

Edlong's Approach to Masking Bitterness: Taste Technologies to Drive Sensory Experiences

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Executive Summary

Bitterness is one of the most challenging sensory attributes to manage across food and beverage categories. Whether originating from plant proteins, botanical extracts, caffeine, nutraceuticals, or processing by-products, bitter tastes can negatively influence the consumer acceptance of food products.

Scientific evidence shows that bitterness perception is mediated by a large family of G protein-coupled receptors (TAS2Rs), each triggered by different structural motifs of bitter compounds. With approximately 25 known human TAS2Rs, any single product may trigger several receptors simultaneously, making bitterness both complex and multifaceted.¹

Edlong has developed a sensory led, taste architecture approach that minimizes bitterness perception using multiple sensory channels. Strategically designed masking technology works by signaling to the brain taste, aroma, and mouthfeel cues, while bitter taste on the tongue is suppressed through receptor inhibition.

This white paper summarizes the biological foundation of bitterness, key insights from current research, and how Edlong applies science-backed strategies to help manufacturers create more palatable products.

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1. Understanding Bitterness:

A Biological Challenge - Bitter Taste Receptors (TAS2Rs)

Humans are thought to have evolved bitter taste receptors as a protective mechanism against ingesting potentially harmful substances. Many naturally occurring toxins in plants are bitter, so the ability to detect and avoid bitter compounds likely provided a survival advantage by reducing the risk of poisoning. Research suggests bitter receptors are not limited to the tongue and may have functions in other tissues, implying broader biological roles than simply detecting food. The diversity of human bitter receptors is thought to reflect evolutionary pressures from varying diets and environmental exposures to toxic compounds.¹ Over time, this sensory system became highly sensitive, allowing humans to recognize even small amounts of potentially toxic chemicals. While not all bitter compounds are harmful, the evolutionary role of bitterness is widely regarded as an early warning system that helped our ancestors make safer food choices.

Human bitterness perception is mediated by a network of approximately 25 known TAS2R receptors, each capable of responding to structurally diverse bitter molecules, allowing for the detection of over one thousand bitter substances. Many plant-based and functional ingredients activate broadly tuned receptors, which respond to a wide variety of bitter compounds including phenols, terpenoids, and saponins.^{2,3}

Each receptor detects different bitter compounds, some are specialized (narrowly tuned) while others respond to dozens of different bitter molecules (broadly tuned)⁴:

- ☐ Broadly tuned (generalist), e.g., TAS2R10, TAS2R14, TAS2R46
- ☐ Narrowly tuned (specialist), e.g., TAS2R38 (activated by PROP)

Bitter compounds activate TAS2Rs through dissolving in saliva, allowing physical binding to a pocket on the taste receptor. The binding pocket recognizes the chemical features, specific to that receptor and binds. The receptor changes its 3-dimensional structure and activates gustducin which triggers a signaling cascade where the taste cell releases ATP, stimulating sensory nerves and signaling to the brain a bitter perception.

2. Bitter Compounds in Foods

As illustrated in Fig. 1, bitterness in foods often arises from plant secondary metabolites, including:

- ☐ Phenols (example: flavonoids found in tea and grapes)
- ☐ Alkaloids (example: caffeine found in coffee)
- ☐ Terpenoids (example: cucurbitacins found in bitter melon)
- ☐ Saponins (example: ginsenoside found in ginseng)
- ☐ Amino acids and Peptides (example: phenylalanine found in cheese)

Food processing can also generate bitterants:

- ☐ Protein hydrolysis (bitter peptides)
- ☐ Fermentation metabolites (esters, peptides, aldehydes)
- ☐ Maillard reaction products (furans)



Figure. 1: Bitter compounds naturally occurring in plants or generated during food processing

3. Food Industry Debittering Techniques

Food science literature highlights several methods investigated to remove or reduce bitter compounds in foods:

☐ Remove the bitter compounds

- Adsorption can be used to bind bitter compounds to physically remove them, often resulting in removal of desirable aroma compounds as well.
- Protein debittering with fractionation and purification techniques.

☐ Convert the bitter compounds

- Encapsulation, emulsions, and protein interactions can modulate bitterness delivery and perception.⁴
- Fatty acids, peptides, and polysaccharides can bind or sequester bitter molecules, reducing receptor exposure.⁴

☐ Changing human perception

- Ingredients to modify perception – sweet, salt, sour, and aroma compounds
- Mechanisms to inhibit receptor binding.

