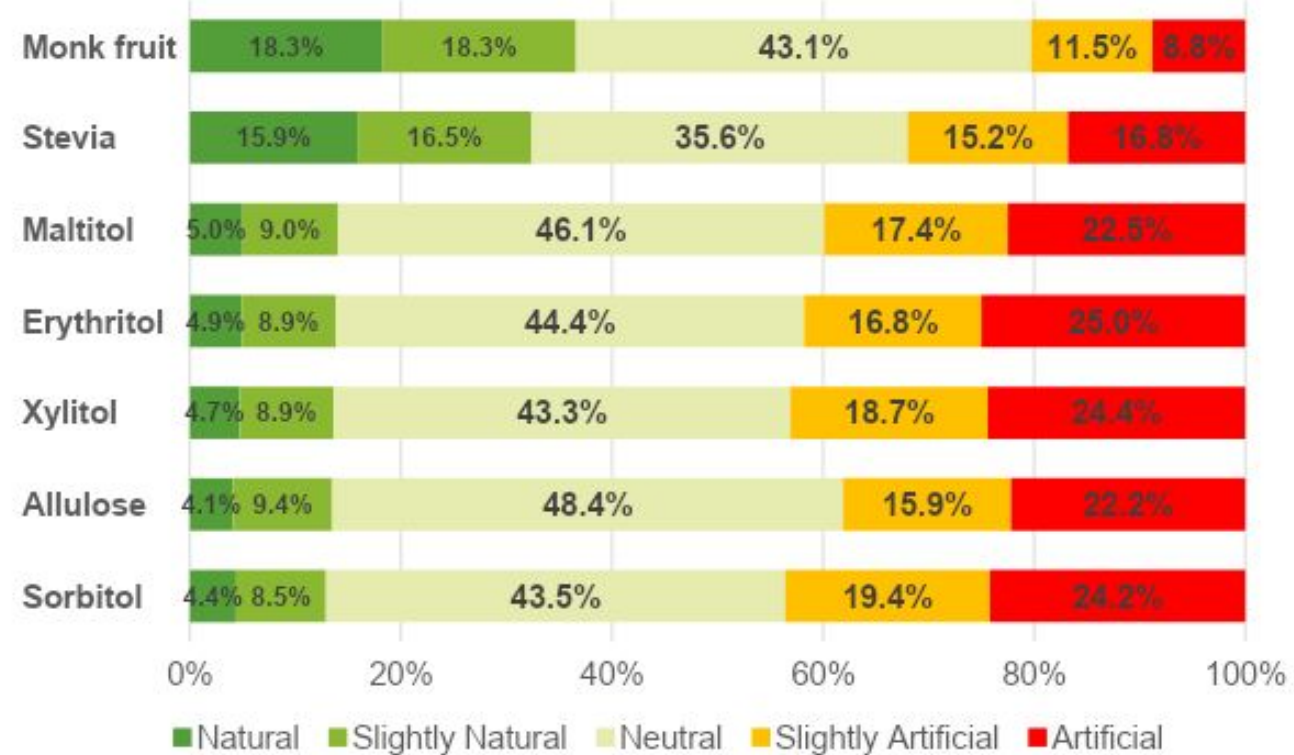
Acceptance and Awareness of Different Sweeteners - Canada



Q: To what extent are you likely to accept the following ingredients in your food? (Canada, 2022)



Q: To what extent do you think the following ingredients are natural? (Canada, 2022)



- Nearly a quarter of Canadian consumers said they would accept stevia, making it the most acceptable sweetener. Meanwhile, stevia has a good reputation among consumers, nearly a third of consumers do think stevia is natural.



