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Systematic Review

Factors Affecting Taste: A Systematic Review

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***ABSTRACT*:**
Aim/Objective: To review the scientific literature on the factors affecting sense of taste. **Materials and Methods:** Data Sources: Original reports and reviews obtained through internet searches from 1992 through February 2017 using the headings of "taste," "taste buds," "taste disorders," altered taste" taste thresholds," and "aging." Articles frequently cited in reference lists were also included. All data was reviewed, tabulated, and summarized. Data Extraction: Criteria for extraction included data quality and validity, statistical treatment of the data, venue of publication, and relevance to clinical care. **Results:** Losses of taste are common in the elderly occurring as a result from normal aging, certain disease states, medications, surgical interventions, and environmental elements. **Conclusion**: Taste loss occurs as a result from normal aging, disease states, drugs, surgical interventions, and environmental exposure. Deficits in these taste senses cannot only reduce the pleasure and comfort from food, but are a risk factors for nutritional and immune deficiencies as well as adherence to specific dietary regimens.
Key words: Taste, taste buds, taste disorders, altered taste, taste thresholds, aged, aging.

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INTRODUCTION

Taste, what we experience in our day to day life, is in reality a mixture of several sensations. The most fundamental component of this mixture is in no doubt, the (pure) taste sensation, but nevertheless, olfactory and other sensations (e.g. the texture of food as sensed by tactile receptors, firmness or lack of it of the food material, associated sense of heat and pain (as in chillies etc.) also contribute.[1] The taste sense is mainly a function of the taste buds, but the sense of smell contributes to a great extent to taste perception. [2]Taste perception can be altered by many physiological events, man-made and naturally occurring chemicals, substances and prosthesis, disease, surgery, smoking etc. Deficiencies in these chemical senses can not only reduce the pleasure and comfort from food, but also represent risk factors for nutritional and immune deficiencies as well as adherence to specific dietary regimens. These decrements can lead to food poisoning or over exposure to environmentally hazardous chemicals that are otherwise detectable by taste and smell. The aim of this article is to enlist all the factors affecting taste sensation and their management so as to improve overall health, self-sufficiency, and quality of life.

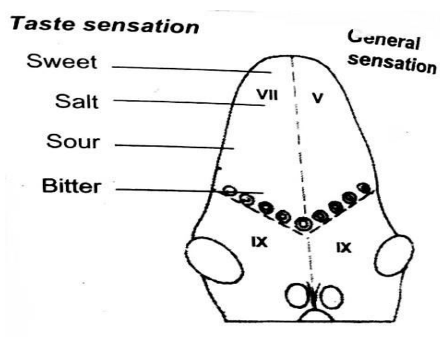
Historical background: Original reports and reviews obtained through internet searches from 1986 through February 2018 using the headings of "taste," "taste buds," "taste disorders," altered taste" taste thresholds" and "aging." Out of which 13 articles and 3 textbooks were included for review. All data was reviewed, tabulated, and summarized. Data Extraction. Criteria for extraction included data quality and validity, and relevance to clinical care.

Study	Year	Number of Subjects/Articles	Results
Brown J E et al	1986	23 pregnant/23 non pregnant	Altered taste in pregnant females
Doty RL et al	1989	58 patients with parkinsonism disease	Olfactory disorder part of larger sensory dysfunction
Schiffman SS et al	1992	34 of 831 patients over 20 years	Pollutants altered taste and smell
Cowart BJ et al	1994	52 young adults and 60 elderly	Declined bitter taste sensation with age
Matsuda T et al	1995	12 young and 12 elderly	Marked age-related changes in taste sensitivity to NaCl
Schiffman SS et al	1997	All articles reviewed 1966 through June 1997	Loss of taste common in elderly, normal aging, certain disease states, medications, surgeries and environment factors.
Mennella JA et al	2005	143 children and their mothers	Genetic variation of the A49P allele influenced bitter perception in children and adults
Yoshinaka M. et al	2006	320 men and 319 women	Significant association between subjective taste dissatisfaction and certain oral factors.
Doty R L et al	2008	124 article review	Numerous drugs affect patients sense of taste
Pavlos P et al	2009	34 non-smokers and 28 smokers	Smoking decreased taste sensitivity
Overberg J et al	2011	99 obese and 94 normal weight children.	Obese subjects identified taste qualities less precisely.
Baharvand M et al	2014	22 head and neck cancer patients	Head and neck radiotherapy impaired taste
Batisse C et al	2017	31 studies out of 615 reviewed	Oral health and oral care influences taste

