CLEAN LABEL CONFERENCE

Sodium Reduction: Using Clean Label Salty, Umami and Kokumi Taste Modulation

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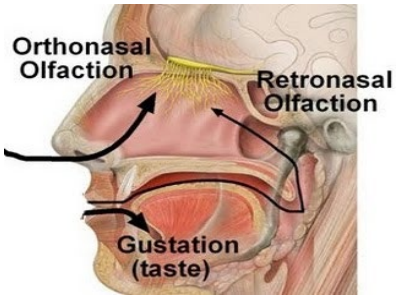
Executive Summary

- Saltiness Modulation: The four mechanisms are Substitution including KCl, Surface Area such as microspheres, Umami as in seaweed, and Neuroscience like expectancy constancy.
- Umami Modulation: There are also four mechanisms. Clean Label MSGs such as reduced sodium soy sauce, Vegetable Extracts including seaweed extract, and Natural PAM like umami peptides are recommended.
- Kokumi Ingredients: The tripeptide Glutamyl-Valyl-Glycine is the most potent kokumi compound
- Stacking is a clean label sodium and MSG reduction strategy for blending the three types of plant-based savory ingredients to make foods salty, rich and delicious.

Agenda

- Module 1: Salty- neuroscience, ingredients and modulators
- Module 2: Umami- neuroscience, ingredients and modulators
- Module 3: Kokumi- Ingredients
- Module 4: Stacking to make foods salty, rich and delicious

“Flavor” involves all 5 senses.....



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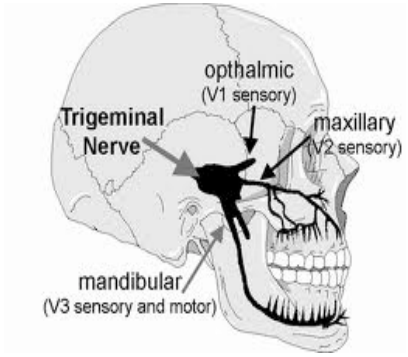

- Taste (5 basic including salty and umami)
- Smell (aroma)
- Somatosensation (Touch):
  - Mechanoreception: Touch, Pressure and Vibration (Prescott, 2015),
  - Thermoception: Temperature,
  - Nociception: Pain (Youseff, 2015), and
  - Up to total 30 senses? (Smith, 2016) can they all be part of somatosensation?
- Vision (“Seeing the flavor”. Acree, 2013)
- Sound is the Forgotten Flavor Sense (Spence 2015. Gastropod, 2015)

Taste Receptors

Taste receptors had been identified during the rapid advances of taste physiology and neuroscience in the past 15+ years (NIZO, 2011)

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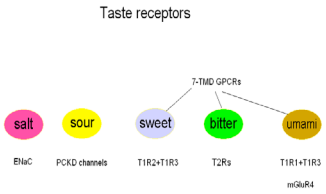
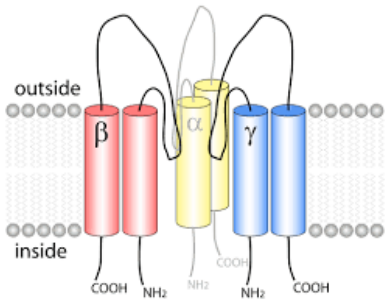
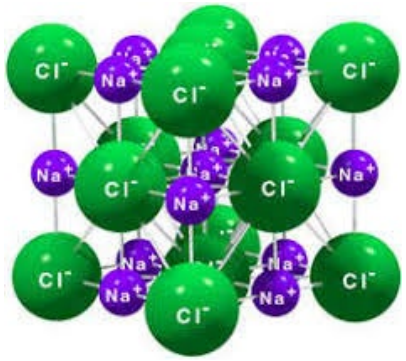


- **Bitterness:** 25 Receptors: T2Rs. Family: GPCR. 2000.
- **Sweetness:** 1 Receptor: T1R2/T1R3. Family: GPCR. 2001. And a newly found secondary pathway.
- **Umami:** 1 Receptor: T1R1/T1R3. Family: GPCR. 2002.
- **Sourness:** "Receptor": PKD1L3/PKD2L1. Family: Ion Channel. 2006.
- **Saltiness:** "Receptor": ENaC. Family: Na Channel. 2010. And a newly found secondary pathway in Type III cell.
- **"Fat":** Receptors: CD36, GPR120, FA1. Family: Several GPCR.
- **"Calcium"**: Receptor: CaR. Family: GPCR
- **"Water":** Receptor: Aquaporins. Family: Channel
- **"Starchy"**: Proposed (Lim, 2016)

