Taste Modifying Considerations for Natural High Intensity Sweeteners

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Overview

- Flavor Perception
  - Sensory Inputs and Influence
  - Physiology of Taste and Smell
- Taste Modifying Technology
  - Complex Signal Analysis and Hedonic Effects
    - Strong Tastants and Flavors
    - Congruent Flavors and Phantom Aromas
  - Physical/Chemical Phenomenon
    - Scavenging
    - Binding Interactions

Flavor Perception

- Taste
  - Sweet, Sour, Bitter, Salty, Umami
- Smell
  - Orthonasal, Retronasal
- Chemosthesis
  - Warmth, Itching, Stinging, Burning
- Tactile
  - Astringency, Pressing, Mouthfeel

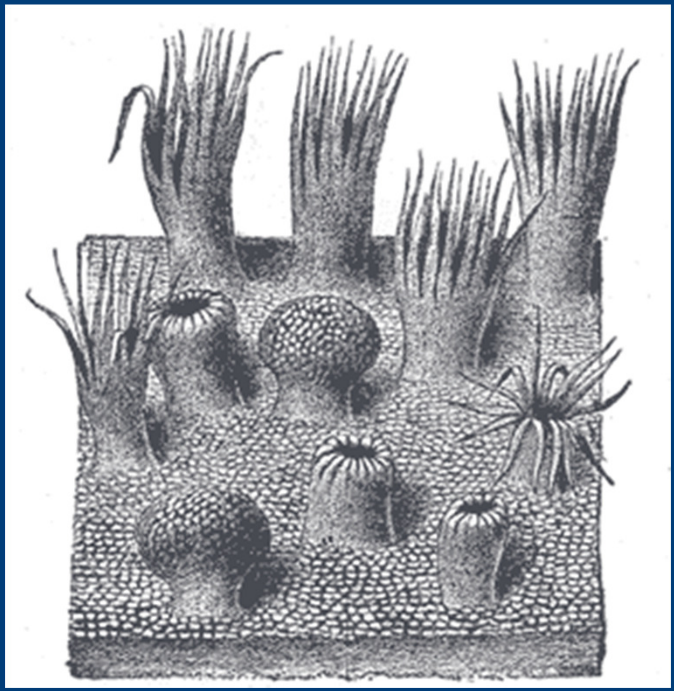
Environmental Stimuli → Transmission of Information → Cognition of Signal → Sensation Perception

Summary: Neural Mapping and Integration of Taste

- Humans are hardwired for different taste attributes
  - (+) hedonics
    - Salty (minerals)
    - Sweet (energy)
    - Umami (protein rich)
  - (-) hedonics
    - Sour (rancid)
    - Bitter (poison)
  - The neural network changes based upon experience (e.g. sour cream, stinky tofu, durian fruit)

Gustation Location

- Occurs in taste buds in the papillae
- Taste bud is a bundle of taste receptors, each one specialized for one type of taste
- Taste receptors are a special kind of neural cell that do not have axons
- Taste receptor cells have small pores that are exposed to the environment
- ~1.5 Million taste receptor cells



Chemesthetic Sensation

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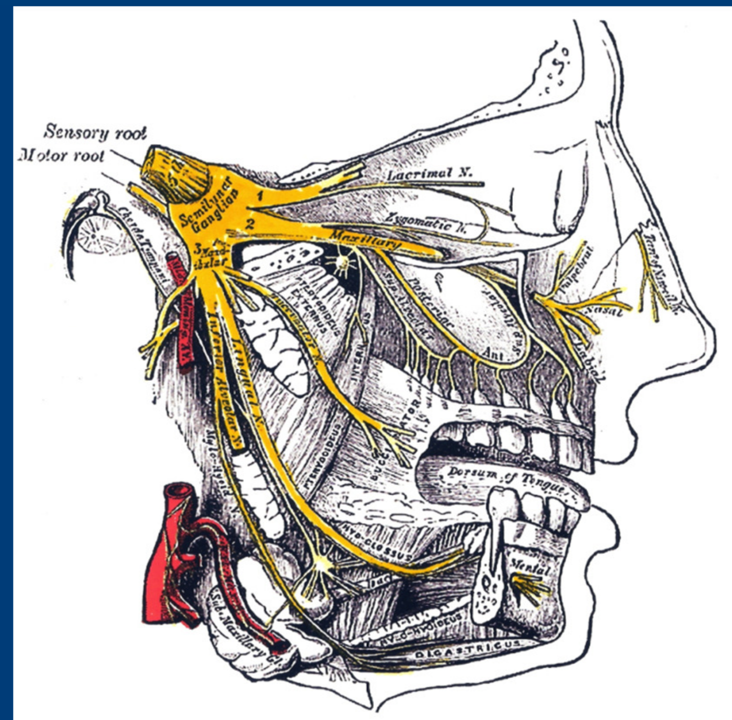
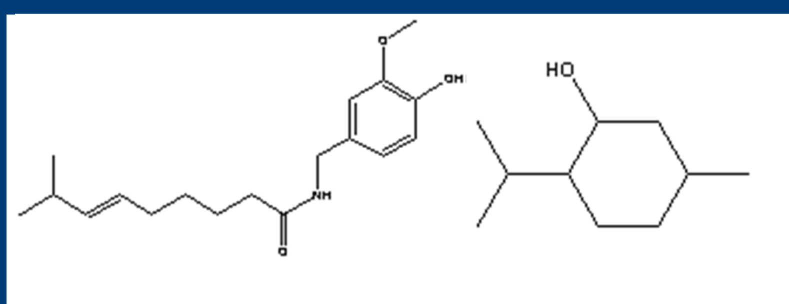
- The cold and hot sensations caused by heat compounds (e.g., capsaicin) and cooling compounds (e.g., menthol) and tactile sensation
- Temperature sensation caused by transient receptor potential (TRP) channels in the trigeminal nerves



