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DNA Array Analysis of Salty Taste Response

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Summary

Chemical compounds as food constituents are received at taste buds and the resulting taste signals are transduced up to the brain by way of taste nerves, nucleus of the solitary tract and parabrachial nucleus (PBN). The PBN as a relay nucleus for taste signal transduction possesses cells whose responses are differential depending on whether the taste information is acceptable or reversive. The present study aims at gene expression profile analysis on taste information-depending cell properties in PBN and also on how the acceptable taste information is offered by taste stimuli including NaCl.

1. Gene expression properties in PBN at a baseline

We excised the four tissues from rats: 1) PBN itself, 2) the dorsomedial in PBN (PBNdm) responding to acceptable taste, 3) the ventrolateral in PBN (PBNvl) responding to aversive tastes and 4) the principal sensory trigeminal nucleus (Pr5) as a relay nucleus for somatosensory transduction. DNA microarray analysis of total RNA samples extracted from these four tissues at a baseline was carried out. We then selected 31 genes whose between-tissue differences in expression intensity were large, and analyzed their expression patterns in PBN by in situ hybridization. As a result, 19 among the 31 genes were found to show larger signal intensities and frequencies generally in the nuclei than in the other parts. Particularly stronger expressions were observed for 5 genes in PBN as a whole, 6 in PBNdm, 3 in PBNvl, and the rest (5 genes) in Pr5.

2. Gene expression responses in PBN at an intermediate end point after tastant application

Animal experiments were carried out using the three taste solutions, 0.1 M NaCl, 0.1 M HCl, and a mixture of 0.1 M NaCl, 0.1 M HCl, 0.1 M sucrose and 5 mM denatonium (bitter substance). Pure water were used as a control. The stimulation with 0.1 M NaCl and that with 0.1 M HCl actually gave differences in expression intensities of some particular genes; 40 genes were found to be up-regulated by the NaCl stimulation, with 45 genes down-regulated. The mixed tastant solution and the pure water (control) gave a large difference, and our analysis for significantly up- and down-regulated gene numbers revealed that 29 among 8,000 genes were expressed with more than two-fold intensities and 130 with less than half intensities. The result suggests that taste responses can be represented as gene expression profiles at the PBN.

The two samples 1) 0.2 M NaCl / 0.5 M sucrose (NS) as an acceptable tastant and 2) 5 mM denatonium benzoate / 0.1 M HCl (DH) as a reversive tastant, as well as pure water as a control, were applied to the rat oral cavity. The present study on gene expression analysis by DNA microarray method disclosed that PBN was different from Pr5 in molecular modality and also that, in particular, PBNdm and PBNvl constantly differ from each other in cell property regarding taste information. It deserves to note that PBNdm responds to an acceptable taste of NaCl applied at a low concentration, while an aversive, condenced NaCl taste is responded by PBNvl. These taste differentiation analysis at the DNA level would contribute to a basic understanding of the palatability of this important salt, NaCl.