DISCUSSION

The aim of the study is to determine the various factors that affect the sense of taste and their management so as to improve the quality of life of the patient. Various chemicals from food stimulate taste buds during chewing and swallowing, while tongue movements, especially pressing food against the roof of the mouth, prolong or improve taste sensations on the soft palate. Persons with artificial prosthesis that cover the soft palate lose sensory input from food in this mouth region. The temporal sequence of taste sensations during chewing and swallowing of food provides the uniqueness or "melody" of each recipe.[4] At present, receptors for 13 different chemical substances are identified. These include the following: 2 sodium receptors, 2 potassium receptors, 1 chloride receptor, 1 adenosine receptor, 1 hydrogen ion receptor, 1 ionosine receptor, 2 sweet receptors, 2 bitter receptors, 1 glutamate receptor.

For practical purposes, the activity of these receptors has been grouped into four categories called the primary sensations of taste and they include *sour, salty, sweet, and bitter.* Sour taste is caused by acidic substances, and the intensity of taste is proportional to the logarithm of the concentration of hydrogen ion. Salty taste is contributed mainly by the cations of ionized salts, but some salts also activate other receptors in addition, and this explains the slight difference among salty-tasting items. Sweet taste is the result of activation of several receptor types, including sugars, glycols,aldehydes, alcohols and various other organic chemicals. Bitter taste is also caused by the activation of several different receptors associated with organic chemicals.[2] Long-chain, nitrogen– containing items and alkaloids are the two most common substances.

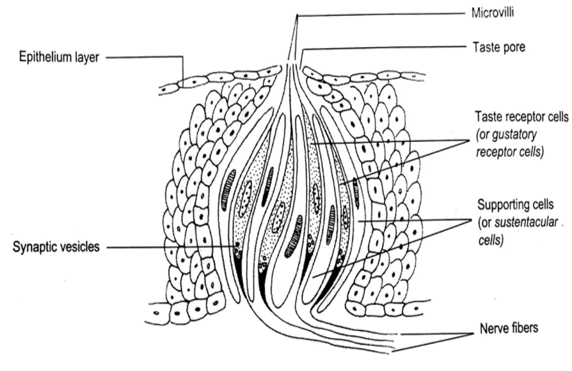


They include medicinal compounds such as quinine, caffeine, strychnine and nicotine. A strong bitter taste often causes a rejection of the substance, and this is related to the fact that dangerous toxins found in some plants are alkaloids.[3]

Distribution of the specific sensitivity: the tip of the tongue is very sensitive to the sweet taste, the back (near the 'V') to the bitter, the sides are sensitive to sour and salty tastes. The mid dorsum of the tongue is rather insensitive to taste.[1]

A taste bud is composed of about 50 modified epithelial cells, some of which, the subtentacular cells, serve a supporting function while others are the actual receptor cells. The receptor cells are continuously replaced by mitosis from the surrounding epithelial cells. Taste cells constantly reproduce themselves with a lifespan of approximately 10 days. This continuous process of renewal makes the sense of taste vulnerable to malnutrition, which can impair reproduction of taste cells and reduce taste sensitivity. The apical surfaces of the taste cells are arranged around a taste pore. The structural components in taste cells have been shown to play a role in taste transduction, including sodium channels. Microvilli or taste hairs protrude from the pore and act as receptor surface for taste molecules. Sensory nerve fibers are intertwined among the cell bodies to form polysynaptic elements that respond to activity in taste cells.[2]