Global Launches of Natural Non-Nutritive Sweeteners in 2023

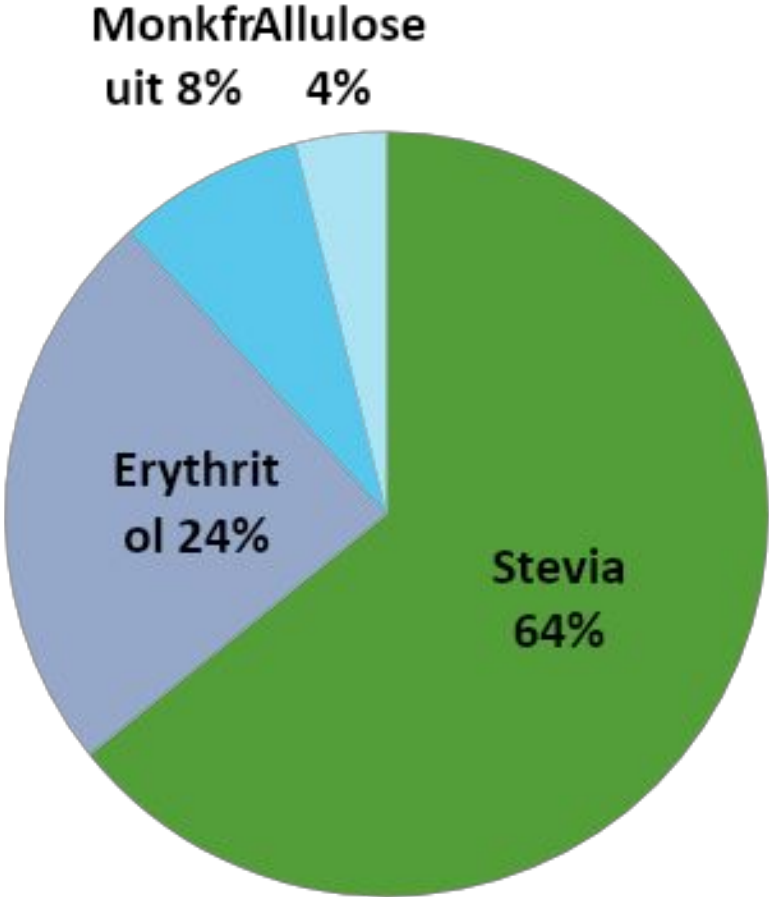
STEVIA



High-potency sweeteners share

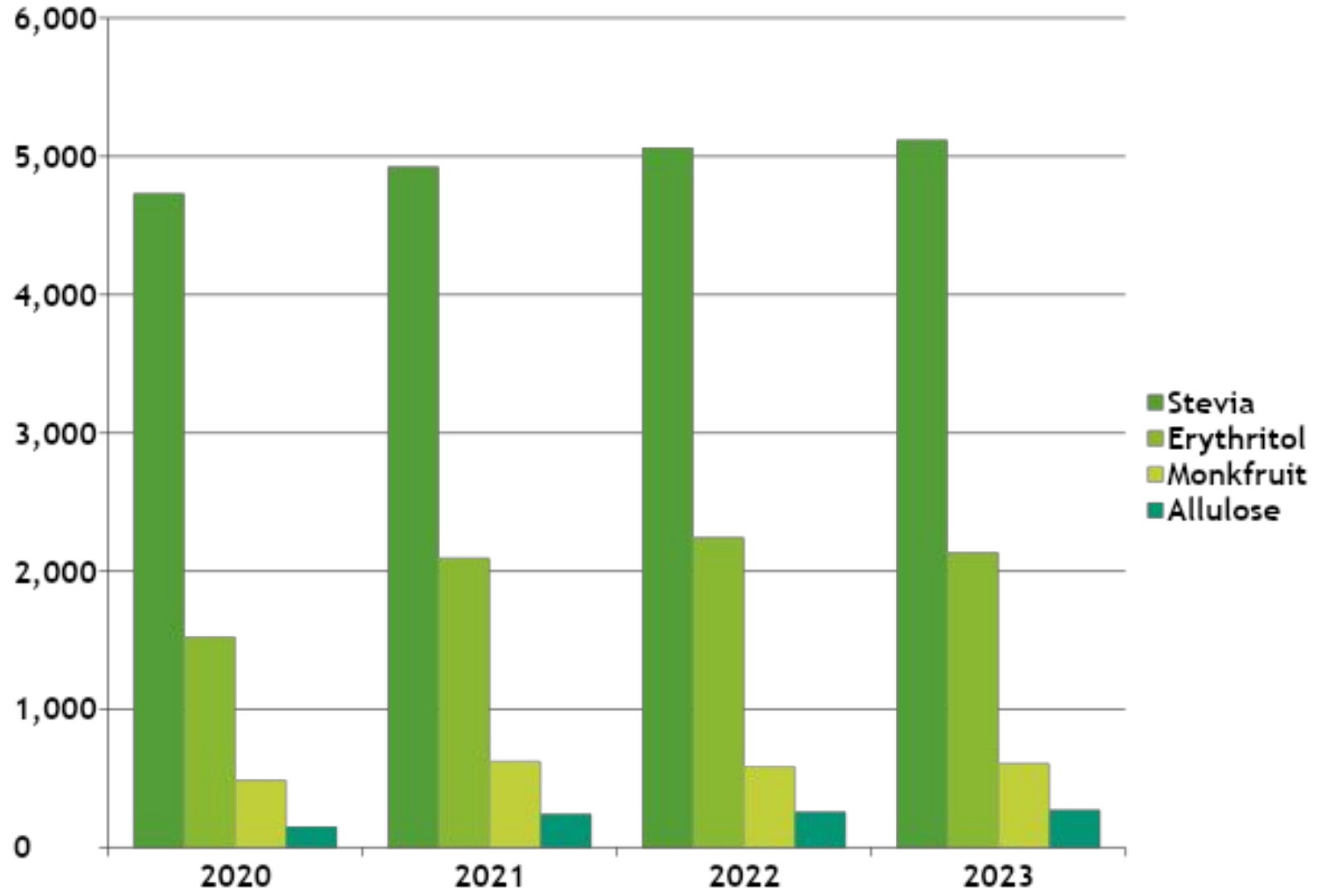
Erythritol commonly complements high-potency sweeteners but allulose is growing in popularity