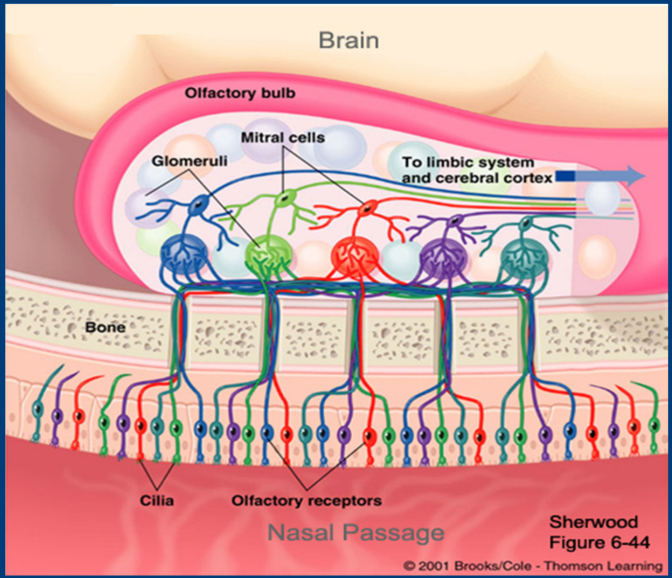


Physiology of Taste

- Taste is closely related to the senses of touch, sight, and hearing
- Tastants are coded in terms of time and intensity
- Insular Cortex (emotion)
- Frontal Cortex, Orbitofrontal Cortex, Hypothalamus (memory, convergence, emotions)
- Amygdale (trigeminal response)

Olfactory Sensation

- Nose
  - Aroma Perception
    - Nasal
    - Retronasal
    - 80% of flavor perception arrives through aroma
  - Physiology
    - 6 million neurons pass through cribriform plate
    - Odor binding proteins transport volatiles across mucus membrane to olfactory epithelium



Physiology of Olfaction

- Aromas interact with the olfactory bulb
  - Spatial and Temporal Patterns
- Olfactory Bulb interact different centers in the brain
  - Pyriform Cortex (core area of smell)
  - Orbitofrontal Cortex (decision making, emotion)
  - Hypothalamus (feeding behavior, pheromone recognition)
  - Limbic System (emotion, memory)

Perception Summary

- Sensations are a learned experiences
- Stimulus→ Transduction →Cognition
- Three types of sensorial mechanisms: chemesthetic, gustatory, and olfactory
- Each type of sensation has a unique pathway and uses a different set of nerves
- Sensations can be modified by interfering with the perception process
- Aroma and taste tie into “memory” and “emotion” centers of the brain

Overview: Taste Modifying

- Taste modifying is the process of changing taste attributes through the use of psychochemical or chemical means
- Two Classes of Modifying
  - “**MASKING**” relates to psychochemical
  - “**BLOCKING**” relates to chemical processes

Taste Modifying Techniques

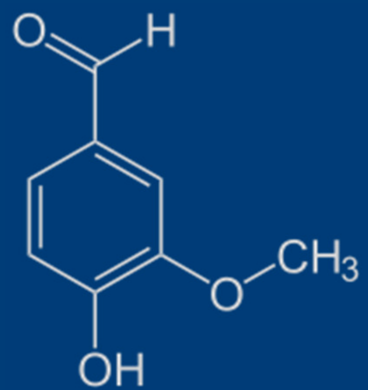
- Blocking
  - Removal of bad tasting components
  - Physical Barriers
  - Scavengers, Complexing agents
  - Bitter taste reducing compounds on a molecular level
- Masking
  - Strong Tastants
    - Salt, Sweeteners, Acidulants,
  - Congruent Flavors
    - Complementary to point of modification
  - Phantom Aromas
    - Sweet, acrid, salty flavorants
  - Chemesthetic