4. Understanding Human Bitterness Perception

As split-tongue experiments demonstrate, masking with sweetness is central, not peripheral.⁵ Bitterness masking by sucrose persists even when sweet and bitter stimuli are physically separated on opposite sides of the tongue, demonstrating that masking is fundamentally a central neural process rather than merely a peripheral receptor-level phenomenon. The research by Kroeze et al supports that the brain is actively involved in suppressing bitterness, rather than suppression occurring only at the taste receptor level.

Multi-modal approaches may offer more robust real-world bitterness reduction than single-modality strategies in some applications. These findings align closely with Edlong's taste technology strategy.

5. Edlong's Approach to Bitterness Masking – A Two Step Approach

Step #1: Leveraging Cross Modality of Aroma, Taste and Mouthfeel

Edlong's bitterness-masking philosophy is grounded in cross-modal sensory modulation, using their suite of proprietary Taste Technologies to influence how the brain integrates taste, aroma, and mouthfeel signals.

This approach leverages well-documented neuroprocessing principles, including:

Aroma–Taste Interactions

Aroma compounds associated with sweetness, saltiness, and umami can shift attention away from bitterness and enhance positive flavor cues. As a result, masking can be achieved by changing sensory perception without changing formulation chemistry.⁶

Mouthfeel-Taste Interactions

Mouthfeel can also influence how bitterness is perceived, although this area is less extensively studied than aroma–taste interactions. Edlong has observed strong potential in using creamy, fatty, or mouthwatering mouthfeel cues to help reduce the perception of bitterness. These texture-driven signals may reduce the sharpness, harshness, and lingering character often associated with bitter compounds by shifting perception toward a smoother, more balanced sensory profile.

Step #2: Identifying Blockers to Target Specific Receptors

In order to identify ingredients that inhibit receptor uptake, Edlong determined which specific TAS2R receptor was activated by which food source. Edlong first identified bitterants present in many foods and beverages. These included Caffeine, Quinine, and Bitterants produced from bioconversion (Table 1)

Bitterants	Caffeine	Casein-Derived Peptides through Bioconversion	Quinine
Receptors	TAS2R7	TAS2R1	TAS2R4
Activated	TAS2R10	TAS2R4	TAS2R39
	TAS2R14	TAS2R14	TAS2R43

Table 1: Bitterants binding to specific Bitter Taste Receptors (TAS2Rs) (Ziaikin, Bitter DB⁷).

