Umami in Foods: What is Umami and how do I Explain It?

Beyond the four better known tastes of salty, sweet, bitter, and sour, umami finds its place as the fifth basic taste evoking savory, full-bodied, and meaty flavor sensations. Until the 20th century, umami was not thoroughly understood in Western societies; however, it has been unknowingly appreciated for years in stocks, broths, aged cheeses, protein-rich foods, tomato products, dried mushrooms, and kelp among others.

For decades, there has been much concern and confusion over the presence of monosodium glutamate (MSG) in food and its connection with umami as a basic taste sensation. For this reason, the purpose of this white paper is to provide clinicians with an overview of umami and the substances which elicit the umami taste response so that they are better prepared to educate consumers on the science and culinary applications of umami.

What's in a Name?

The formal discovery of umami traces its roots back to a chemistry professor, Dr. Kikunae Ikeda, at the Imperial University of Tokyo. In 1908, Dr. Ikeda proposed umami as a distinct taste recognizable in "dashi" which is Japanese stock flavored with kelp and dried bonito flakes. His research identified glutamate, an amino acid, prevalent in the broth ingredients as the contributors of this unique taste. The term "umami" was coined from the Japanese adjective for delicious (*umai*). Although research on umami in foods continued throughout the 20th century, it was not until the discovery of a unique taste receptor in 2000 that umami was firmly established as the fifth basic taste.

What is Umami?

As with all food, it is the chemistry between taste buds, odorant receptors, and food ingredients that allows for the perception of taste and flavor. In the case of umami, there are several compounds which trigger the umami taste receptors. These include glutamate, a salt of glutamic acid, specific ribonucleotides, and glutamate salts including monosodium glutamate (MSG), potassium glutamate, and calcium glutamate among others. Together, chemical interactions of these compounds with the glutamate receptors elicit the taste perception of umami.

Glutamate, a key compound in cellular metabolism, taste, and neurotransmission (1), is a salt of the non-essential amino acid glutamic acid. Among food ingredients, glutamate is present in both its free amino acid form (glutamic acid) and in its bound form as glutamate within dietary proteins; however, when bound to proteins, glutamate is tasteless and does not elicit the umami response (2-4). The taste sensation of umami requires protein hydrolysis which renders free glutamic acid. Although some foods naturally contain free glutamic acid (**Table 1**), common food processing techniques such as dehydration, fermentation, aging, and ripening assist in breaking down proteins into smaller peptides and individual amino acids. This results in protein hydrolysis and liberation of free glutamic acid. Several methods of food preparation can enhance the concentration of free glutamic acid in food. For example, moist heat preparation utilizing stocks or broths as a base ingredient also renders free glutamic acid and elicits the umami taste response (5).

Table 1 Free Glutamic Acid (FGA)

Meat, Poultry and Seafood	FGA mg/100g	Dairy/Eggs	FGA mg/100g	Fruits	FGA mg/100g	Vegetables	FGA mg/100g	Misc	FGA mg/100g
Beef	10	Emmenthaler	308	Avocado	18	Cabbage	50	Soy sauce	412 - 1264
Pork	2.2 - 9	Parmesan (Parmegiano reggiano)	1200 - 1680	Apple	4	Chinese cabbage (Napa)	100	Fish sauce	621 - 1383
Pork Fillet	40	Cheddar cheese	182	Grape	5 - 184	Spinach	48	Oyster sauce	900
Cured Ham	337	Stilton	820	Grape juice	258	Green asparagus	49	Green tea	668
Chicken	1.5 - 22	Roquefort	1280	Kiwi	5	Corn	106		
Chicken Bones	40	Gruyere de Comte	1050	Tomato	140 - 246	Green peas	106		
Scallop	140 - 159	Saint Paulin	210	Fresh tomato	260	Carrot	33		
Snow crab	19	Camembert	390	Processed	230	Onion	51		
Blue crab	43	Danish Blue	670	Grapefruit (white meat)	11.5	Potato	10 - 102		
Alaska king crab	72	Gouda	460	Grapefruit juice	18.6	Sweet potato	60		
White shrimp	20	Cow Milk	1	Orange juice	21	Mushroom	42 - 180		
Bonito	285	Goat Milk	4	Nectarine	9.6	Shiitake mushroom (fresh)	71		
Sardines	280	Human breast milk	19	Peach juice	32	Shiitake mushroom (dried)	150		
Mackerel	215	Whole chicken egg	15	Plum (yellow fruit)	7.9	Enoki Mushroom	21.8		
Tuna	188	Chicken egg yolk	46	Prune	14.4	Truffles	8.5		
Cod	44	Chicken egg white	0.2	Prune (dry)	18.6	Broccoli	176		
Shrimp/Prawn	43			Strawberry	44.4	Soy beans	66		
Squid	146								
Oyster	137								
Clam	208								
Mussel	105								

Table content obtained from:

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The sodium salt of glutamic acid, MSG is highly utilized in the food industry as a seasoning or flavor enhancer. It is produced through extraction from fermented molasses made from sugar cane or beets, or the fermentation of starch hydrolysates from cassava, corn, and rice (6). In the United States (U.S.), MSG is classified as a generally recognized as safe (GRAS) substance by the Food and Drug Administration (FDA), (http://www.fda.gov/Food/FoodIngredientsPackaging/ucm328728.htm), while in Europe, MSG is classified as a food additive. Differences in the two classifications between the U.S. and Europe should not be considered significant given the fact that the European Union uses a different regulatory system for categorizing the safety of food ingredients. For example, according to the 2007 update to the Hohenheim consensus on MSG, the final ruling stated that glutamate salts should be regarded as harmless for the whole population (7).

In addition to glutamate salts, 5'-ribonucleotides present in all living materials including food ingredients of animal and vegetable origin have been shown to trigger umami taste receptors. Among these small molecules which serve as building blocks of deoxyribonucleic and ribonucleic acids, guanosine 5'-monophosphate (GMP), inosine 5'-monophosphate (IMP), and adenosine 5'-monophosphate (AMP) interact with umami taste receptors. Although these naturally occurring compounds are present in a variety of different foods, GMP is more abundant in plant foods, IMP is more abundant in meats, and AMP is abundant in fish and shellfish (8). Of particular interest with regard to these compounds, research has shown that each substance synergistically enhances the umami taste perception when consumed with foods containing free glutamic acid and/or MSG (3).

<u>How do I explain "umami" to patients and clients?</u>

Culinary descriptors of the umami taste include savory, mouth fullness, depth of flavor, and meatiness. Because the umami taste is experienced in a wide variety of foods, the taste of umami is often regarded as distinctive and unique to individual foods. For example, Parmesan cheese and sun-dried tomatoes each contain free glutamic acid which triggers the umami taste receptors; however, both of these foods are uniquely different in their flavor profiles. Overall, umami-eliciting ingredients add to the complexity of a food by synergistically interacting with ingredients to balance, layer, and catalyze flavors. This increases the palatability of food.

Although western cultures have previously lacked traditional culinary terms to adequately describe the sensation of umami in foods, it can very simply be explained as a basic taste which increases the palatability or pleasantness of foods. The umami compounds are, by nature, not very palatable or tasty by themselves. Likewise, salt by itself is not very appetizing; yet when added to a recipe for chocolate chip cookies or grilled flank steak, salt increases the deliciousness and flavor profile of the resulting products. Although humans only have five basic taste receptors, it is the interaction of food ingredients and these tiny sensory organs on the tongue that result in a plethora of flavors.

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