Masking by Strong Tastants, Congruent Flavors, and Chemesthetics

- Taste perception can be masked by congruent flavors
  - Neural Integration (requires knowledge of flavor)
  - Chocolate, Grapefruit
- Taste perception can be masked by alternative tastants
  - Sodium Salts
  - Sweetness
  - pH Modifiers
- Chemesthetics
  - False triggering of hot and cold receptors

Masking by Phantom Aromas

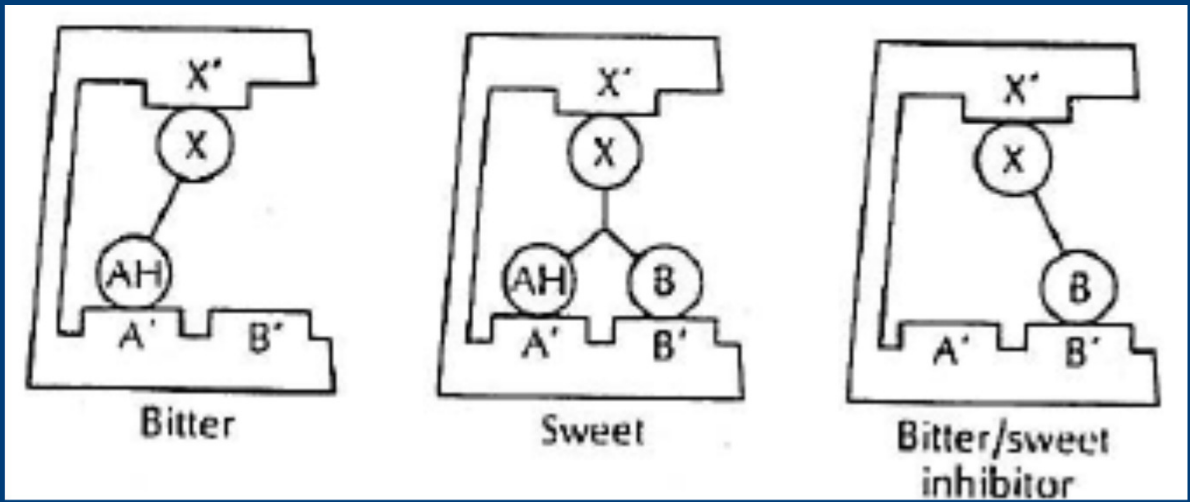
- Adds a taste or odor that causes the mind to ignore the taste or odor of another compound
- Neural map requires training
- Vanillin
  - People become adept at identifying vanillin at a young age because of its association with sweetness. In imperceptible quantities, the person does not taste the vanillin, but it does distract from other tastes.



Suppression of Taste Transduction: Molecular View

- Molecules that can complex or scavenge the offending molecule; can disrupt the transport to receptor
- Antagonists of taste receptor binding sites
- Modulators of taste biding sites
- Modulators of other proteins involved in taste transduction
  - Gustducin, PLCβ2 (phospholipase C B-2), PDE Pathway
- Compounds which can influence the neurotransmitter release, binding, or reuptake
- Modulators of signal quenching

Blocking Taste Molecules: Structure-Function Relationships



- Okai unified bitter/sweet taste receptor model.
  - AH amino or hydrophobic group
  - X second hydrophobic group
  - B Lewis base

Polymers and Complexing Agents

- Sequestering agents and complexing agents need to be used in relatively high concentration
  - Alginates, β-cyclodextrin, cyclofructans, phosphatidic acid / β-lactoglobulin, Treated Egg Proteins, Chitosan
- Bitter compound preferentially interacts with sequestering agent compared to taste receptor

Low-Molecular Weight Compounds for Taste Suppression

- Small molecules present some large possibilities
  - Gymnemic acid (60% suppression; 0.5% usage)
  - Neodiosim (80% suppression; 10ppm usage)
  - Zinc ion (salt of $ZnSO_4$) (50%-70% suppression; 25mM)
    - Zinc salts can exhibit astringency at >25mM concentration
  - Amino Acids (e.g. L-serine, L-proline)

Summary

- Taste modifying requires an understanding of which taste principle is to be suppressed
- Taste Modification needs to be evaluated in terms of time-intensity
- Literature doesn't support the idea that there is one complete technology available for modifying various taste modalities
  - Masking, Complexation, Encapsulation, Molecular Interactions
- Understand that targeted taste mode suppression can cause suppression of other taste modalities

Conclusion and Outlook

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- Off-taste mitigation in the food and beverage industry remains a large challenge
- High throughput matrix approach to identification of taste mode suppressing compounds
- Bitter taste is the most complex quality of all taste modalities due to the large number of T2R receptors
- Future looks to characterize the binding sites of taste receptor cells.

Citations

- Ley, Jakob P; “Masking Bitter Taste by Molecules”; *Chemosensory Perception*; 13 February 2008
- Talebi et al. “Beverage Products." Patent 20090226804. 18 September 2008.
- Slack et al. “Methods of Identifying Modulators of the Bitter Taste Receptor." Patent 20100129833. 17 December 2009.

Thanks for Your Attention

Questions?

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