Saltiness: Detection and Perception



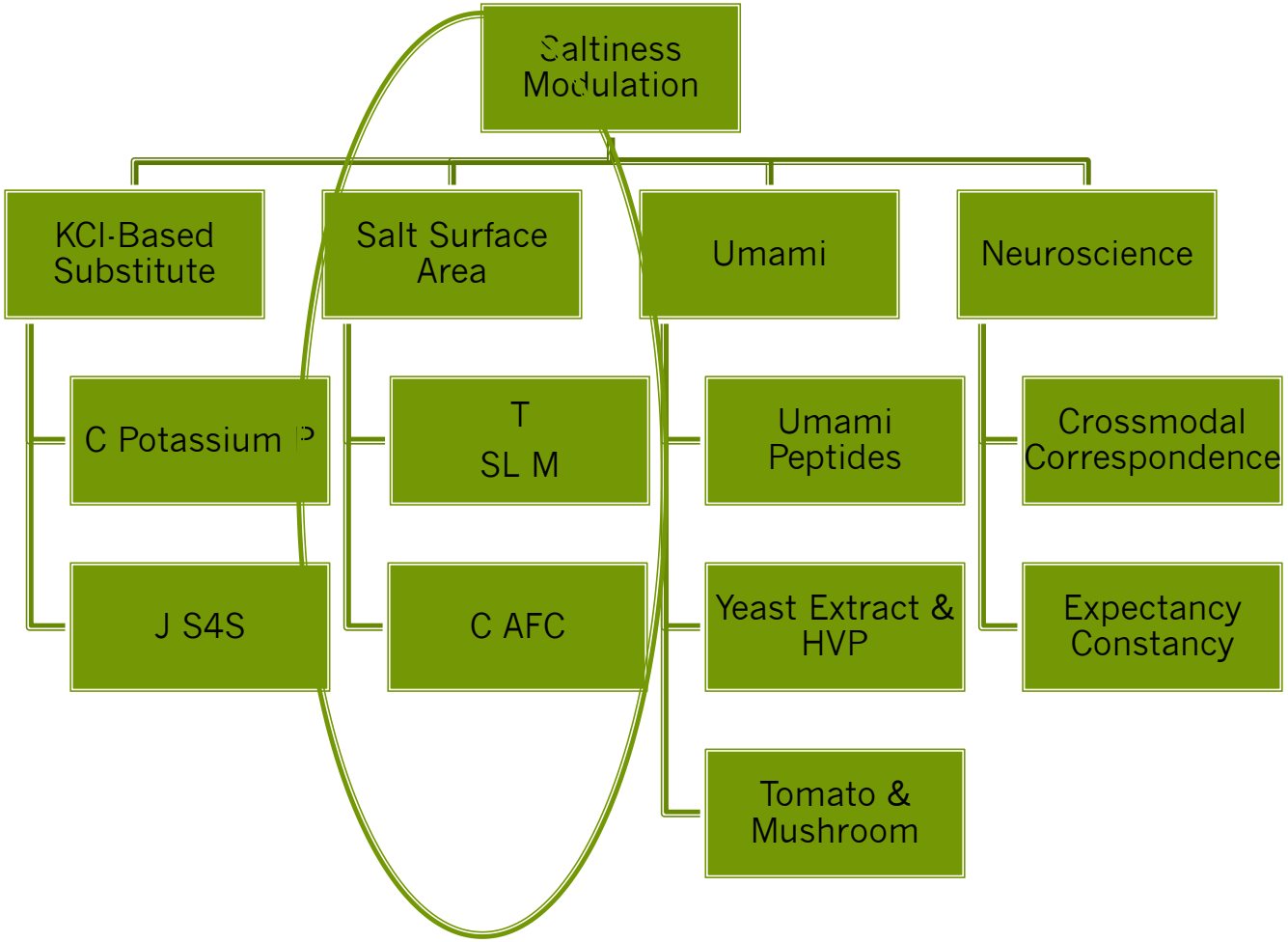


- Neuroscience:
  - **ENaC:**
    - These ion channels have transmembrane domains joined by a large extracellular loop, are selective for Na over other cations.
    - ENaC is likely a trimer and composed of 3 subunits
  - **Secondary pathway:** Non-selective to Na thus responds to both high level NaCl and any level KCl. (Chemosensory Transduction, Zufall and Munger, 2016. Chap. 16)
- Taste:
  - **Low level= salty and appetitive**, high level (>150mM)= bitter and aversive
  - A little bit of **salt (0.2%) made vegetables less bitter** (Bakke et al, 2018)
  - **Overweight/obese individuals were prone to consume more salt**, had reduced salt sensitivity, and higher preference for salty foods (Li et al, 2017)

Sodium Nutritional Claims by Country (Salt reduction guide for the food industry, CTAC, 2014)

Claim	USA	Canada	Codex
Sodium free	**≤ 5 mg /serving**	≤ 5mg /serving	<5 mg /100g
Very low sodium	≤ 35 mg /serving	-	<40 mg /100g
Low sodium	≤ 140 mg /serving	≤ 140mg /serving	<120 mg /100g
No salt added	**No NaCl added, Na compounds; can contain intrinsic Na**	-	-
Reduced sodium	**≥25% less Na than "earlier version"**	≥25% less Na than "earlier version"	-

Saltiness Modulation: There are 4 ways to do it, substitutes, surface area, umami and neuroscience. (W2O, 2022)



Saltiness Modulation: Increasing salt surface area is the ultimate clean label but mostly only good for topical applications

