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Changes in orosensory perception related to aging and strategies for counteracting its influence on food preferences among older adults

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ABSTRACT

Background: The aging of the world population is accelerating. To meet the food and nutritional needs of the expanding aging population, it is necessary for both food researchers and food industry to obtain a good understanding of how aging affects orosensory perceptions. There is a need for potential strategies to counteract these adverse effects on food preferences in order to maintain food appetite in old age.
Scope and approach: This review paper has two main objectives: 1) to review evidence and causes of orosensory changes with aging and to indicate influences of age-related orosensory changes on elderly's food preferences; 2) to summarize the effects of compensatory strategies (e.g., flavor and texture modifications) for counteracting age-related orosensory changes and suggest potential compensatory strategies for further investigations, which have great potential to contribute to the food appreciation among specific elderly segments with greater orosensory impairment and higher needs for sensory modified foods.
Key findings and conclusions: Research indicates that the interindividual variability in orosensation impairment among the elderly population is not only increased with age, but also related to events (e.g. increased dependence) that are associated with aging. Generally, flavor and texture modifications are the most important strategies in compensation of losses in masticatory and chemosensory ability thus enhancing the appreciation of foods and stimulating food intake, especially among the less dependent elderly with poorer health. In future studies, food researchers and food industry should consider targeting these specific subgroups of elderly while exploring a well-balanced multisensory compensatory framework for specific food systems.

1. Introduction

The population of industrialized countries is currently aging and will continue to do so in the decades to come (Koehler & Leonhaeuser, 2008). The percent of senior citizens aged above 65 is increasing significantly in European countries (WHO, 2015), and it is predicted that the future population aged 80 and above will be even larger as more individuals are expected to live to higher ages (Koehler & Leonhaeuser, 2008). These demographic changes presents challenges to social and public policies (Koehler & Leonhaeuser, 2008; Walker & Maltby, 2012), as public expenditures for health care, food supply systems, and welfare services for older adults will rapidly increase (Giacalone et al., 2016).

Malnourishment of the elderly is one of the significant problems in this segment of the population (WHO, 2015). Changes in orosensory function can lead to poor appetite, which can contribute to the nutritional deficiency in older adults (Brownie, 2006). Increasing the elderly's food appetite, which may increase their food intake generally, is a key factor to achieve the prevention of malnourishment among the older adults (Brownie, 2006; Mathey, Siebelink, De Graaf, & Van Staveren, 2001). Levering food appeal is an important direction for people working within food innovations and food catering for the elderly. Thus, it is critical for product developers and food providers, especially those who are interested in promoting healthy aging through food consumption,

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to have sufficient knowledge on how aging affects orosensory perception and food preferences. Such knowledge would support further development of compensatory strategies for elderly with orosensory impairment (Mathey et al., 2001; Popper & Kroll, 2003).

Situated within this context, this paper has two main objectives: 1) to review evidence and causes of orosensory changes with aging and to indicate influences of age-related orosensory changes on elderly's food preferences; 2) to summarize the effects of commonly-used compensatory strategies (e.g., flavor and texture modifications) for counteracting age-related orosensory changes, suggest potential compensatory strategies deserve further investigations, which can contribute to the food appreciation among specific elderly segments with greater orosensory impairment and higher needs for sensory modified foods.

This review focuses on the chemical senses, which include gustation, olfaction and also oral somatosensory perception, as these are considered as most important in the food experience. Changes in vision and audition, albeit also relevant, will therefore not be discussed in depth in this review.

Recently, orosensory perception and food liking of older adults or practical sensory methods using the elderly are of great interest in related research areas, which can be seen from two recent review articles of high-quality about related topics (Doets & Kremer, 2016; Methven, Jiménez-Pranteda, & Lawlor, 2016).

Different from the scope of the above reviews, this article is more focusing on giving a concise overview of potential compensatory strategies which may counteract age-related orosensory changes and contribute to the food appreciation among specific elderly segments, which will be helpful for food product developers and providers.

2. Influences of aging on orosensory perception

Generally speaking, the aging process of the human being is associated to a decline in orosensory functions, which can be a consequence of e.g. senescence of the sensory receptors systems and reductions of their neural systemic efficiency (Imoscopi, Inelmen, Sergi, Miotto, & Manzato, 2012; Kremer, Mojet, & Kroeze, 2005; Tepper & Genillard-Stoerr, 1991). The orosensitivity usually decrease gradually with aging and some of the older people with orosensory loss are not aware of the occurrence (Nordin, Monsch, & Murphy, 1995). The independent influence of aging on orosensory perception has been widely demonstrated in the food science literature, yet reported effects are highly variable in their magnitudes among individuals and across different stimuli in various food or drink media (Kremer et al., 2005; Mattes, 2002; Murphy, 1993). The following sections will review existing evidence and major causes of perceptual changes across the orosensory senses – taste, smell, trigeminality and oral touch – emphasizing also that different senses are affected differently by the aging processes. Some examples are shown in Table 1. Possible explanations for inconsistent research results will be explored as well.

