

## Evaluation of gustatory and olfactory function among premenopausal and postmenopausal women and men

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### Original Article

#### Abstract

**BACKGROUND AND AIM:** The sense of taste is a chemical sense which allows everyone to perceive the flavor of what is eaten or drunk. Also, the sense of olfaction is also a chemical sense contributing to the sense of taste to perceive the taste and flavor of food. In the present work, the gustatory and olfactory function in pre- and postmenopausal women and men were studied and compared to each other.

**METHODS:** Fifty postmenopausal women, 50 age-matched men, 50 young women and 50 young men were evaluated in this study and enrolled through simple sampling method. The aim of this study was explained for patients and in case of their consent, they were given the questionnaire. Taste threshold for each of the four main tastes for all of the participants in the study was determined at one step between 8 am to 11 am while they had not consumed any food since one hour before the test. The whole mouth taste method was used in this study. Also, the Davidson and Murphy tests were performed and the quality identification and intensity ratings of olfaction were measured.

**RESULTS:** Three individuals among the postmenopausal women group and 2 old men were not able to detect sweet taste even in high concentration; in the group of young men, one man was not able to detect bitter taste even in high concentration. This study showed that 2% of postmenopausal women and 4% of matched men were not able to detect the odor of isopropanol even at a concentration of 70% and there was a significant relationship between odor perception of isopropanol and olfactory intensity between the two groups of pre- and postmenopausal women as well as men.

**CONCLUSION:** Taste dysfunction directly influences nutritional status. In this study, the strength of the sweet taste perception was significantly lower among women after menopause; however, there was no significant difference between the perception of other tastes among postmenopausal women and men of same age.

**KEYWORDS:** Taste; Olfactory; Menopause

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The sense of taste is a chemical sense which allows everyone to perceive the flavor of what is eaten or drunk.

This sense is of vital importance as it allows individuals to distinguish between harmful and deadly substances or undesirable and desirable foods.<sup>1-3</sup> The sense of taste is important for dentistry from two perspectives: first, taste is a stimulus for the secretion of saliva; and second, sweet taste is considered

desirable for most of people. However, carbohydrates are the main cause of tooth decay.<sup>4,5</sup> The nature of certain chemicals stimulating the receptors of taste has not yet been completely identified. Physiology studies have identified at least 13 chemical receptors for perceiving taste. In general, the ability of mentioned receptors is categorized into four major groups, i.e. main types of taste including sour, sweet, salty and bitter.<sup>6,7</sup>

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Taste disorder among adults is very prevalent in many communities and it is considered as the most common oral sensory disorder following pain. The prevalence of taste disorder increases with age, and about 40% of those with this disorder are more than 65 years of age. In the United States, nearly 100000 people visit a dentist or doctor complaining about taste disorder annually. Taste disorders include a range of sensory disorders varying from incomplete perceiving to the loss of taste. Compared with males, females complain more about taste disorder. Taste disorder is multifactorial and menopause is considered as one of its factors.<sup>8-14</sup>

Olfaction is also a chemical sense contributing to the sense of taste to perceive the taste and flavor of the food. This sense is one of the most unknown senses for human, mostly due to the fact that the sense of olfaction is a subjective phenomenon which is not easy to study in lower animals. Changes in taste and olfaction make the food tasteless and therefore, the nutrition and quality of life could be endangered.<sup>14</sup> There is little information available concerning taste changes among postmenopausal women. The present study aimed to assess probable changes in taste and olfaction among pre- and postmenopausal women and compare it with men.

## Methods

This research was cross-sectional analytical study which was conducted among 200 patients in Kerman, Iran, who referred to the department of oral medicine in the School of Dentistry, offices and clinics of dentistry from October 2010 to January 2011. The method of sampling was simple. The purpose of the study was described to all the persons and after obtaining consent, they were given the questionnaire. All participants were informed of the purpose of the questionnaire and apprised that a decision to decline participation would not affect their medical care. A trained clinical assistant was available to respond to any questions or concerns.