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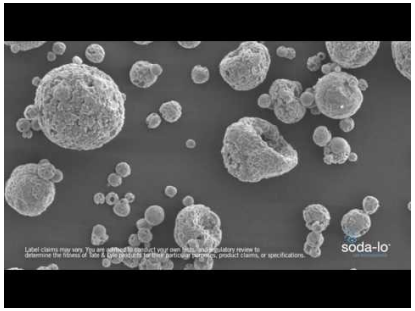
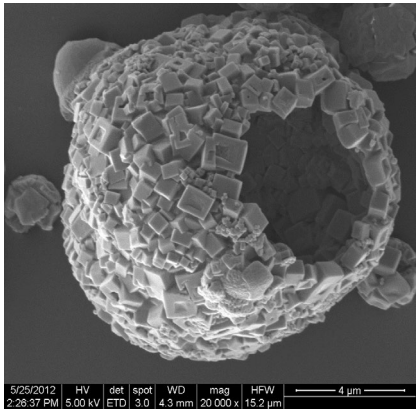
Chemistry & Neuroscience	Supplier, Taste, and Regulatory
SL M   	• Company T • **Extra Fine**, 20-30micron, for snack seasoning, up to **50% reduction** • **Fine N**. 200 microns for topical salted snack. Tumbler+ scarf plate applicator • Fine 600 microns for bread • **~30% reduction** • Usage: ~25% salt by weight. Intact only in **dry/almost dry foods.** • Label: salt or sea salt (<1.5%)

Saltiness Modulation: There are 4 ways to do it, substitutes, surface area, umami and neuroscience. (W2O, 2022)

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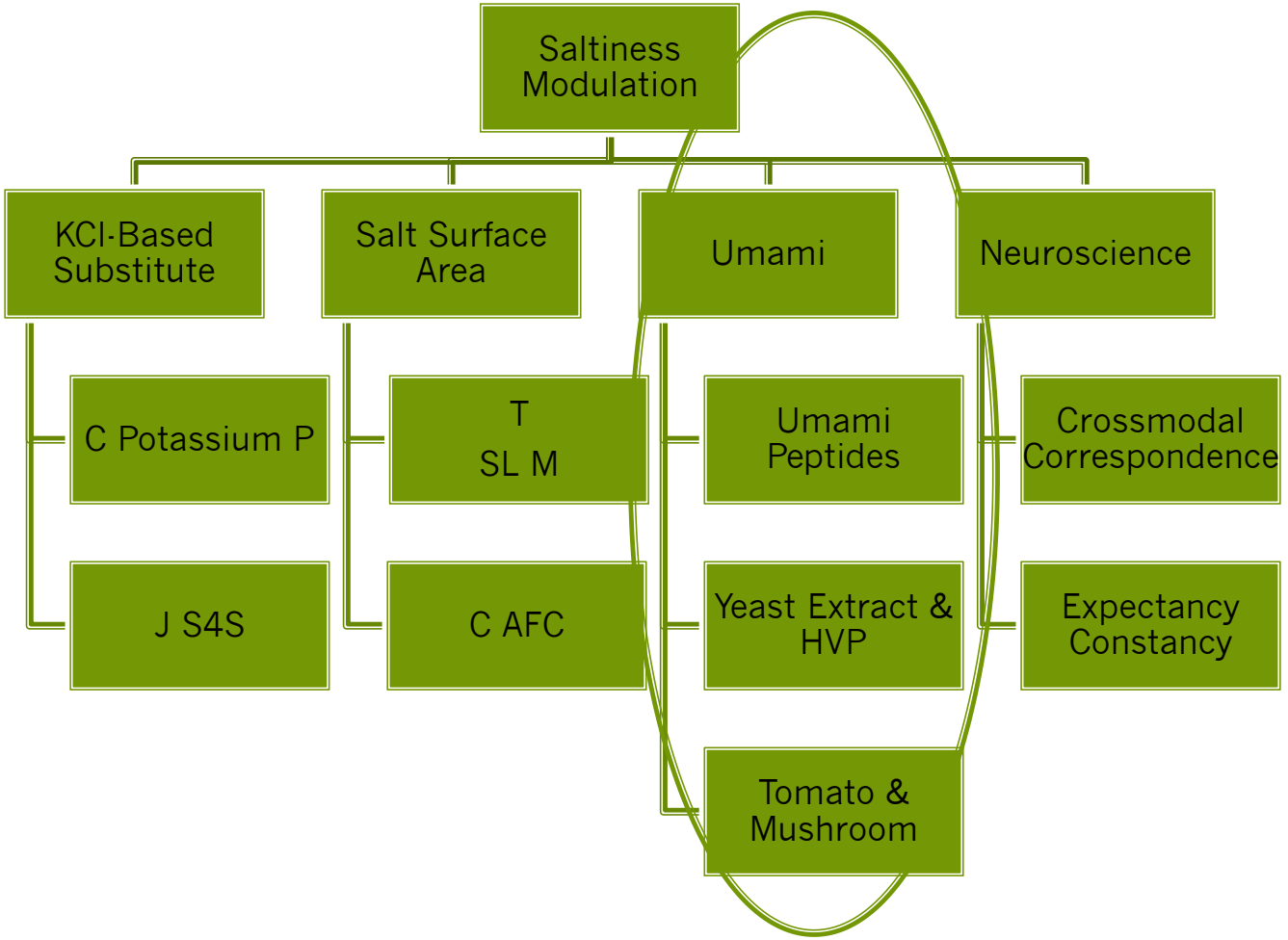

