

Umami's Molecular Magic

By Kimberly J. Decker, Contributing Editor

The chemical nature of umami—the fifth taste—reveals much about its potential as a key contributor of flavor to foods.

In search of umami

Umami resides anywhere you find free amino acids, the 5' nucleotides inosine monophosphate (IMP) and guanosine monophosphate (GMP), and—to a lesser and less-well-understood extent—some small peptides, organic acids and minerals. But the biggies are the glutamate and the nucleotides. The former is the most-prevalent amino acid in nature, perhaps most familiar to the general public as its sodium salt, monosodium glutamate, or MSG. Commercially, MSG is produced through fermentation of starches or sugars in a controlled environment with a microorganism, *Corynebacterium glutamicum*. The initial fermentation step produces crude glutamic acid, which is subsequently filtered, purified and neutralized into monosodium glutamate. As for 5' nucleotides, IMP naturally occurs most prevalently in animal sources—aged beef and Japanese bonito flakes, for instance—while GMP comes mainly from plant sources, like mushrooms.

Science may be on the cusp of identifying other compounds to augment these, according to a recent Italian study (“Studies on Umami Taste. Synthesis of New Guanosine 5'-Phosphate Derivatives and Their Synergistic Effect with Monosodium Glutamate,” *Journal of Agricultural and Food Chemistry*, 56:1043-1050, doi: 10.1021/jf072803c). The study synthesized certain N2-alkyl and N2-acyl derivatives of GMP and tested them for their synergistic effect with MSG. The derivatives enhanced MSG from 20% to more than 500% more than IMP. Their enhancing power was related to their chemical structure, with researchers explaining “the exocyclic NHR group of the guanine moiety is actively implicated in the synergism between GMP derivatives and MSG.”

Tasters' choice

Just how these tastants work their umami magic has, until recently, remained a mystery. And, until the scientific community started figuring it out in earnest, the very legitimacy of umami as a taste was itself a matter of dispute. “When some scientists actively started studies on umami, there was some debate that umami was just a unique taste that only Asian people recognized—or that the umami taste could be reproduced by a mixture of the other four basic tastes,” says Kumiko Ninomiya, director, Umami Information Center, Tokyo. What settled the debate was the discovery in 2000 by researchers at the University of Miami School of Medicine of dedicated umami taste receptors embedded in the cells of the tongue.

When these receptors—known as G-protein-coupled receptors, or GPCRs—bind an umami tastant such as glutamate or a 5' nucleotide, a G protein called gustducin turns on a sequence of signals that, ultimately, triggers a nerve impulse the brain reads as “umami.” These signals work through an ion channel known as TRPM5, also located on the taste cells. Transgenic mice lacking the TRPM5

channel can't taste umami—or sweet or bitter, for that matter—but can taste salt and sour. So, the more we learn about umami, the more we learn about how our other taste perceptions operate, too.

Renee Zonka, R.D., associate dean, Kendall College, Chicago, stresses this umami benefit with her students. “I teach from the point of nutritional cooking,” she says. “In nutritional cooking, we’re trying to reduce salt, we’re trying to reduce fat, we’re trying to push up flavor. And I teach them that they’re not only going to be working in restaurants—they’re going to be working all areas of health care: hospitals, senior living centers. And since seniors start losing their taste acuity, you need to punch up flavor. You need less salt if you have the umami sensation. So this is one way to really punch flavor up and keep sodium down.”

Curiously, our affinity for umami isn't just a coincidence of culture or food fashion. As Ninomiya points out: “All basic tastes have physiological meanings. Each taste has a function as a gatekeeper.” We’ve evolved to wrinkle our noses somewhat at the “aversive” tastes, bitter and sour, because bitter compounds are commonly toxins, and sourness often indicated spoilage. On the other hand, an affinity for the so-called appetitive tastes conferred an evolutionary advantage. “Sweet is there to encourage you to eat things that have a high carbohydrate content,” says Ray Salemme, Ph.D., CEO, Redpoint Bio, Cranbury, NJ. “Salt is appetitive to make sure that you bring essential salt nutrients into your body—particularly sodium. And umami is there to encourage you to eat foods that are rich in proteins and nucleic acids. So the rationale for umami isn't just a hypothetical thing. It's a very basic biological and chemical rationale.”

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