Inclusion criteria included physical health

and lack of systemic disease, absence of oral diseases and diseases affecting saliva such as Sjogren's syndrome, lack of taking any medication affecting saliva such as blood pressure medication, lack of upper respiratory tract infection such as common cold during the last 15 days, lack of smoking and drinking alcohol. Also, people should not have been under stress and or exposed to very cold weather. They were told not to use chewing gum, foods and drinks one hour prior to the study and to avoid eating spicy food from the night before and avoid applying perfume, cologne, any cream and soap, or any aromatic substance on their face, hands and their body on the day of study. About postmenopausal women, at least 6 months should have passed from the cessation of menstruation.<sup>3,8,14</sup>

All patients were studied by a researcher and a questionnaire<sup>3,8,14</sup> was completed for each patient. The purpose of the study was described to all of the participants and the questionnaire was distributed to them. In the meantime, all the individuals were assured of the confidentiality of the information of the questionnaire and that the information was used only for statistical analysis.

Before the experiments, each subject was given a questionnaire for taste function that included five general questions, five specific taste questions and three questions for women only as follows:

### A. General questions:

1. Have you experienced a loss in taste?
2. How long have you had taste loss? Was the loss sudden or gradual?
3. What was the precipitating event for your taste problem?
4. Have you experienced changes in hot and cold sensations in your mouth?
5. Have you experienced reduced salivation or dry mouth?

### B. Specific taste questions:

1. Can you taste the sweetness of ice-cream?
2. Can you taste the saltiness of potato chips?

3. Can you taste the sourness of lemons?
4. Can you taste bitterness of coffee?
5. Which taste you prefer most?

C. Questions for women only:

1. What is the duration of complete amenorrhea?
2. Can you taste four basic tastes as strongly as before menopause?
3. Do you have a diet change after menopause?

**Determination of the taste threshold:**

Taste threshold for each of the persons in the study was determined at one step. The test was conducted between 8 am to 11 am. The whole mouth taste method was used in this study.<sup>15</sup> Using four primary substances including sodium chloride (NaCl), sucrose, citric acid and quinine hydrochloride (HCl-quinine, Merk Germany), solutions in different concentrations were prepared (each of four tastes were in 5 concentrations based on molarity). During the study, the solutions were kept at room temperature and were changed every six months. First, 3 ml of the most dilute solution (solution number 1 related to each of four tastes) was given to each person to keep it in the mouth for 30 seconds and then spit it out of the mouth. If the person stated the desired taste correctly, then the first concentration was considered as his/her taste threshold for that taste. But if a person could not distinguish a certain taste or could not distinguish it correctly, then he/she was given solution number 2 with higher concentration; and this continued till the taste was correctly distinguished and the taste threshold was determined. In the intervals between using different concentrations related to one taste, 5 ml of distilled water was given to the person to wash his/her mouth for 30 seconds in order to remove the effect of previous solution.<sup>9,16</sup> In The meantime, a questionnaire for individuals was completed.

**Determination of olfactory threshold:** The Davidson and Murphy test was used to determine the olfactory threshold<sup>16</sup>. In this test, isopropanol solutions (9.9%, 15%, 23%,

32%, 48%, 53% and 70%) and a glass of water were given to the patient (each time one of each concentrations in one glass and the same amount of water in the other glass) and the patient was asked to smell the content of two glasses and choose the proper substance. If the person selected the substance correctly, then that concentration was detected as his/her olfactory threshold, otherwise, the higher concentration was given to the person. In this method, the patient should be seated; with his head resting on a flat surface and parallel to the Frankfurt plane in a quiet room with closed doors and just patient and the researcher should be in the room.

Also, Smell function was measured using the Sniffin' Sticks odor identification test kit (Burghart Medical Technology, Wedel, Germany) which is based on pen-like odor dispensing devices.<sup>17</sup> The pens are approximately 14 cm long, with an inner diameter of 1.3 cm. Instead of liquid dye, the pen's tampon is filled with 4 ml of liquid odorants. Using a four-alternative forced-choice paradigm, odor identification was assessed for 16 common odors. The threshold, discrimination and identification test was performance based on Welge-Luessen et al. study.<sup>18</sup>

Ethical considerations were taken into account throughout the study, and the patients' names and medical information remained completely confidential. The research proposal was approved by the Ethics Committee of Kerman University of Medical Sciences, Kerman, approval code 126.92.k.