2.1. Taste

The sense of taste comprises five “basic” taste qualities: *saltiness* produced by sodium ions, mainly from table salt; *sweetness* evoked by sugars and artificial sweeteners, such as sucrose and aspartame; *sourness* produced by hydrogen ions of various organic acids; *bitterness* from quinine, caffeine and many other substances; *umami* taste typically produced by monosodium glutamate and other substances such as disodium inosinate and disodium guanylate (Toko, 2000; Yamaguchi & Ninomiya, 1998). *Astringency* is also an important sensation which can activate the taste sense and the trigeminal system as well (Schöbel et al., 2014) and the rough puckering sensation may be impaired with the decline in salivary function.

Changes in the gustatory sense are classified in three different categories (*dysgeusia*, *hypogeusia* and *ageusia*) based on the impairment level of taste sensation (Schiffman, 2009). The prevalence of these taste abnormalities is low in the general population (0.93%), but increases with aging to 5.1% among people aged 60–69 (see review by Bergdahl & Bergdahl, 2002; Hoffman, Cruickshanks, & Davis, 2009; Imoscopi et al., 2012). For hospitalized patients (aged 56 ± 19 years) exposed to a variety of drugs and diseases, the prevalence increases to about 14% (Imoscopi et al., 2012; Kettaneh et al., 2005). In elderly nursing home residents, it ranges from 14% to 22% (Imoscopi et al., 2012).

2.1.1. Taste perception changes

A variety of studies indicated gustatory sensitivity declined with aging (Kremer et al., 2007; Mojet, Heidema, & Christ-Hazelhof, 2003; Schiffman, 2008). Compared to younger people, older individuals have been found to have greater difficulty in detection of tastants dissolved in water (Mojet et al., 2003; Schiffman, 2008; Stevens, Cain, Demarque, & Ruthruff, 1991), or tended to perceive the tastes as less intense (Murphy, 1993). Nevertheless, when tastants are dissolved in real foods, the influences of aging on the taste sensation became more inconsistent (De Graaf, Polet, & van Staveren, 1994; Kremer et al., 2007), which presumably because of “mixture suppression” of tastes in real food systems.

2.1.1.1. Saltiness. A variety of studies using salt solutions showed significant decreases or a flattened downward slope in saltiness perception with aging (Mojet et al., 2003; Schiffman, Crumbliss, Warwick, & Graham, 1990; Stevens et al., 1991). Stevens et al. (1991) indicated that threshold of sodium chloride solution increased with age. Mojet et al. (2003) reported decreased intensity ratings with aging when salty tastants dissolved in both product and water. However, some studies suggested that little or no effect of age was found when the perceived saltiness of real foods (chicken broth and mashed potatoes) was measured (Drewnowski, Henderson, Driscoll, & Rolls, 1996; Zallen, Hooks, & O'Brien, 1990).

2.1.1.2. Sweetness. Sweetness perception is affected by the aging process negatively, but relatively less influenced compared to other basic taste senses (Murphy & Gilmore, 1989; Schiffman, 2008). Schiffman (2008) reported that the elderly's sweetness detection threshold was 2.7 times higher than the young. However, some studies reported no decrease in sweetness sensation for older adults (De Jong, De Graaf, & Van Staveren, 1996; Gilmore & Murphy, 1989; Mojet et al., 2003).

2.1.1.3. Sourness. Studies using citric acid water solution or beverage showed decrease in sourness intensity perception with age (Murphy & Gilmore, 1989; Zandstra & De Graaf, 1998). However, as for saltiness, when the perceived sourness was studied in real foods, instead of water solutions, some studies found little or no effect with elderly (Stevens & Lawless, 1981).

2.1.1.4. Bitterness. A majority of studies have reported a decline in the bitterness sensitivity of many bitter tastants of older adults, compared to the young (Gilmore & Murphy, 1989; Schiffman et al., 1994). However, the effect appears to be dependent on the specific tastant, e.g., it holds true for quinine but not for urea (Cowart, Yokomukai, & Beauchamp, 1994).

2.1.1.5. Umami. Compared to the other basic tastes, only a few studies have investigated whether age affects umami perception.