Note: Allulose and monkfruit are currently not fully approved for use in Canada



Global Launches of Natural Non-Nutritive Sweeteners

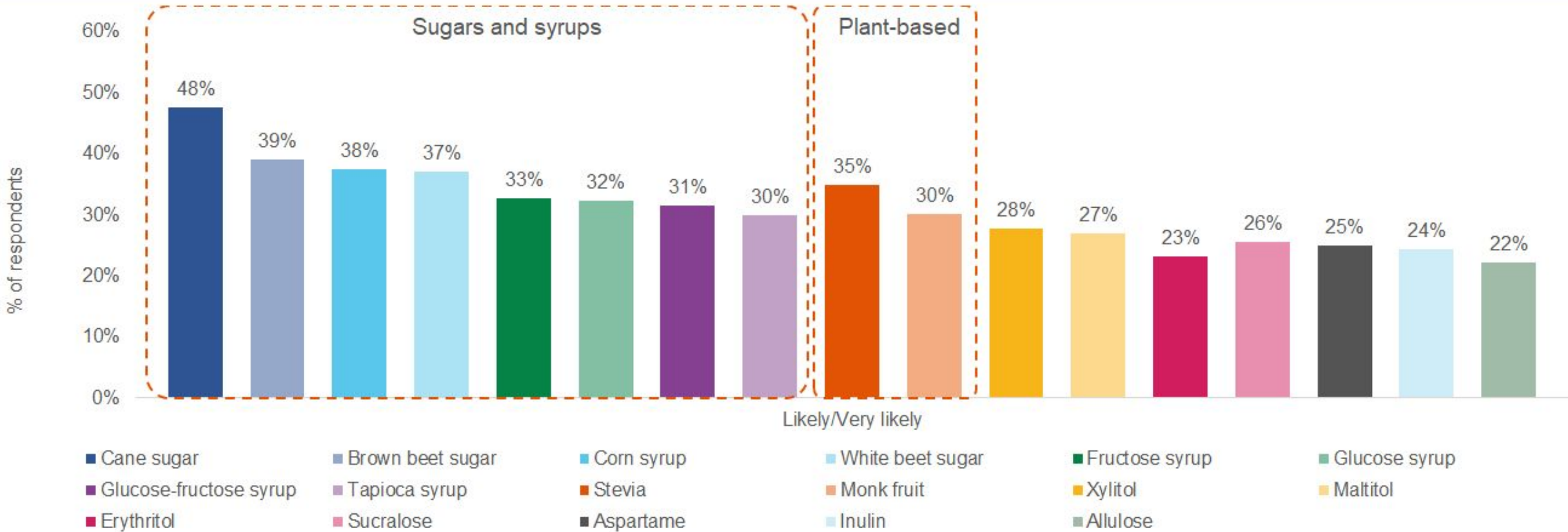
Mintel database also shows that stevia has a 89% market share of high potency sweeteners in 2023



Half of consumers accept cane sugar; other sweeteners vary

Figure 5 | Global: To what extent are you likely to accept the following ingredients in your food? (Responses for “Likely” or “Very likely”) (2022)

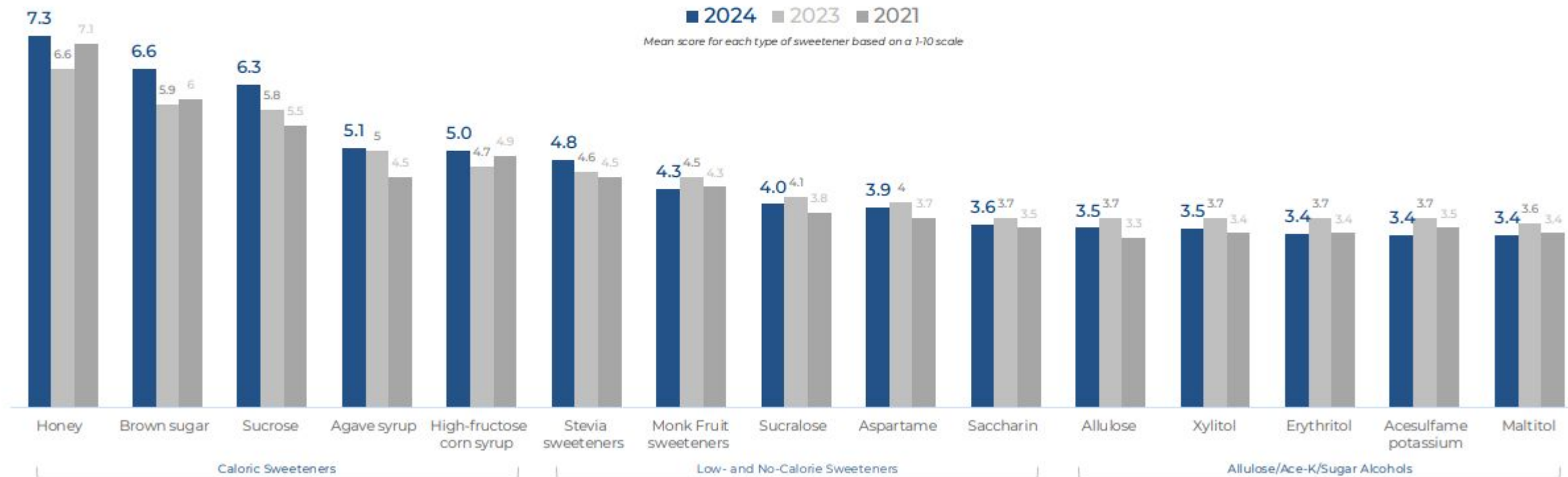
Natural-source sweeteners, including sugars, syrups and plant-based, are most widely accepted