Data were analyzed with SPSS for Windows (version 13.5, SPSS Inc., Chicago, IL, USA) using chi-square test and Student's unpaired t-test. The highest frequency observed in each concentration related to a taste or an odor was considered as the taste and olfactory thresholds for that taste and odor.

## Results

In this research, 50 postmenopausal women [mean age  $\pm$  standard deviation (SD): 59.7  $\pm$  6.7], 50 old men (60.4  $\pm$  5.5), 50 young

**Table 1.** Correct quality identification using whole mouth taste test

Taste solutions	Menopause women	Young women	Old men	Young men
	n (%)	n (%)	n (%)	n (%)
Sucrose	47 (94)	50 (100)	48 (96)	50 (100)
NaCl	50 (100)	50 (100)	49 (98)	50 (100)
Citric acid	50 (100)	50 (100)	50 (100)	50 (100)
Quinine hydrochloride	50 (100)	50 (100)	50 (100)	49 (98)

women ( $22.6 \pm 4.5$ ) and 50 young men ( $24.4 \pm 5.2$ ) were studied in terms of sense of taste and olfaction. To compare the data, the postmenopausal women were compared with men at the same age and again they were compared with young women. Also, men in both groups were compared with each other and finally young men were compared with young women. Among the postmenopausal women, 15 individuals (30%) complained about feeling of an unfavorable taste in the mouth (bitter, pus, sweet, blood, salty and sour taste). Among postmenopausal women, 8 individuals (16%) and also 4 old men (8%) had experienced loss of sense of taste for sweetness of ice cream and saltiness of potato chips and its duration had been between 3 and 15 years. Almost in all these people, the loss of sense of taste had been gradual and had not been associated with a specific event. None of the participants had experienced changes in feeling cold and warm substances in their mouth. Five postmenopausal women (10%), 4 old men (8%), 1 young woman (2%) and 2 young men (4%) complained about the reduction of saliva and dry mouth. Also, 3 postmenopausal women group and 2 old men were not able to detect sweet taste even in high concentration; in the group of young

men, one man was not able to detect bitter taste even in high concentration (Table 1).

Among the postmenopausal women, 5 individuals stated that they were not able to detect sweet taste like before the menopause. The duration of menopause varied between 3 to 15 years. There was no relation between duration of menopause and changes in sense of taste. The strength of the sweet taste among postmenopausal women after menopause was significantly lower than that of men at the same age (Table 2). Also, there was a statistically significant relationship between detecting taste and the strength of the sweet and sour tastes among postmenopausal women and young women. This study showed a statistically significant relationship between detecting taste and the strength of the sour taste among old and young men (Table 3).

In this study, one person (2%) of the group of postmenopausal women and 2 old men (4%) were not able to recognize the odor of isopropanol even in a concentration of 70% (Table 4). There was a statistically significant relationship between the olfaction of this substance and the strength of sense of olfaction among postmenopausal women and young women and also between old and young men (Table 5).

**Table 2.** Percentage of intensity of whole mouth taste test

Concentration levels of taste solutions	Sucrose		P	NaCl		P	Citric acid		P	Quinine hydrochloride		P
	Group 1	Group 2		Group 1	Group 2		Group 1	Group 2		Group 1	Group 2	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
1	10 (20)	2 (4)		5 (10)	0 (0)		2 (4)	0 (0)		2 (4)	0 (0)	
2	14 (28)	2 (4)		3 (6)	3 (6)		0 (0)	3 (6)		2 (4)	0 (0)	
3	15 (30)	10 (20)	*0.012	12 (24)	9 (18)	0.212	10 (20)	5 (10)	0.425	2 (4)	18 (36)	0.091
4	11 (22)	21 (42)		25 (50)	24 (48)		28 (56)	24 (48)		22 (44)	2 (4)	
5	0 (0)	13 (26)		5 (10)	14 (28)		10 (20)	18 (36)		19 (38)	25 (50)	

Group 1: Menopause women, Group2: Old men, Group3: Young women, Group 4: Young men