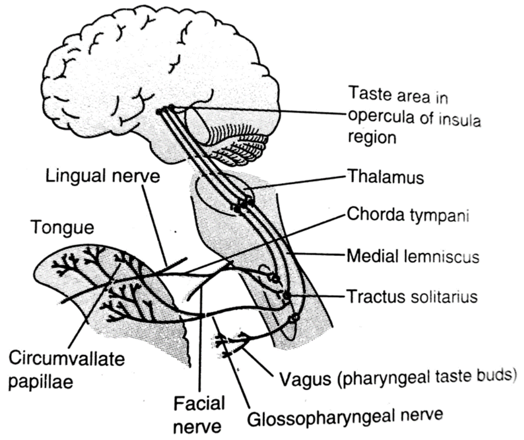
The 3,000 to 10,000 taste buds are found in the adult. Fungiform papillae (fungus-like) and filiform papilla (hair like) are found in the anterior two-thirds of the tongue, the fungiform papillae are scattered between the numerous filliform papillae, circumvallate ('walled') papillae 8-10 form a V-shaped configuration on the posterior one-third of the tongue, and foliate ('leaf-like') papillae are found along the lateral margins of the tongue. A small number of taste buds are found on the palate, tonsils, and epiglottis and in the proximal esophagus. Each taste bud typically responds to only one of the four primary taste substances, except when an item is present in very high concentration; then it may stimulate more than one receptor type. Like other receptors, taste cells produce a receptor potential. The substance concerned must be in solution, (e.g. in the saliva). Application of the substance to the receptors (of the microvilli) which it is sensitive causes the taste cell to be depolarized, and the degree of depolarization correlates with the concentration of taste substance. The binding of a taste substance to its receptor opens ion specific channels that allow sodium to enter the cell. The taste substance elicits a rapid response in the associated sensory fibers that adapts to a lower level within a few seconds. Saliva helps in washing away substances from the receptors.[2, 3]



Transmission of taste signals in the central nervous system. Taste fibers from the anterior two-thirds of the tongue first travel in branches of the trigeminal nerve and then join the chorda tympani, a branch of the facial nerve. Taste sensation from the posterior one –third of the tongue is carried by fibers of the glossopharyngeal nerve, while any taste fibers from the epiglottis or other areas course within branches of the vagus nerve. Most of the taste buds on the soft palate are innerved by another branch of the seventh cranial nerve called the "greater superficial petrosal nerve." The remaining taste buds on the soft palate are innervated by the deep petrosal branch of the ninth cranial nerve. The trigeminal nerve as well as free nerve endings of the chorda tympani nerve, the glossopharyngeal nerve, and the vagus nerves are transduced by the chemesthetic (pungent) tastes. These sensations such as those from nicotine, capsaicin, and piperine (chemicals in red and black peppers, respectively). Pungency is generally not regarded a taste, but rather a different sense related to nociception.[2, 3]

All taste fibers, from their entry into the brain stem, arefunnelled into the solitary tract that eventually synapse in the rostral portion of the nucleus of solitary tract. From here, axons pass rostrally to the ventromedial nucleus of the thalamus and then on to the cerebral cortex in the ventral region of the postcentral gyrus, which curls into the lateral fissure.[2]

In addition, the cortical pathway for taste perception, reflexes for taste involve fibers that course from the solitary tract directly to the superior and inferior salivatory nuclei, containing preganglionic parasympathetic neurons for the eventual activation of salivary secretion by the submandibular, sublingual, and parotid glands. Although some of the adaptive qualities of taste are the result of activity at the receptor level, most taste adaptation apparently occurs through central mechanisms which are not well defined at present.[2]



Factors affecting taste sensations:

