Sensory Biophysics of Flavor Perception: Decoding Chemo- and Mechanosensory Processes at Epithelial Interfaces

Melanie Köhler

Leibniz Institute for Food Systems Biology at the Technical University Munich, Junior Research Group Mechanoreceptors & Sensory Biophysics, Freising, Germany
TUM Junior Fellow TUM Junior Fellow, School of Life Sciences, Technical University of Munich

E-Mail: m.koehler.leibniz-lsb@tum.de

Flavor perception arises when chemical and physical food cues interact with sensory systems at biological interfaces [1]. In my research, I address this question through sensory biophysics, an interdisciplinary field at the interface of membrane biophysics, cell biology, sensory physiology, and food science. My work focuses on how flavor-active chemoreceptors, mechanoreceptors, and ion channels convert food-derived stimuli into cellular signals underlying taste perception, oral somatosensation, and nutrient sensing.

My group studies these questions in oral and gastric epithelial models, with particular interest in how membrane properties, interfacial interactions, and receptor signaling shape sensory responses. Methodologically, we combine atomic force microscopy (AFM) with receptor-based assays, fluorescence calcium imaging, gene expression analyses, model membrane systems including nanodiscs [2], analytical chemistry, computational approaches, and human sensory studies.

The talk will highlight how sensory biophysics provides a mechanistic framework for studying flavor perception across molecular, cellular, and perceptual levels. For example, AFM has enabled us to probe the interaction of a bitter peptide with the taste receptor TAS2R16, revealing ligand binding without downstream signaling [3], and it offers nanomechanical tools to investigate oral texture perception and its relation to mechanosensory pathways [4]. These case studies show how receptor function and membrane mechanics can be resolved as complementary determinants of sensory signaling.

Overall, membrane-centered biophysical approaches provide innovative ways to decode chemo- and mechanosensory processes in flavor perception and open new avenues for designing healthier, sensory-appealing foods that address pressing nutrition and health challenges.

[1] Koehler, M, et al. Nat. Food (2024): 1-7.
[2] Karanth, S, et al. J. Agric. Food Chem. 72.26 (2024): 14521-14529.
[3] Richter, P, et al. Food Chem. (2025): 144448
[4] Karanth, S, et al. Foods 13.21 (2024): 3411