Beyond flavour: how sensory perception shapes health, nutrition and food innovation

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Sensory perception extends far beyond enjoyment, and food is not just food. It represents a sensory experience that profoundly shapes human behaviour, health and quality of life. Our perceptions of flavour, aroma and texture influence dietary choices and emotional well-being and play a pivotal role in disease management.

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Alterations in taste and smell are now recognised as critical factors impacting public health, nutrition and food innovation. This article explores the interception of sensory perception with health, disease, nutrition and consumer preferences, emphasising the growing importance of understanding these connections.

Sensory perception and health

Sensory perception serves as a crucial link between our diet and the management of chronic diseases, influencing both physiological outcomes and the quality of life of patients. Emerging evidence suggests that taste dysfunction—whether caused by illness, medication or ageing—directly impacts nutritional status and therapeutic efficacy. Chronic diseases can alter taste sensitivity or food preferences, often leading individuals to consume more sugar or salt to achieve the same level of flavour satisfaction. In the case of type 2 diabetes, chronic hyperglycemia may impair taste bud function, reducing sweet taste sensitivity and driving overconsumption of high-sugar foods, creating a vicious cycle of glycemic dysregulation (Catamo *et al.*, 2021). Similarly, individuals with reduced sensitivity to salty tastes tend to consume more salt, which increases the risk of developing cardiovascular diseases (Xue *et al.*, 2020).

For individuals with coeliac disease or food allergies, sensory perception becomes even more complex (Liu *et al.*, 2022). The intersection of restricted diets and sensory dysfunction further narrows food choices, potentially leading to reduced nutritional adequacy and diminished life satisfaction. Therefore, specialised interventions that address sensory satisfaction and nutritional needs are essential. Individuals with coeliac disease cite the high cost of gluten-free products and inferior sensory characteristics—texture, flavour and variety—of gluten-free products as major concerns (Bagolin do Nascimento *et al.*, 2014). Moreover, individuals with food allergies have a reduced ability to correctly identify taste qualities, which affects both functionality and physiology, and marginally influences food neophobia (D'Auria *et al.*, 2023).

Sensory loss and disease

Our bodies naturally change with age, but people might not be aware that ageing also changes their senses (Braun *et al.*, 2022). Taste buds shrink and decrease in number, the sense of smell diminishes, olfactory receptor function declines, and texture perception can shift due to dental issues or reduced salivary flow—all of which alter the food experience. This contributes to a reduced pleasure in food consumption and appetite, often leading to malnutrition. As food becomes less appealing, older people frequently add more sugar or salt to enhance flavour, increasing the risk of high blood pressure, diabetes or obesity. Indeed, elderly individuals often favour sweet foods over bitter and sour flavours, so it is essential to minimise the risk from inadequate dietary intake, either through supplementation, dietary changes or a combination of both. For example, the Mediterranean diet can help to rectify poor eating patterns such as low fibre intake and high consumption of salt, sugar and fats, thereby reducing the risk of chronic diseases. Enhancing food variety through colours, textures and flavours can also boost fruit and vegetable consumption (Sergi *et al.*, 2017).

In oncology, abnormalities in taste and smell are prevalent and may contribute to malnutrition (Al-Amouri and Badrasawi, 2024). Cancer patients undergoing chemotherapy often experience dysgeusia or anosmia—total loss of taste or smell, respectively—which can severely affect food intake (O'Donoghue *et al.*, 2023). In a critical period for recovery, the inability to enjoy food can lead to decreased caloric intake, fatigue, and emotional distress, precisely when the body requires extra energy to combat disease and recover from treatment. These sensory disorders underscore the need for sensory-sensitive dietary strategies, an important clinical issue warranting special attention from oncology teams, as nutritional status directly influences treatment outcomes and quality of life during cancer care (Printz, 2025).

Recently, the COVID-19 pandemic highlighted the consequences of sudden sensory loss on health and quality of life (Rogn *et al.*, 2024). For many infected individuals, anosmia (loss of smell) and ageusia (loss of taste) were among the earliest and persistent symptoms, affecting millions worldwide. Although many patients recovered their senses within weeks, a significant number continued to experience partial or complete loss for months after infection, resulting in reduced appetite, unintentional weight loss and increased risk of nutritional deficiencies.