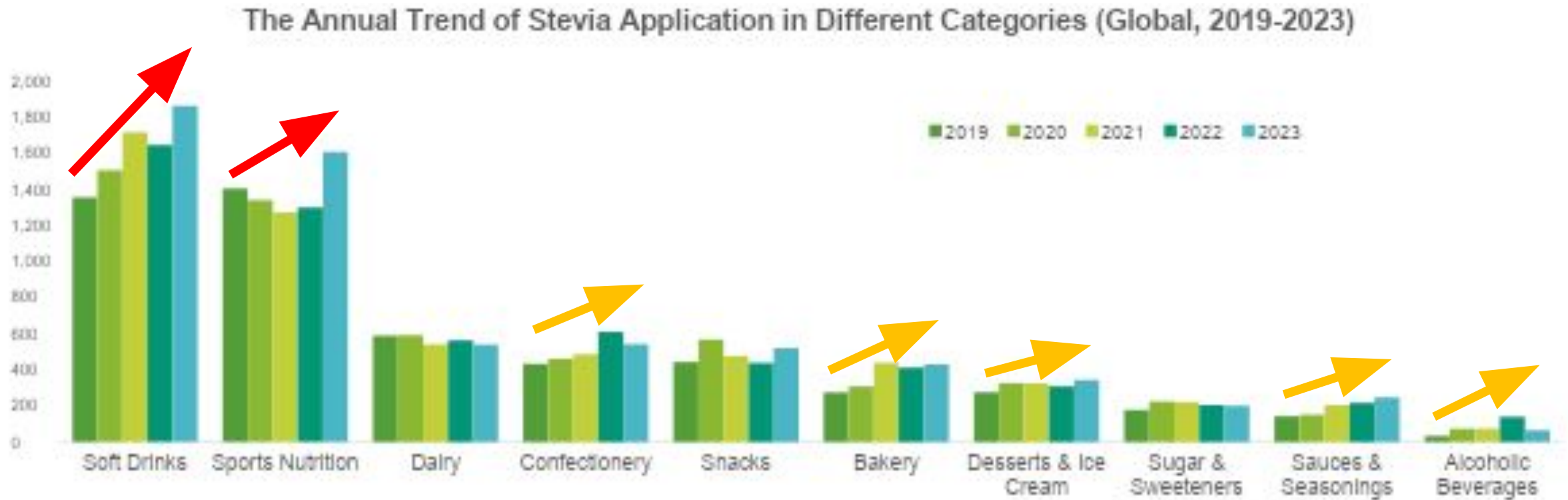
Source: Innova Health & Nutrition Survey 2022

Americans say they are more likely to consume foods and beverages with sugars than those with low- and no-calorie sweeteners, allulose, or sugar alcohols.

Honey is rated as the most likely to be consumed caloric sweetener. Stevia is rated as the most likely to be consumed low- and no-calorie sweetener.



The use of Stevia increases across several categories (2019-2023)



- The application of stevia in soft drinks was the largest and showed an increasing trend, followed by sports nutrition;
- Stevia ranked among the top five applications in the candy category, with the fastest growth rate;
- There are other growth trends in baking, sauces and seasonings, and alcoholic beverages.

Cost Comparison

Sweetener	Relative Sweetness	Cost Per Kg	Sweetness Cost Per Unit
Sucrose	1	1.24	1.2400
HFCS 55	1	0.836	0.8360
Erythritol	0.675	2.75	4.0741
Allulose	0.62	5.25	8.4677
Maltitol	0.7	2.75	3.9286
Sucralose	600	26	0.0367
Aspartame	180	10.88	0.0604
Acesulfame-K	200	7	0.0350
Monkfruit 50% Mog V	150	255	1.7000
Stevia RA97	250	40	0.1600
Stevia RM80	300	280	0.9333