Saltiness Modulation: There are 4 ways to do it, substitutes, surface area, umami and neuroscience. (W2O, 2022)

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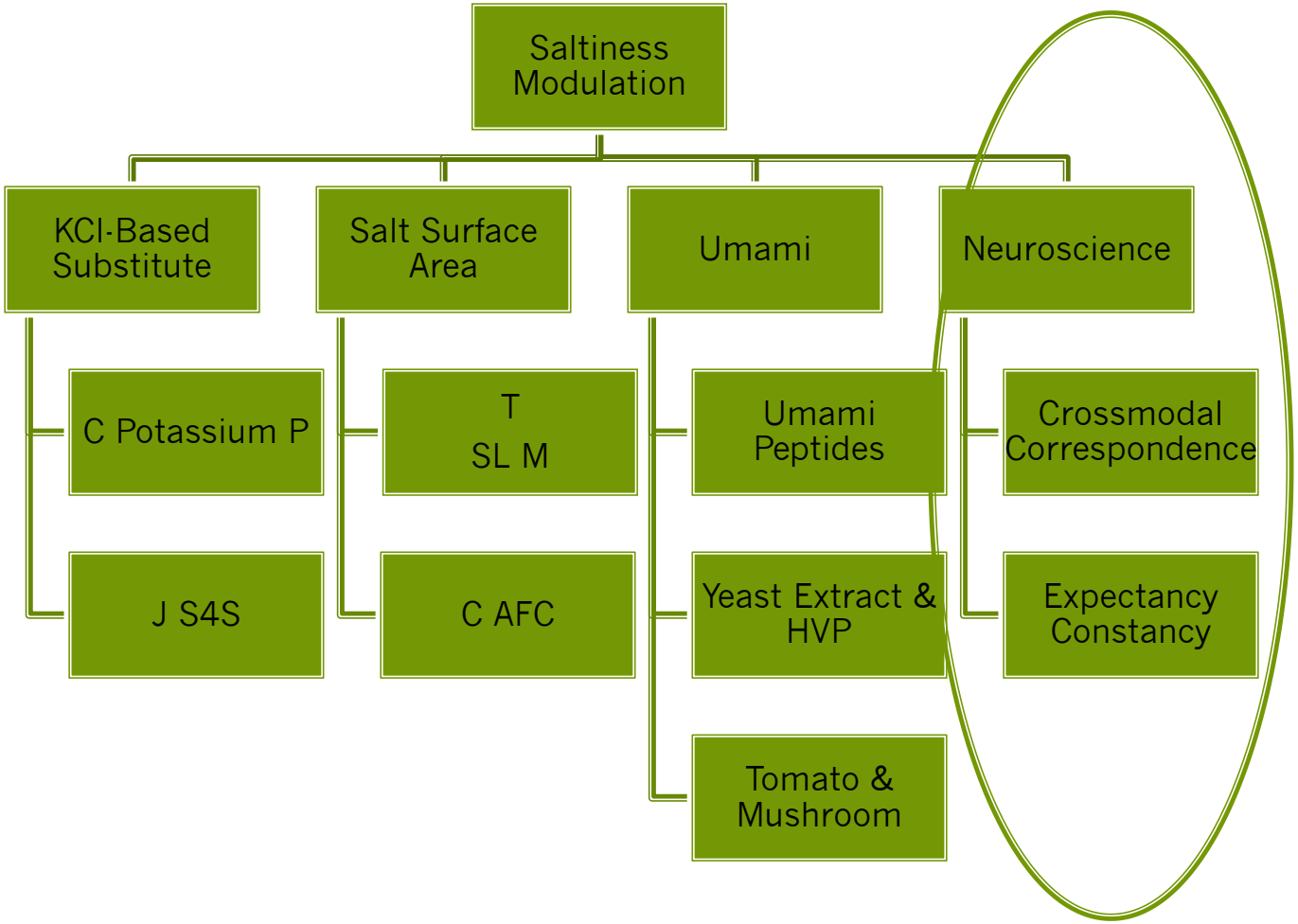
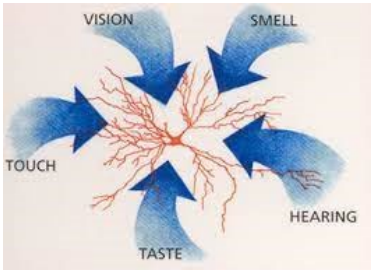


Saltiness Modulation: We can also increase salt perception via crossmodal correspondence



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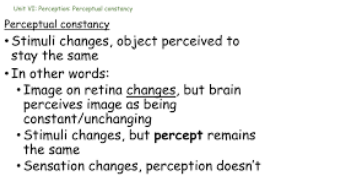

Chemistry & Neuroscience	What and How
Crossmodal Correspondence	• What it is: **Taste-Touch and Taste-Smell** • What it means: Prior association • How to use: Pepper oleoresin, aged cheese aroma, beef or chicken or ham aroma (limitation: Congruent flavor only)
Expectancy Constancy	• What it is: Taste Contrast or **Layering for 30% sodium reduction** • What it means: High-low-high layers or pieces • How to use: In cereals and confections (pieces) and in bakeries (bread, pizza, layers)