Mental health and taste and smell disorders

Taste and smell are intricately linked with emotional and psychological health, and alterations in these perceptions reveal a remarkable connection to mental health conditions. Among individuals diagnosed with major depressive disorder, the prevalence of altered smell and taste is markedly higher compared to the general population, associated with impaired olfactory brain activation (Herrmann *et al.*, 2023) and diminished cognitive processing. These sensory alterations extend beyond depression to various neurodegenerative conditions and have become increasingly common following COVID-19 infections. As previously mentioned, post-COVID-19 individuals frequently report a wide range of chemosensory, trigeminal, and salivary disturbances (Rogn *et al.*, 2024), which adversely affect appetite, food enjoyment and psychosocial functioning. The resultant emotional burden—emotional distress, social isolation, and increased risks of anxiety and depression—highlights the critical intersection between chemosensory function and mental health. Conversely, positive food-related experiences play a crucial role in emotional regulation, with pleasant sensory stimuli activating reward pathways in the brain that contribute to stress reduction, uplift the mood and reinforce positive eating habits (Rolls *et al.*, 2023). The olfactory system maintains direct connections to

the limbic system, making smell perhaps the most emotionally evocative sense. When these sensory pathways are disrupted, implications extend beyond nutrition to broader psychological well-being and social domains.

Food science and technology

Sensory and consumer science has been recognised as a convergent field that combines psychology, neuroscience, nutrition and food science to study how sensory stimuli influence human behaviour, nutrition, health and well-being. It is key to understanding how people perceive and accept food, evaluating the effects of ingredients, and food processing, packaging and storage on sensory qualities. This field also develops innovative testing methods, explores individual differences in food preferences, and employs sensory tools to analyse and model food experiences, ultimately aiming to enhance food quality and pleasantness. The food industry faces a substantial challenge when reformulating products to align with public health recommendations, such as reducing sugar, salt or fat while preserving or enhancing sensory appeal. Indeed, despite increasing awareness of healthy eating habits, consumer acceptance remains heavily influenced by appealing sensory properties. Food that does not meet consumers' tasting expectations will likely be rejected regardless of its health benefits, highlighting a challenge in public health nutrition. This is particularly evident in plant-based alternatives, where sensory characteristics such as bitterness and astringency present significant barriers to broader consumption, even considering their well-known health and sustainability advantages. Sensory-focused literature increasingly notes consumer demands for improved aroma in plant-based milks and yoghurts, and substantial reformulation for cheese substitutes to better replicate umami and mouthfeel (Jaeger *et al.*, 2024). These findings emphasise the strategic importance of sensory optimisation in enhancing consumer acceptance and guiding the future development of plant-based food and beverage alternatives.

Furthermore, interindividual variability in sensory perception further complicates food acceptance patterns. Altogether, genetic and physiological differences, cultural background and personal experience contribute to unique sensory profiles that influence food preferences and choices. For instance, differences in salivary composition and secretion among individuals appear to contribute to each person's experience with food (Khramova and Popov, 2022). An increased number of fungiform papillae also leads to an increased sensitivity to all tastes and somatosensation. Besides, strong evidence links variations and polymorphisms in the bitter taste receptor genes (TAS2R) to differences in the bitterness perception of specific substances as well as in the sweet and umami taste receptors (Feeney *et al.*, 2021). Indeed, alterations in taste response to thiourea compounds, such as propylthiouracil (PROP) and phenylthiocarbamide (PTC), highlight this phenomenon. These compounds are not usually found in food in large amounts, but the way people taste them can affect which foods they prefer, especially bitter vegetables like broccoli and cabbage.