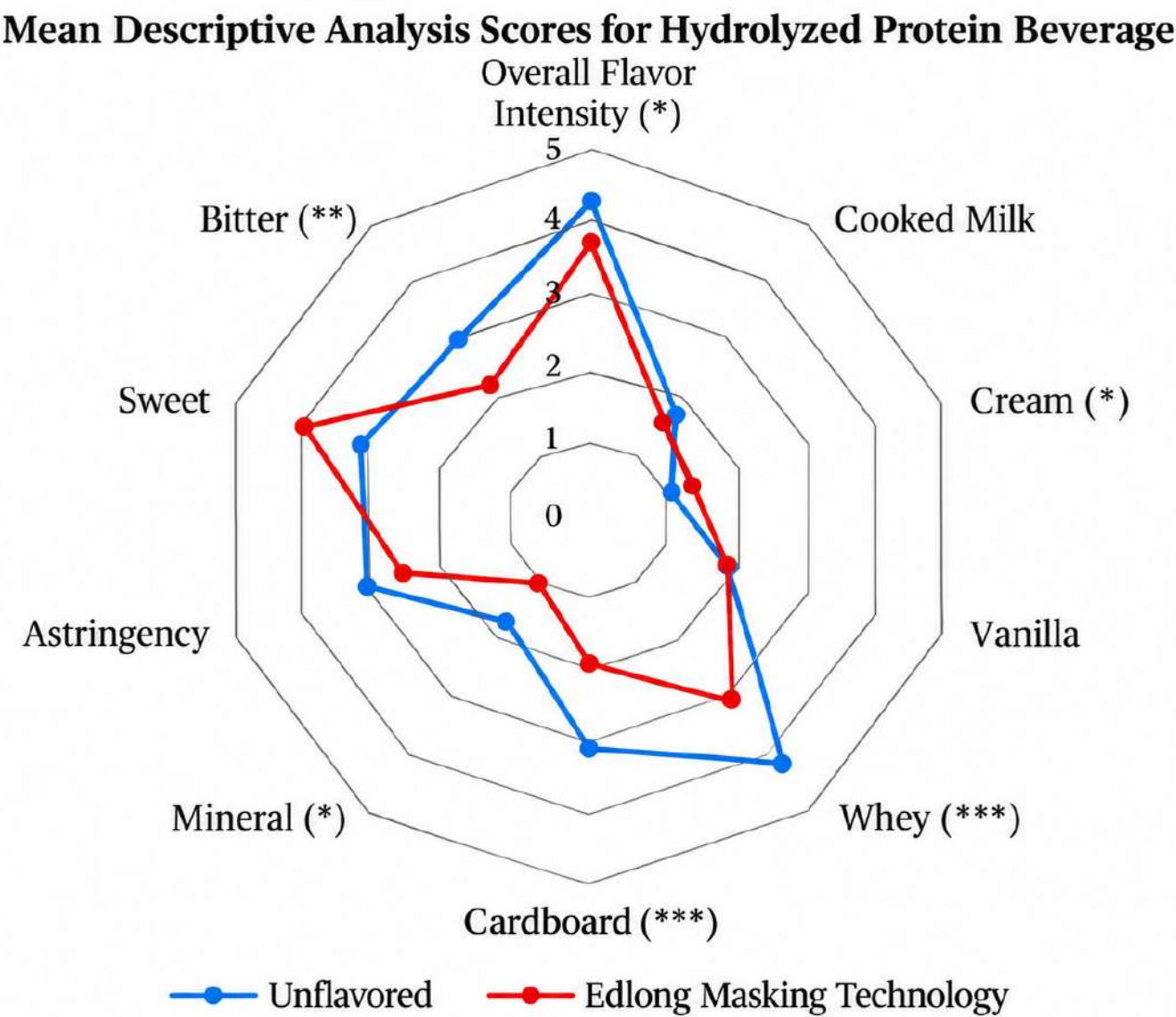
Unique, select tastants were added to the bitterants to determine if the bitterness was reduced. Through this research, Edlong identified unique blends of compounds that supported receptor-informed, ingredient-specific bitterness masking strategies.

This approach was also seen effective in a study by Schwiebert et al where 6-methylfavone was identified as a blocker for TASR39 activity.⁸

The data supports future ingredient-specific masking approaches, including applications for selected novel ingredients.

Two-Step Approach in Application

Utilizing this two-step approach, evidence of bitterness reduction can be seen in Edlong’s internal research. Using a trained Descriptive Analysis panel, two samples of a hydrolyzed whey protein beverage were evaluated. Sample 1 was Unflavored and Sample 2 contained Edlong’s Masking Technology. Panelists perceived a significant reduction in bitterness in Sample 2 with Edlong Masking Technology, as well as a significant reduction in off notes like Whey and Cardboard (Fig. 2).



Post Hoc: Tukey’s HDS 0.1	
Significant at alpha 0.1	*
Significant at alpha 0.05	* *
Significant at alpha 0.01	* * *

Figure 2: Mean Descriptive Analysis Scores for Hydrolyzed Protein Beverage

6. Research Evidence in Support of Cross Modality for Bitter Masking

6.1 Research from Haines and Simons at The Ohio State University

The above referenced study by Haines and Simons was presented at the Society of Sensory Professionals Conference in 2024. It informed Edlong’s subsequent internal research on bitterness masking. In this study, cold brew coffee was evaluated with and without nose plugs containing water vs. milk to see how aroma affects the perception of bitterness.

	Nose Closed (No Aroma)	Nose Open (Aroma Present)
Cold Brew Coffee with Water at 17% vs. Cold Brew Coffee with Whole Milk at 17%	No significant difference in Bitterness Intensity in DA	Coffee with Whole Milk is significantly lower in Bitterness Intensity in DA
	No significant difference in Bitterness in Paired Comparison	Coffee with Whole Milk was selected significantly more as being Less Bitter in Paired Comparison

Table 2: Results of Bitterness Study conducted by Haines and Simons⁹

The results summarized in Table 2 suggest that **olfactory cues contributed substantially to the observed reduction in bitterness** when milk was added to coffee. These findings led Edlong to conduct internal sensory testing to understand if their Dairy Taste Technology could be used to reduce bitterness in coffee.