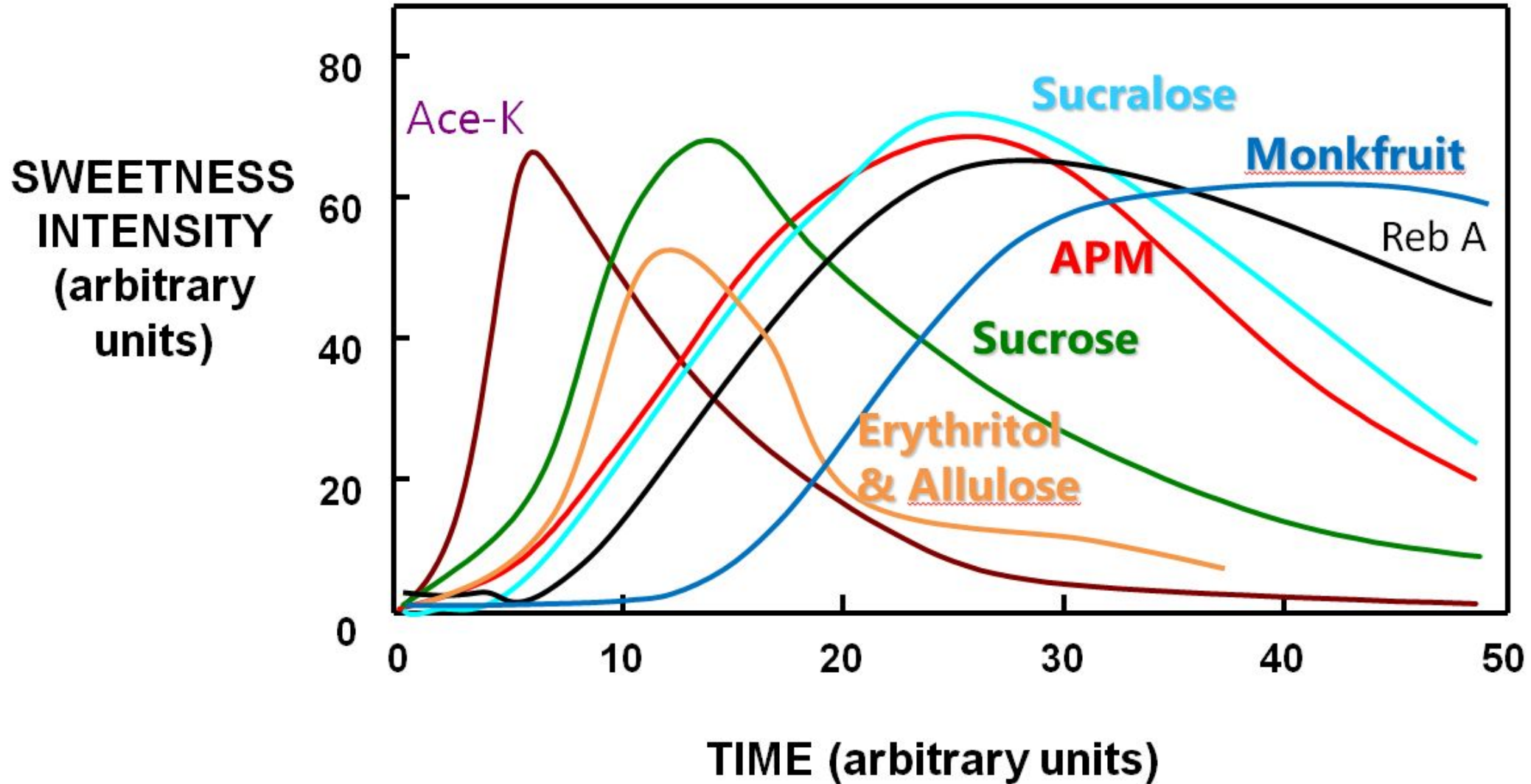
Costs are estimated and change frequently or may be different in various countries

Sugar Reduction Savings – RA 97

Ppm Stevia	Sugar(g) Replaced	X sugar	% Cost Savings	Savings	Label Example
16	1	625	9.5%	\$95,000	Natural Flavor
50	2	400	18.4%	\$184,000	Stevia Leaf Extract
70	2.5	357	22.7%	\$227,000	Stevia Leaf Extract
90	3	333	27.1%	\$271,000	Stevia Leaf Extract
150	4	267	35.2%	\$352,000	Stevia Leaf Extract
200	5	250	43.5%	\$435,000	Stevia Leaf Extract

- Sugar price: \$1.24/kg
- Reb A 97 price: \$40/kg
- Sugar spend: \$1,000,000
- Tastings were performed in 10 brix sugar in water at room temperature
- Assumed no bulking agents needed