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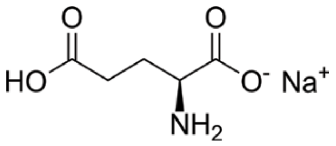
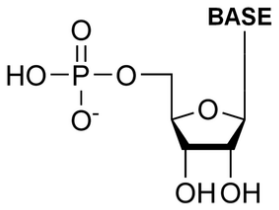
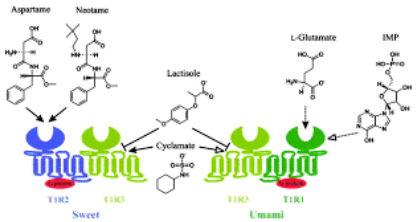
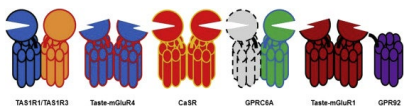
Umami Taste: Detection and Perception



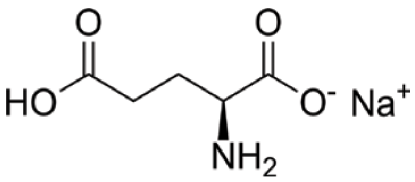






- Neuroscience:
  - Receptors: All GPCRs
    - **Primary: T1R1/T1R3**, MSG binds at VFT in T1R1 subunit only (Chemosensory Transduction, Zufall and Munger, 2016.)
    - **5 secondary pathways:** Responding to other amino acids and peptides Taste-mGluR4, Taste-mGluR1, CaSR, GCPR6A, GPR93.
- Taste:
  - MSG: **Umami= "Delicious"**
  - More umami at higher temperature (Green et al, 2016)
  - Could be a flavor enhancer, in addition to being a basic taste.
- Regulatory:
  - USA: GRAS (MSG) labeled as MSG, Codex: Natural flavour

Umami Modulation: There are also 4 ways to do it. (W2O, 2022)



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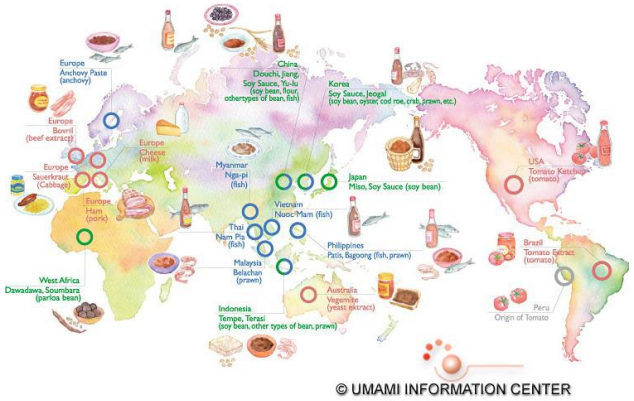

- Umami Modulation
  - MSG
  - Clean label MSG
    - Yeast Extract
    - HVP
    - Soy Sauce, Fish Sauce, Chicken Broth
  - Vegetable Extracts
    - Tomato
    - Mushroom
    - Seaweed
  - Natural PAM
    - Nucleotides
    - Other PAM
    - Umami Peptides

Umami Modulation: There are also 4 ways to do it.

(W2O, 2022)

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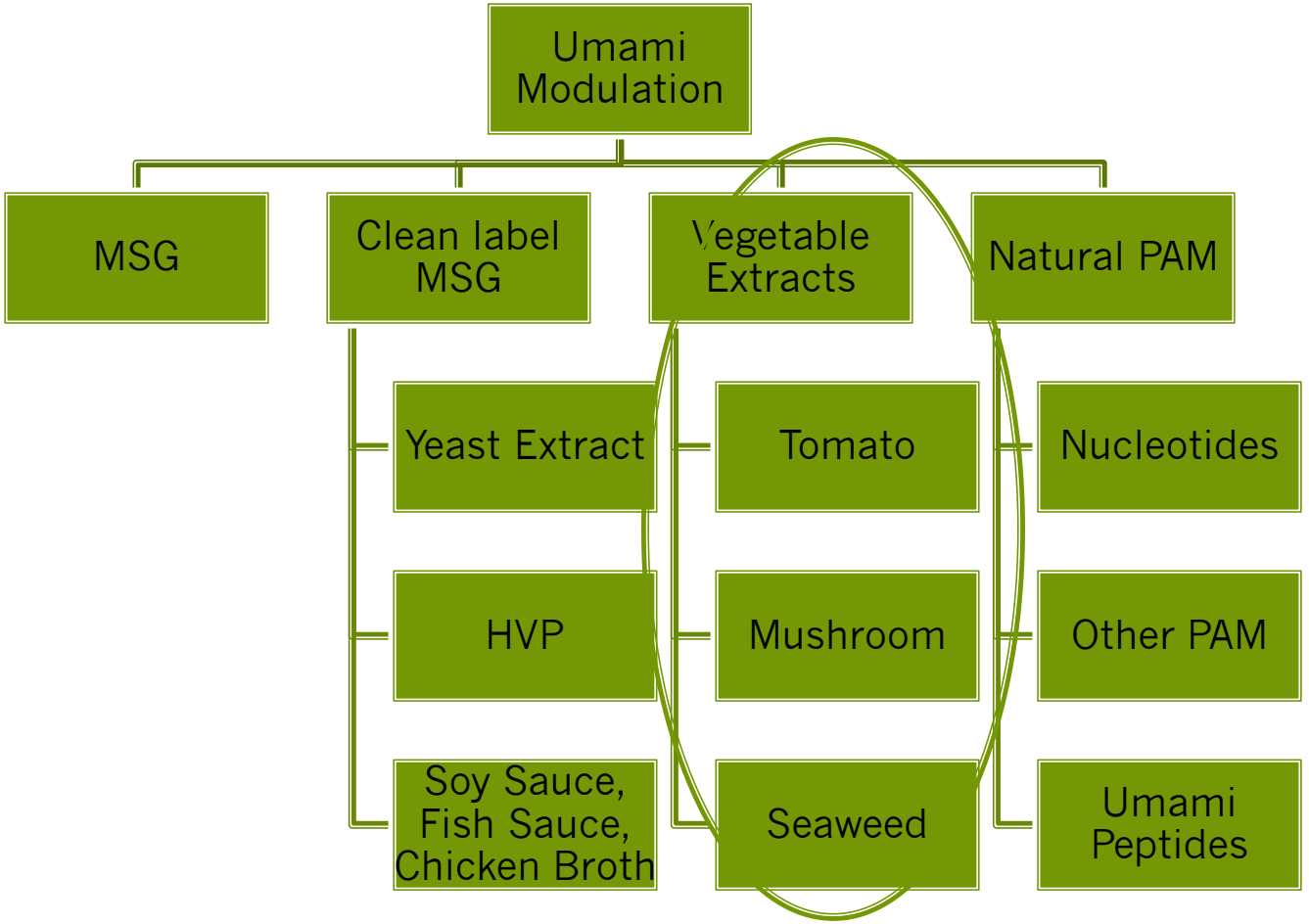