\*P < 0.05 is significant

**Table 3.** Mean total taste intensity ratings from whole-mouth taste test

Taste solutions	Total taste score (mean $\pm$ SD)											
	Group 1	Group 2	P	Group 1	Group 3	P	Group 3	Group 4	P	Group 2	Group 4	P
Sucrose	1.30 $\pm$ 2.50	1.40 $\pm$ 3.70	*0.010	1.30 $\pm$ 2.50	1.09 $\pm$ 3.42	*0.010	1.09 $\pm$ 3.42	1.15 $\pm$ 3.32	0.460	1.40 $\pm$ 3.70	1.15 $\pm$ 3.32	0.080
NaCl	1.30 $\pm$ 3.52	1.10 $\pm$ 3.90	0.060	1.30 $\pm$ 3.52	1.10 $\pm$ 3.46	0.140	1.10 $\pm$ 3.46	1.15 $\pm$ 3.51	0.090	1.10 $\pm$ 3.90	1.15 $\pm$ 3.51	0.250
Citric acid	0.90 $\pm$ 3.85	0.85 $\pm$ 4.15	0.210	0.90 $\pm$ 3.85	1.05 $\pm$ 4.17	*0.010	1.05 $\pm$ 4.17	1.09 $\pm$ 3.22	0.060	0.85 $\pm$ 4.15	1.09 $\pm$ 3.22	*0.020
Quinine hydrochloride	1.00 $\pm$ 4.19	0.65 $\pm$ 4.51	0.280	1.00 $\pm$ 4.19	0.90 $\pm$ 4.65	0.710	0.90 $\pm$ 4.65	1.01 $\pm$ 4.50	0.220	0.65 $\pm$ 4.51	1.01 $\pm$ 4.50	0.110

Group 1: Menopause women, Group2: Old men, Group3: Young women, Group4: Young men

\*P < 0.05 is significant

SD: Standard deviation

**Table 4.** Percentage of intensity of isopropanol

Concentration levels of isopropanol	Group 1	Group 2	Group 3	Group 4
	n (%)	n (%)	n (%)	n (%)
9.9	0 (0)	0 (0)	0 (0)	0 (0)
15	0 (0)	10 (20)	0 (0)	7 (14)
23.3	0 (0)	10 (20)	10 (20)	15 (30)
32	19 (38)	14 (28)	15 (30)	15 (30)
48	16 (32)	16 (32)	10 (20)	12 (24)
53	10 (20)	0 (0)	13 (26)	1 (2)
70	5 (10)	0 (0)	2 (4)	0 (0)

Group 1: Menopause women, Group 2: Old men, Group 3: Young women, Group 4: Young men

**Table 5.** Mean total isopropanol concentration from whole-mouth taste test

Isopropanol	Total taste score (mean $\pm$ SD)											
	Group 1	Group 2	P	Group 1	Group 3	P	Group 3	Group 4	P	Group 2	Group 4	P
Isopropanol	4.50 $\pm$ 1.21	4.30 $\pm$ 1.05	0.200	4.50 $\pm$ 1.21	5.50 $\pm$ 1.42	*0.010	5.50 $\pm$ 1.42	5.40 $\pm$ 1.12	0.320	4.30 $\pm$ 1.05	5.40 $\pm$ 1.12	*0.010

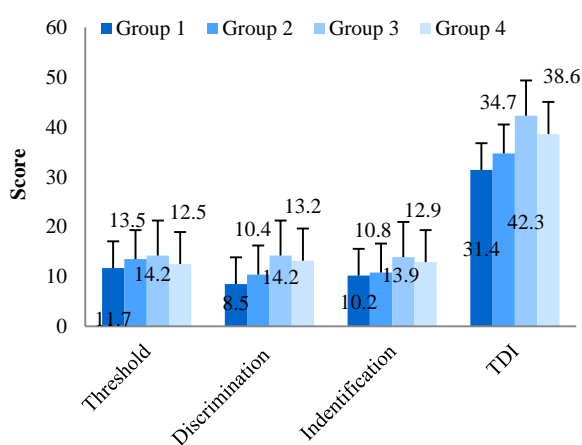
Group 1: Menopause women, Group 2: Old men, Group 3: Young women, Group 4: Young men

\*P < 0.05 is significant

SD: Standard deviation

Three postmenopausal women (6%), 2 young women (4%) and one old man (2%) stated that they had felt changes in their sense of olfaction. However, this disorder has not any effect on their daily activities.