Sweetness Time/Intensity Graph

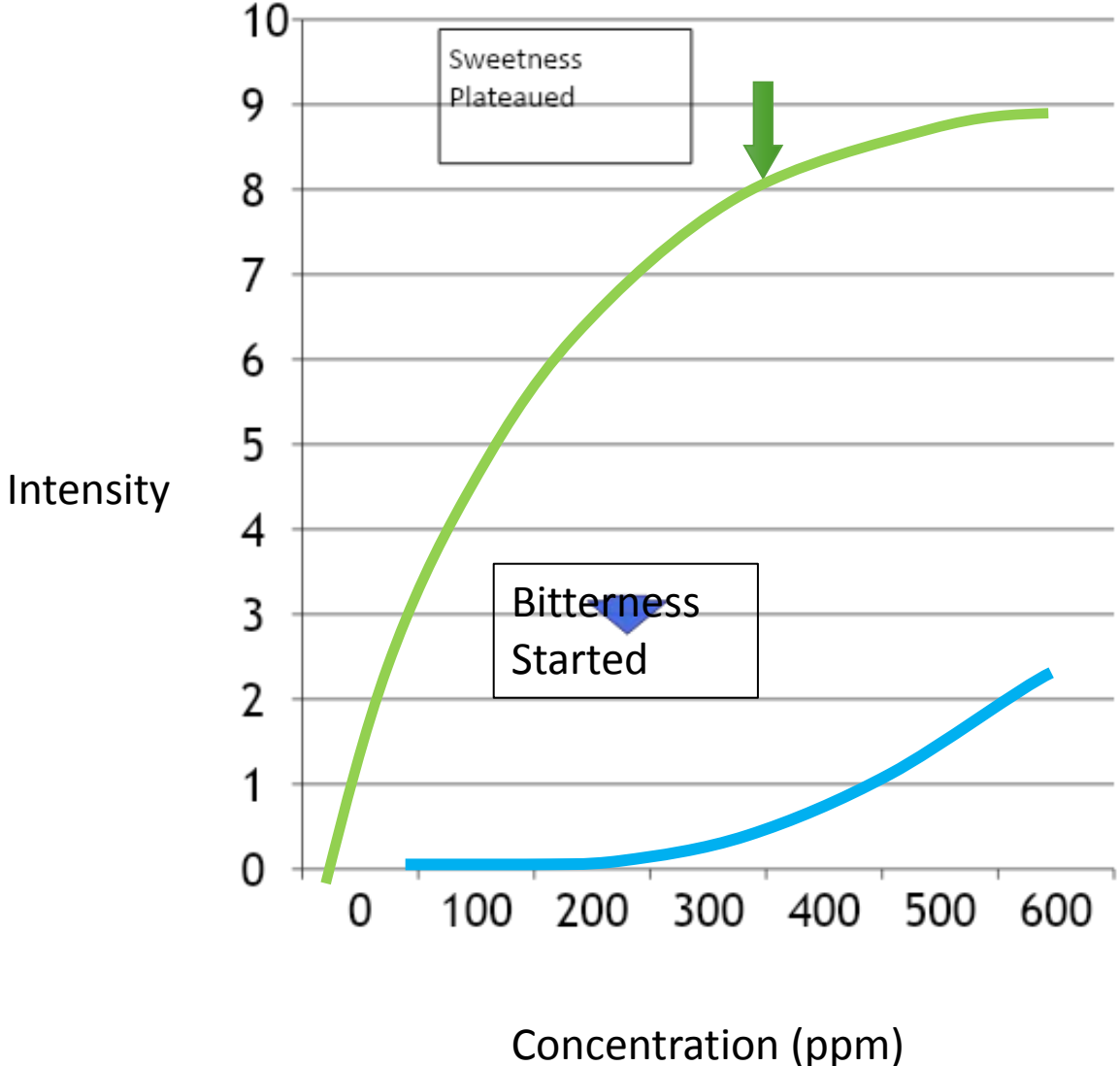


Natural Sweeteners Background

- Natural sugar alternatives are more expensive compared to artificial sweeteners because they depend more on farming, harvesting, extracting, fermenting, etc.
- Farming also creates higher risk of price fluctuations
 - Limited suited farmland – farmers may choose to switch to another cash crop if it is more profitable
 - Poor weather
 - Poor crop yield
 - Pests
 - Labor



Sweetness and Bitterness Intensity – Reb A



High-Purity Glycosides

Glycoside	Relative Sweetness	Cost	Solubility in Water	Heat Stability	Sensory
Reb A	120 - 420	\$	0.5%	200 °C	Sweet with off-notes at high use levels
Reb B	150 - 400	\$\$	0.01%	180 °C	Significantly less sweetness lingering than Reb A
Reb C	30 - 60	\$\$\$	0.01%	180 °C	Sweetness enhancer for bulk sweeteners
Reb D	220 - 440	\$\$\$\$	0.04%	180 °C	Significantly less off-notes/aftertaste than Reb A
Reb M	230 - 450	\$\$\$\$\$	0.1%	140 °C	Sweeter than Reb D with very clean and sweet aftertaste
Steviolbioside	70 - 100	\$\$	0.01%	180 °C	Sweet with distinctive flavor
Stevioside	120 - 400	\$	0.1%	200 °C	Sweet with off-notes at medium to high use levels