1. **Aging:** Sequential decrease in the chemical sense of taste are an unfortunate but common aspect of aging. These decrements can alter food choices and intake and subsequently exacerbate disease states, impair nutritional status and immunity, and produce weight loss. Conversely, nutritional deficits may cause chemosensory loss. Sensory stimulation derived from food is especially important in old age when other sources of gratification may be less frequent Experimental data in humans,

monkeys, and rodents, indicate that the full range of taste quality is broader than the 4 prototypical tastes (sweet, salty, sour and bitter). Taste qualities such as metallic (iron salts), umami (monosodium glutamate/5'-nucleotides), and chalky (calcium salts) are also mediated by taste nerves. Amino acids other than monosodium glutamate have unique taste qualities. Fat sensations can be detected on the lateral posterior sides of the tongue without tongue movement, which suggests that some fatcomponent may also activate taste nerves. In Japan the word "umami" is used to describe the taste of monosodium glutamate as well as the meaty taste of certain fish and broths. The cause of changes in taste in normal aging in the absence of factors such as disease and medications is not fully understood. While some studies have found reduced numbers of papillae and/or taste buds, other studies have found no losses during normal aging. Mistretta concluded that taste losses from normal aging are due to changes in taste cell membranes (e.g., altered functioning of ion channels and receptors) rather than losses of taste buds.

Elderly persons also have decreased ability to discriminate intensity differences between various concentrations of a tastant.[4]

Marked age-related changes in regional taste sensitivity also occur over different areas of the tongue. Impairments with age also occur in perception of complex food systems, which requires integration of taste and smell sensations. Aged persons have reduced ability to identify foods on the basis of taste (and smell). Malnutrition and wasting make it even more difficult to identify foods and food ingredients based on sensory cues. Taste losses in perception of sweet and salty qualities can have health consequences. Decrements in sweet taste perception make elderly persons with diabetes more vulnerable to adverse effects from excess sugar consumption. Losses in perception of salt (NaCl) can make it difficult for hypertensive patients to comply with severe salt restriction simply because food to them may seem tasteless. If elderly persons add NaCl to reduce bitterness of foods (one effect of adding NaCl), this can increase blood pressure and the chance of stroke in salt-sensitive hypertensive patients. Reductions in intake of salt should be gradual because severe reduction in salt intake can backfire and increase preference for salt. [4]

2. Medical conditionsand Medications also play the major role in taste losses and distortions in both healthy and wasting older patients. Clinical studies have implicated over 250 drugs in altered taste sensations. Prescription medications are consumed disproportionately by the elderly with per capita consumption 3 times higher than their younger counterparts. According to Lewis et al, the average number of medications used by community-dwelling elderly persons older than 65 years ranges from 2.9 to 3.7 medications, and this number increases significantly for elderly persons living in nursing homes.Drugs secreted into the saliva can cause adverse effects on the taste system either by modifying taste transduction mechanisms or by producing a taste of their own. Drugs can diffusing from the blood stimulate receptors on the basolateral side of taste receptor cells. Taste losses associated with drugs or concurrent with protein malnutrition and wasting may also be caused by impaired turnover of taste cells, although there have been no formal experiments to test this hypothesis. The relative frequencies with which drugs alter taste and smell have not yet been determined using quantitative experimental testing procedures.[4-6]

Table -1 Representative Medications or Treatments that alter taste	
Lipid-Lowering Drugs	Cholestyramine, clofibrate, fluvastatin sodium, gemfibrozil, lovastatin, pravastatin sodium
Antihistamines	Chlorphenlramine maleate, loratadine, terfenadine and pseudoephedrine
Antimicrobials	Ampicillin, ciprofloxacin, clarithromycin, ofloxacln, streptomycin, tetracyclines
Antineoplastic drugs	Cisplatin, doxorubicin and methotrexate, vincristine sulfate
Anti-inflammatories	Auranofin, colchicine, dexamethasone, diclofenac potassium/diclofenac sodium, dimethyl sulfoxlde, gold, hydrocortisone, D-penicillamine and penicillamine
Bronchodilators and Other Asthma Medications	Albuterol sulfate, cromolyn sodium, flunisolide, metaproterenol sulfate, terbutaline sulphate
Antihypertensives and Cardiac Medications	Acetazolamide, adenosine, amiloride, benazepril hydrochloride and hydrochlorothiazide, betaxolol hydrochloride, captopril, clonidine, diltiazem, enalapril, ethacrynic acid, nifedipine, propranolol, spironolactone
Muscle Relaxants and Drugs for the Treatment of Parkinson Disease	Baclofen, dantrolene sodium, levodopa
Antidepressants and Anticonvulsants	Amitriptyline hydrochloride, carbamazepine, clomipramine hydrochloride, clozapine, desipramine hydrochloride, doxepin hydrochloride, fluoxetine hydrochloride, imipramine, lithium carbonate, phenytoin, trifluoperazine
Vasodilators	Dipyridamole, nitroglycerin patch
Radiation therapy	Radiation to the head