Umami Modulation: Vegetable extract is the cleanest label

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Chemistry & Neuroscience	Supplier, Taste, and Regulatory
0.5% Shiitake Extract Powder (Shiitake mushroom high in natural MSG and nucleotides)	• Company NF • Label: Shiitake extract? (**8% protein**, 5% total salt with up to 5% added at the end of manufacture)
0.25-0.5% Seaweed Extract Powder (Kombu, historically original source of MSG found in nature. Salty and flavor enhancement)	• Company NF • Usage: Reduce if tasted seaweedy • Label: Kombu extract? (**1% protein**, 16% total salt with 11% intrinsic and 5% added salt at the end)
0.5-0.75% Fermented Rice Extract Powder (From sake lees, as high nucleotides yeast extract replacer. Mild soy sauce flavor)	• Company NF • Usage: Reduce if tasted soy sauce • Label: Fermented rice extract? (**25% protein**, 22% total salt added during fermentation)

Umami Modulation: Vegetable extract is the cleanest label

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Chemistry & Neuroscience	Supplier, Taste, and Regulatory
MU (UB) 	• Company S/A • Composition: **Water, tomato concentrate, sea salt, mushroom extract, seaweed extract.** • 22% sugar. 7% salt. 1% potassium. 5% protein. 110 cal/100g • Usage: 1% (0.3% -1.1%) • **Up to 45% Salt reduction or MSG reduction.** Also kokumi effect. • Label: USA= **natural flavor, sea salt**. EU= natural flavouring, sea salt. • Liquid, powder version on special request

Umami Modulation: There are also 4 ways to do it.

(W2O, 2022)

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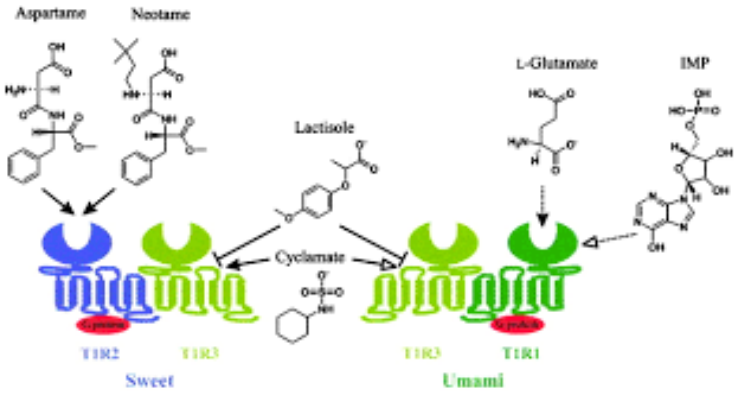