- Cost of premium stevias are higher because they are in the leaf at much lower concentrations
- Recent breeding in stevia leaf have developed significant increases in Reb D and M yield

Glucosyl Steviol Glycosides

Item	Estimated Sweet Enhancement	Potential Directional Sensory	Beverage Max Usage Labeled as Natural Flavor
FEMA 4728	85 - 140	Most common sweetness enhancer	175ppm
FEMA 4845	70 - 140	May add mouthfeel and blocking capabilities	100ppm
FEMA 4876	100 - 160	May add mouthfeel	120ppm
FEMA 4909	150 - 220	Best sweetness enhancer	65ppm
FEMA 4910	90 - 130	May add mouthfeel	135ppm
FEMA 4931	120 - 150	May add mouthfeel	100ppm

- Overall, these GSG's are a good value for the great taste quality as they contain some Reb D and Reb M and similar chemical structures
- Typically used as upfront sweetness enhancers but also may have some blocking and mouthfeel capabilities
- Sweetness and sensory are just starting guidelines and not fully developed
- For complete information, please see: <https://www.femaflavor.org/fema-gras>

Leaf Extract Process Overview



Harvest and
dry the leaves



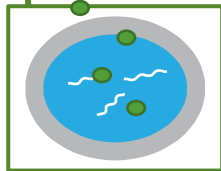
Steep
in water

- Basic water extraction of steviol glycosides from the leaves



Primary
Purification

- Separating the glycosides from other leaf components/impurities by macroporous adsorption resin



Secondary
Purification

- High purity glycosides are obtained from the crystallization process



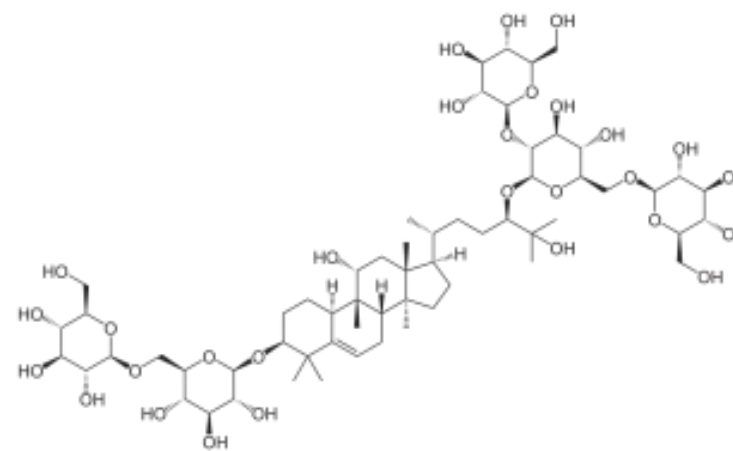
Finished
Product

- The product from purification is dried to form white to off-white fine powder



Monkfruit Extract Properties

- Natural, zero-calorie sweetener about 100–250 times sweeter than sugar
- Extracted from monk fruit drying the fruit juice into concentrated powder
 - Has the benefit of a cleaner label due to the word fruit
- Heat and pH stable
- High in unique antioxidants called mogrosides that give it its intense sweetness
 - Mogroside V is the primary sweetener, like Reb A is for stevia, with purity ranges from 10-90%



Formulating with Monkfruit Extract

- Best value and most common are 40 & 50% Mog V in terms of sweet profile and cost
- Monkfruit juice liquid concentrate 3.5% taste great at most use levels but about 1.5X the cost per sweetness
- Heat and pH stable
- May be good to combine with stevia at very high SE (>12% in beverage) due to plateau in sweetness of high potency sweeteners, the reported synergy in literature
- Stevia is still the better non-nutritive sweetener since it is lower cost-in-use and less linger
- Recommended max use level is around 175ppm for Mog V 50% before off-notes become more apparent in drinks
- FEMA 4711, Beverages <60ppm, Monkfruit Extract

Formulating with Mogroside V 50%

Sugar replaced (°brix)	Use Level		
	<u>Milk</u> (ppm)	<u>pH 7</u> (ppm)	<u>pH 3.2</u> (ppm)
0.00	0	0	0
0.50	14	21	35
1.00	28	42	70
1.50	42	70	105
2.00	63	105	147
2.50	91	140	189
3.00	119	182	238
3.50	147	224	287
4.00	189	273	350
4.50	231	329	413
5.00	273	385	476

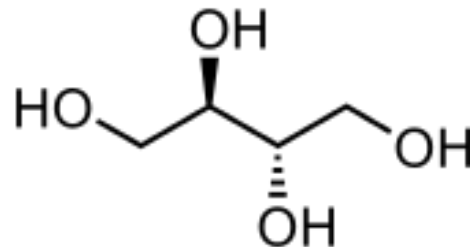


Monkfruit Regulatory Approvals

- US
- China
- Japan
- Korea
- Mexico
- Australia
- New Zealand
- Colombia
- Singapore
- Canada (Tabletop and Supplement only). Supplement requires prior authorization.
- Ecuador
- Peru
- Guatemala
- Honduras
- El Salvador
- Nicaragua
- Costa Rica
- Panama