6.2 Internal Research at Edlong

Edlong conducted paired-comparison testing to evaluate the perceived bitterness of coffee, details as follows:

Test 1: Whole milk in Coffee vs. Water in Coffee

Test 2: Whole milk in Coffee vs. [Water + Edlong Cream Taste Technology] in Coffee

Panelists identified **reduced bitterness** in samples formulated with the Edlong Cream Taste Technology. This is consistent with sensory literature indicating that dairy-associated volatiles and mouthfeel can influence perceived bitterness through cross-modal effects. Tables 3 and 4 summarize the results of the evaluation.

Test 1 – Whole milk in Coffee vs. Water in Coffee, n=12, Replicated

Sample Description	Which Sample is MORE BITTER?
Control with Whole Milk	2
Test with Water	22

*Coffee with Whole Milk **is significantly less bitter** than Coffee with Water.

Table 3: Results of Test 1: Whole milk in Coffee vs. Water in Coffee (Ref.: Internal Edlong Data)

Test 2 – Whole milk in Coffee vs. [Water + Edlong Cream Taste Technology] in Coffee, n=12, Replicated

Sample Description	Which Sample is MORE BITTER?
Control with Whole Milk	12
Test with [Water + Edlong Cream Taste Technology]	12

*Coffee with Whole Milk **is not significantly different in bitterness** than Coffee with Water + Edlong Cream Taste Technology.

Table 4: Results of Test 2: Whole milk in Coffee vs. [Water + Edlong Cream Taste Technology] in Coffee (Ref.: Internal Edlong Data)

7. Summary of the Science Behind Edlong's Bitterness Masking

Edlong's bitterness-masking method is designed around the source of the bitterness and how bitterness is perceived. The research summarized earlier shows that bitter perception begins when specific bitterants activate TAS2R receptors, but the final sensory experience is shaped by the brain's integration of taste, aroma, and mouthfeel signals. Edlong's two-step approach uses both sides of this science: first, cross-modal flavor design helps redirect perception away from bitterness; second, receptor-informed screening helps identify tastants that can target the bitter pathways most relevant to a specific ingredient system.

Edlong's two-step approach combines cross-modal taste architecture with receptor-informed inhibition strategies. First, Taste Technologies use positive aroma, taste, and mouthfeel cues - such as creaminess, sweetness, saltiness, umami, and mouthwatering effects - to help the brain perceive the overall product experience as less bitter. Second, Edlong identifies the bitterants most relevant to a food or beverage system, maps them to the TAS2R receptors they activate, and screens selected tastants to find combinations that reduce bitterness at the source.

Together, the two steps create a more complete masking strategy. Cross-modal design improves the full sensory experience the consumer perceives, while receptor-informed development targets the source of bitterness more precisely. This dual approach helps explain why Edlong's internal testing showed reduced bitterness and reduced off notes in product systems containing Edlong Masking Technology. Rather than relying on a single masking ingredient, Edlong builds an integrated flavor architecture that can be adapted to the bitterant profile, receptor activity, and sensory context of each application.

8. Applications Across Food and Beverage Categories

This two-step approach is especially useful in products where bitterness is driven by multiple mechanisms at once: receptor activation from specific bitterants, lingering aftertaste, harsh aromatic notes, and thin or astringent mouthfeel. By combining targeted bitterness reduction with positive sensory cues, Edlong can build masking systems that improve overall balance without relying on a single masking tool.

- ☐ Plant-based, Hydrolyzed, and Dairy Proteins
- ☐ Natural Colors
- ☐ Caffeinated beverages
- ☐ Nutritional and Wellness Beverages, Bars, and Snacks

9. Continuing Research

Cholesterol has been identified as a ligand for at least one bitter receptor.¹⁰

Edlong plans to investigate if dairy products that contain cholesterol would also demonstrate this novel property, allowing for bitter reduction. This new area of research is just beginning to be explored.

10. Conclusion

Bitterness is scientifically complex, but it is manageable through strategic, sensory-forward design. By integrating published receptor biology, cross-modal sensory science, and flavor architecture expertise, Edlong provides practical, label-friendly solutions to reduce bitterness by shaping the full sensory experience the brain receives.

This approach allows food and beverage developers to create better-tasting products, increase the speed of development cycles, and improve consumer acceptance across a wide range of applications.

11. References

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Acknowledgments

A special thank you to Dr. Danielle Reed, Chief Science Officer, Monell Chemical Senses Center for her invaluable input into this white paper.