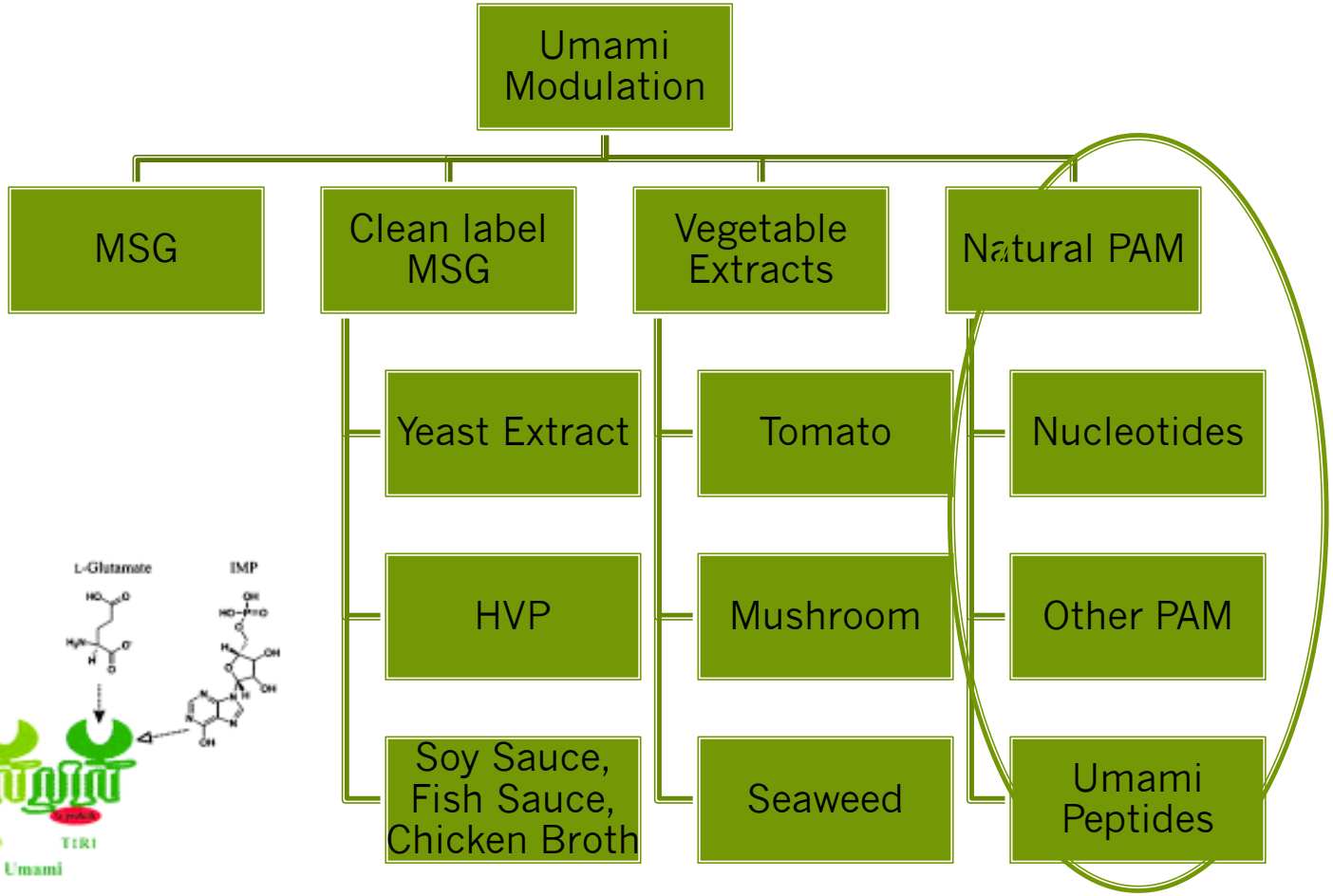

Umami is a Taste Found Abundantly in Nature:

The trick is combining the basal item with a synergistic item (Adam, 2015 and Umami, Mouritsen and Styrbaek, 2015), (A, 2022)

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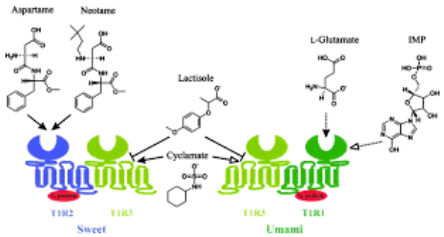
Umami Modulation: Nucleotides, which have been traditionally used to enhance MSG (8x, Company A), were proven to be Positive Allosteric Modulators (PAM).



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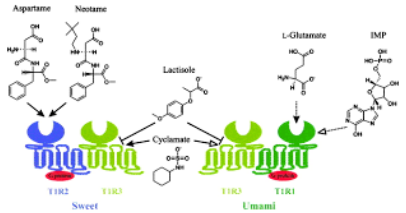
Chemistry & Neuroscience	Supplier, Taste, and Regulatory
5'-nucleotides: IMP (inosinate) and GMP (guanylate), 50/50 blend	• Company A • Umamiinfo.com • Extracted or fermented • 98% MSG+**2% (IMP+GMP)**= 400% MSG in perception (Salt Reduction Food Industry Guide, 2014) • Labeled as I+G
KA Yeast extracts with nucleotides , +fermented wheat gluten and maltodextrin	• Company A • **IMP+GMP, MSG** • Label: **yeast extract**, fermented wheat

Umami and Salty Modulation: Salty taste can be enhanced by exploring with newly discovered umami and/or salty peptides