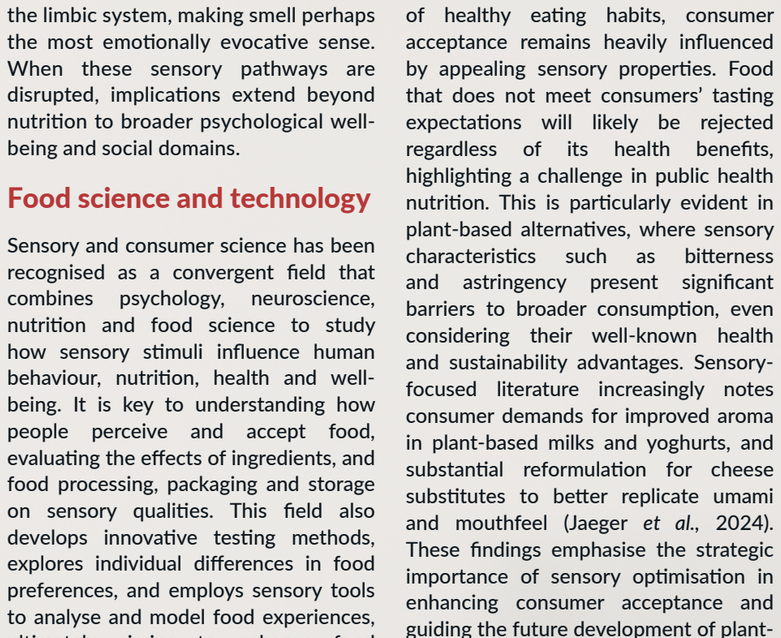

Figure 1: The multidimensional impact of sensory perception on health, nutrition and food innovation.

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This variability reinforces the need for dietary guidelines and food product development to consider a wide range of sensory preferences. Molecular and cell-based research that is being developed in the BeTASTy project will provide deep insights into how individuals perceive astringency, bitterness and other mouthfeel properties. Understanding the mechanisms by which specific compounds interact within the oral cavity with components involved in flavour perception—namely, oral epithelial cells, saliva and chemosensory taste receptors—enables the development of more precise strategies to mask undesirable taste attributes, such as astringency and bitterness. In parallel with this mechanistic understanding, BeTASTy will also explore masking strategies, including how certain polysaccharides or carbohydrates interact with bitter molecules, generating knowledge to support the development of natural solutions for reducing unpleasant flavours in healthy, plant-based foods.

Conclusion

A comprehensive understanding of sensory mechanisms—from molecular interactions to psychological outcomes—is vital for developing effective strategies in nutrition, public health and food innovation. Projects like BeTASTy are fundamental in addressing integrative approaches that span molecular biology, sensory science, psychology, and food engineering. The ultimate objective remains clear: transforming healthy food from a reluctant necessity into a pleasurable, preferred choice across populations.

Sensory perception goes beyond enjoyment and influences human health and well-being. The trigeminal nerve and taste receptors, including bitter taste receptors (TAS2Rs) found on the apical surface of taste receptor cells (or gustatory cells) in taste buds, are important biological components involved in flavour perception. Changes in taste and smell caused by illnesses, ageing, or infections like COVID-19 can result in loss of appetite, weight loss, emotional distress, and ultimately, a reduction in quality of life. At the same time, food science and industry work to address these issues by developing innovative solutions to improve flavour, texture and acceptability of healthy food options.

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BeTASTy
MAKE HEALTHY FOOD

PROJECT SUMMARY

Mouthfeel properties are crucial for human survival, nutrition, health and well-being. Unpleasant taste and mouthfeel properties in plant-based food, such as bitterness and astringency, are a challenge for the food industry, as flavour is key to consumers' food choices. BeTASTy will contribute to deciphering the physiological and neural mechanisms involved in the interindividual unpleasant taste and mouthfeel perceptions through innovative molecular and cell-based approaches.

PROJECT LEAD PROFILE

Susana Soares is an Assistant Professor at University of Porto – Faculty of Sciences (FCUP, Portugal) and an Assistant Researcher at the Portuguese Research Centre for Sustainable Chemistry (LAQV/REQUIMTE, Portugal) and the principal investigator of BeTASTy. Susana and her team are focused on developing integrative molecular and cellular approaches for understanding and modulating unpleasant food flavour properties.

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