Relationship between taste receptor functions and diets in vertebrates

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Abstract

Taste perception plays an essential role in diet choice. Among five basic tastes (sweet, umami, bitter, salty, and sour), umami and sweet tastes are sensed by G protein-coupled receptors (GPCRs) termed T1Rs. Umami tastes are sensed by a heteromeric complex of T1R1 and T1R3, while sweet tastes are sensed by the T1R2 + T1R3 heterodimer. Cell-based assays have been developed using cultured cells heterologously expressing these receptors. The most popular approach to detecting the cellular response to a tastant is to measure changes in intracellular Ca^{2+} concentration using Ca^{2+}-sensitive fluorescent dyes. We have established a new luminescence-based high throughput assay system applicable to the taste receptor-expressing cells. This assay can overcome the limitation of ligands that contain fluorescent compounds and is suitable for the taste evaluation system.

Retention of the taste receptors over timescales is shaped by feeding ecology. For example, some obligate carnivores, such as cats, lost T1R2, consistent with lack of sugars in their diet. Birds, which evolved from presumably carnivorous theropod dinosaurs, have also lost T1R2. Using the luminescence-based assay system, we revealed that nectarivorous birds, such as hummingbirds[1)] and songbirds[2)], have subsequently acquired the ability to detect sugars by changing the function of their T1R1/T1R3. Furthermore, by examining taste receptor responses from representatives of all major primate lineages, we were able to track the evolution of the umami receptor responses and determine when the glutamate response, which is a characteristic of human T1R1/T1R3, evolved. We propose that insectivorous mammalian ancestors had a nucleotide-sensitive T1R1/T1R3 and that the multiple lineages of primates, including ancestors of humans, have evolved the umami taste receptor for detecting glutamate of their leafy diets[3)]. These findings shed new light on the adaptive radiation of vertebrates and helps reveal the genetic basis of dietary niche divergence.

References

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3) Toda Y., Hayakawa T. et al.: *Curr. Biol.* 31:4641–4649, Correction 4675–4676 (2021).