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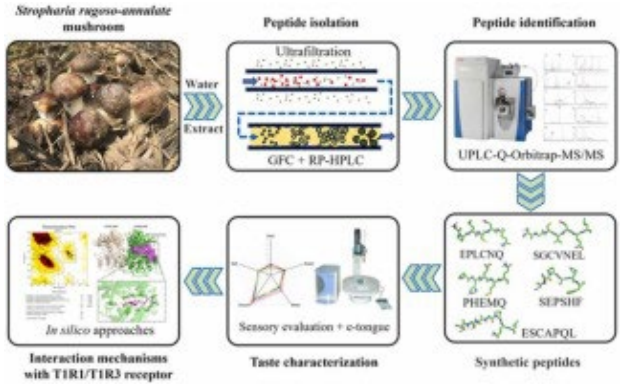
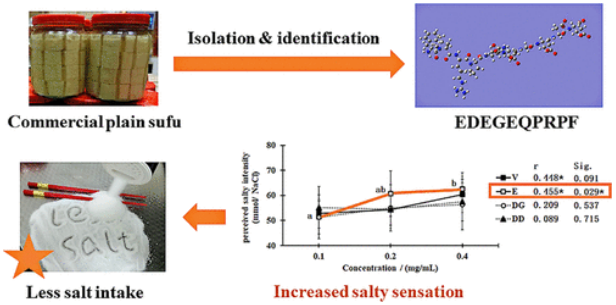
Chemistry & Neuroscience	What and How
Umami Peptides 	• What it is: 1) **Mushroom peptides** that bound to T1R3 VFT, in addition to its MSG bound to T1R1 VFT (U China 2022). 2) **Preserved egg yolk** 5 peptides both VFT (U China 2022) 3**) 4 Peptides from cured fish** were either Umami or Umami PAM (U China 2022). 4) 2 peptides from **pufferfish** (U China 2022). 6) **Cured ham lactyl dipeptides** Maillard product (U Italy 2022) • What it means: natural flavor • How to use: Explore
Salty Peptides 	• What it is: Unusual Maillard products. 1) **Pea peptide+ sugar** (Rutger's 2021), 2) **Fish skin protein+ glucosamine** (U China, Austria and Canada 2020) 3) 4 Salty deca peptides from **fermented tofu** (U China 2021) • What it means: natural flavor • How to use: enhanced salty 25%, umami and kokumi

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Kokumi: Not yet proven to be a basic taste

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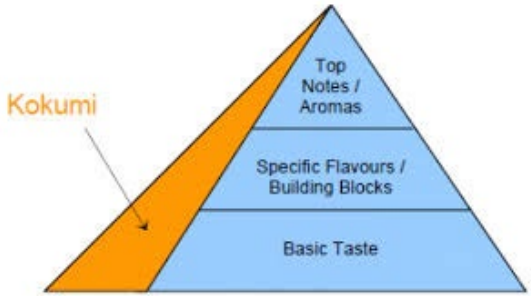
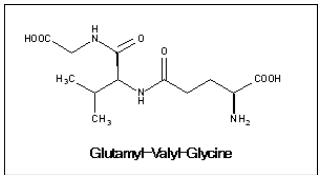


- Neuroscience: CaSR receptor reported (A 2021), possibly part of oral somatosensation. Itself tasteless.
- Taste, **Kokumi= "Rich"**
  - Mouthfulness, thickness, continuity and harmony (Company A, 2022)
  - Rich taste, best known for hearty and long finish. Mouthwatering punch at initial taste, and lends an overall balance and richness to foods (Company NF, 2022)
  - Kokumi allowing a reduction of salt , sugar and fat without sacrificing taste. (Company A, NF, S, 2022, Deakin U 2021)

Kokumi Ingredients: The most potent kokumi is a tri-peptide Glutamine-Valine-Glycine



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Chemistry & Neuroscience	Supplier, Taste, and Regulatory
Tripeptide Glutamyl-Valyl-Glycine* KF found in garlic, onion, scallop. Also Fish sauce, yeast, soy sauce, shrimp paste, cheese, and even beer. Available in compounded flavor from Company A.	• Company A • **FEMA 4709, soup< 50ppm** • **"The most potent kokumi substance"** (per two websites, review 2022) • Usage: 2.5-40ppm • Label: Could be natural flavor

Chemistry & Neuroscience	Supplier, Taste, and Regulatory
0.5-0.75% K Powder (Fermented soy sauce)	• Company NF • Composition: **23% protein**, 11% total salt all added during fermentation. Corn maltodextrin carrier. • Label= Soy sauce

Kokumi Ingredients: There are also high-kokumi yeast extract commercially available

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Chemistry & Neuroscience	Supplier, Taste, and Regulatory
0.1-1% S K	• Company A • Composition: **Yeast extract with high kokumi**. **9% protein (glutathione)**+ 1% salt. • Label= Dried Yeast

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Stacking

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Flavor

High

Low

Salty, Rich & Delicious

Sight, Sound, & Touch

Kokumi Ingredients

Umami Modulators

Saltiness Modulators

Tastants: Salt, MSG

Executive Summary

- Saltiness Modulation: The four mechanisms are Substitution including KCl, Surface Area such as microspheres, Umami as in seaweed, and Neuroscience like expectancy constancy.
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- Kokumi Ingredients: The tripeptide Glutamyl-Valyl-Glycine is the most potent kokumi compound
- Stacking is a clean label sodium and MSG reduction strategy for blending three types of plant-based savory ingredients to make foods salty, rich and delicious.