3. **Medical conditions**[4]

Table 2.—Representative Medical Conditions That Affect the Senses of Taste	
Nervous	Alzheimer disease ,Bell palsy, Damage to chorda tympani, Epilepsy Head trauma, Korsakoff syndrome, Multiple sclerosis, Parkinson disease, Tumors and lesions
Nutritional	Chronic renal failure, Liver disease including cirrhosis, Niacin (vitamin B3) deficiency, Vitamin B12 deficiency ,Zinc deficiency
Endocrine	Cushing syndrome, Diabetes mellitus Hypothyroidism, Kailman syndrome ,Turner syndrome
Viral infections	Acute viral hepatitis, Influenza like infections
Genetic disorder	Many persons cannot sense the bitter taste of phenyl thiocarbamide (PTC) unless given in very high concentrations; such cases may be called selective taste blindness; it is a genetic disorder.
Local	Allergic rhinitis, atopy, and bronchial asthma ,Sinusitis and polyposis ,Xerostomic conditions including Sjögren syndrome

4. **Radiation of the oral cavity**- e.g., in radiotherapy for the treatment of oral cancer causes destruction of taste buds and loss of taste sensation.[1]After head and neck irradiation, perception of taste concentration and taste sensitivity of all classical four basic taste qualities were severely impaired.
5. **Area**- Stimulation of a small area of the tongue by one drop of solution produces weaker sensations as compared to tasting the same solution by the whole mouth
6. **Temperature**- The optimal sensitivity to taste-producing solutions occur when their temperature range is within 30-40 ^{0}C.
7. **Adaptation**- It is a common experience that taste producing substances produce adaptationquickly if kept in one place in the mouth. The adaptation is peripheral.[3]
8. **Surgical interventions**.[4]
9. **Obesity**- Obese children and adolescents have less sensitive taste buds. That means that for obese children, sweet foods taste less intensely sweet, bitter foods are milder and salt is not as readily perceived[7].
9. **Environment- Pollutants**: People (such as agricultural workers) who have frequent andrepeated contact with pesticides, often report a persistent bitter and metallic taste in the mouth.[8]
10. **Smoking**-Smoking a cigarette or cigar, when the smoker places the taste buds in contact with chemical compounds that greatly decrease the taste buds' ability to register salty, sweet, sour and bitter tastes.[9]
11. **Pregnancy**- Nearly two-thirds of pregnant women experience changes in taste. Pregnant women have been found to have a reduced sensitivity to salty tastes, which may be the body's way of ensuring increased salt intake during pregnancy.[10]
12. **Oral health, Oral hygiene and Prosthetic treatment**- The deterioration of oral health status, deficient oral hygiene and prosthetic treatment may lead to changes in taste ability. Removable prosthesis covering the palate has a variable impact on taste perception, which may depend on the taste modality. Also, low number of teeth, multiple untreated carious lesions, periodontal disease or prosthetic treatment leading to impaired masticatory performance impacts taste perception.[11]

CONCLUSION

Losses of taste are common in the elderly and result from normal aging, certain disease states (especially Alzheimer disease), medications, surgical interventions, and environmental exposure. Deficits in these chemical senses cannot only reduce the pleasure and comfort from food, but represent risk factors for nutritional and immune deficiencies as well as adherence to specific dietary regimens. Chemosensory decrements can lead to food poisoning or over exposure to environmentally hazardous chemicals that are otherwise detectable by taste and smell. Use of flavour-enhanced food can increase enjoyment of food and have a positive effect on food intake and immune status. The prevention of dental disease and promotion of good oral health practices and dental treatments contribute to maintaining taste ability. Thus the role of a dentist is important in maintaining or improving masticatory function.

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