Erythritol

- Erythritol occurs naturally in certain fruits and mushrooms
- Commercially produced via fermentation
- **Functionality:**
 - Erythritol provides upfront sweetness to balance out the delayed sweetness of stevia to be overall more sugar-like
 - Does not spread as easily as sugar and less browning in baking
 - Has cooling effect at increased use level
 - One of the better tolerated sugar alcohols by digestive system
- **GRAS levels vary on application**
 - Beverages < 3.5%
- **Can be labeled as a natural flavor under FEMA 4819**
 - Beverages < 1.25%



Formulation Tips

- Calculate the total sweetener contribution in the finished application in terms of sucrose/brix equivalence. For example, in a 100ml beverage, how much sugar would be in the drink?
- For projects that plan to use stevia to sweeten up to 6 sucrose / brix equivalents, start with Reb A. For higher sweetness projects, add on the premium rebaudiosides or monkfruit to top off the sweetness. This would provide the best value for your product.
- After finding the right high potency sweetener blend, the formula may still need some tweaking such as mouthfeel, bulking or acidity. Gums or other hydrocolloids may be needed for mouthfeel.
- Bulking may be needed to maintain net weight or for baking and candies. Consider using maltodextrin, sugar alcohols or fiber.

Long Term Outlook - Stevia

- Fewer stevia plants and unfavorable weather will result in a shorter supply this season. Contract ASAP but prices have already gone up.
- Good time to reformulate from stevioside and low purity Reb A to high purity Reb A due to the current and expected low cost due to higher yield in the stevia leaf
- Premium stevias pricing will continue to come down
 - Investment in traditional cross-breeding led to finding varieties of stevia with significantly higher yield of desirable glycosides
 - Farmers will plant more high Reb D and M varieties as demand increases
 - Increased competition from bio-converted and fermented stevias
 - Commercializing other uses of the remaining stevia plant will lower glycoside costs
 - Fiber
 - Polyphenols
 - Protein



Long Term Outlook - Monkfruit

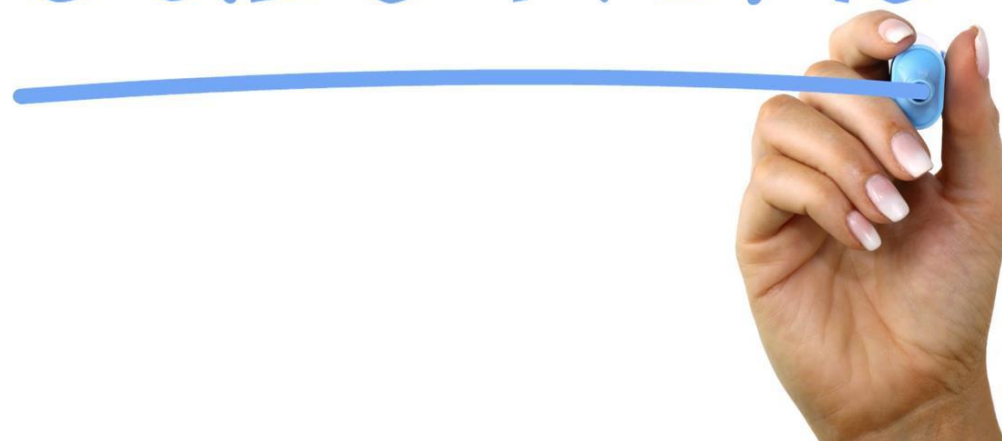
- Monkfruit prices are near the bottom and are expected to increase due to higher demand and lower yield due to heavy rains
- Continued investment in traditional cross-breeding will increase mogroside content and fruit yields
- New labor-saving technologies
- The industry is also exploring monkfruit derived from genetically modified enzymes and fruit. It isn't expected to gain broad appeal and regulatory approval in the near future but may be a factor in the long term like it currently is for stevia
- Continued global regulatory approval, particularly for monkfruit and bio-converted/fermented stevia, will improve the reach of those sweeteners

Long Term Outlook – Low Calorie Bulking

- Erythritol price has stabilized, and we anticipate it to slowly rebound this coming year due to these factors below. Contract now for 2025.
 - Higher global commodity prices
 - Lower output, many factories had already started to pivot to make other products with the existing capacities
 - Higher demand due to low price with fewer companies wary about recent flawed studies
- Keep an eye out for regulatory approval of Allulose in Canada
- Allulose prices is expected to remain steady over the next year and the supply is stable. We expect to see more established manufacturers of other low calories sweeteners enter the field. The current global economic situation is prohibiting new launches since allulose is one of the most expensive options for sweetness.
- Demand is higher with longer production lead times. Tate is having some trouble fulfilling customer orders.



QUESTIONS



Hank.Wang@Howtiangroup.com