Three postmenopausal women were not able to identify the smell of the pen, even at high concentrations (n-butanol 4 percent), score = 0. The analogy of threshold discrimination identification (TDI) scores of postmenopausal women showed a decrease in the olfactory function ( $31.4 \pm 3.6$ ) (Figure 1).



**Figure 1.** The threshold, discrimination and identification (TDI) scores of all patients  
Group 1: Menopause women, Group 2: Old men, Group 3: Young women, Group 4: Young men

## Discussion

The senses of taste and olfaction play a role in our nutrition, respiration and protect us from harmful chemical substances around us. Thus, disorder in these senses may significantly influence quality of life. For instance, increased use of sugar and salt as well as impaired sense of taste among people with diabetes or high blood pressure has been reported.<sup>19,20</sup> Taste problems are prevalent in human communities; and ear, nose and throat specialists and oral health specialists are mainly the first ones who detect these disorders. Various tastes either satisfy body needs or cause avoidance reactions. The smell stimulates appetite and also protect us from toxins. For a long time,

flavor has been considered as a part of the sense of olfaction. Many patients complain about the loss of the sense of taste; however, they still show a normal sense of taste. In most of these patients, flavor has a problem.<sup>14</sup>

Complaining about flavor is seen in two ways: complaining about reduction or loss of the sense of taste (hypogeusia or ageusia) or continuous unpleasant taste in the mouth (phantogeusia), often related to the change in the quality of flavor (dysgeusia) or burning mouth syndrome (BMS).<sup>21</sup> Etiopathology of disorder in the sense of taste is multifactorial; and menopause is considered as one of these factors. Menopause is a natural phenomenon in women that occurs around the age of 50 years and is associated with some physical changes. Changes after menopause occur in various sensory organs such as organ of taste which cause disorder in the sense of taste and oral discomforts. During this period, changes such as mucosal dryness, burning sensation and disorder in the sense of taste in the oral cavity can be seen. However, the cause and main relationship between taste changes and menopause have not been identified (hormonal changes). Also, disorder in the sense of taste causes food to be tasteless and results in disorder in eating, nutrition and quality of life.<sup>14</sup> The reduction of taste perceptions and willingness to intake more salt and sugar in diet may lead to dangerous health status in elderlies' life.<sup>3,4</sup> Some studies have been conducted to identify probable causes of change in taste among women after menopause. The reduction of taste performance after menopause not only is important to enjoy eating food, but also directly influences food consumption and consequently nutritional status. This study investigated the sensed of taste and olfaction among pre- and postmenopausal women and compared them with the men of the same age.

This study showed that 30% of postmenopausal women complained about the feeling of an unfavorable taste in the oral cavity. The strength of the sweet taste among postmenopausal women after menopause

was lower than that of men. Also, there was a statistically significant relationship between detecting taste and the strength of the sour taste among old and young men.

Wardrop et al.<sup>22</sup> showed that prevalence of oral discomforts among women after menopause was 46%. However, this value for women before menopause was 6%. These researchers showed that symptoms of oral discomforts after hormone replacement therapy were relieved in almost 2/3 of postmenopausal women. However, Delilbasi et al.<sup>3</sup> and Tarkkila et al.<sup>23</sup> suggested that there was no difference in the reduction of oral symptoms between women who have taken hormone replacement therapy and those who have not. Based on these studies, changes in the mouth among women after menopause may have various causes and may not be necessarily associated with hormonal changes.<sup>3,23</sup> Wardrop et al.<sup>22</sup> conducted a study on postmenopausal women and reported the correlation between mouth changes and psychological symptoms. Bercovici et al.<sup>24</sup> concluded that mouth problems among women after menopause were due to the effect of topical stimulants and in other words, it was concluded that the high maturation values found in the oral smears of the menopausal women were not the result of hormonal effect but that of local mechanisms or irritating factors.

One of the differences between this study and that of Kaneda et al.<sup>8</sup> is that we studied women in two groups but Kaneda et al. evaluated women in general. Kaneda et al.<sup>8</sup> indicated that there was no difference in detecting threshold for sucrose between young and old individuals. However, the present study showed that the perceived sweetness was significantly lower after menopause. Studies conducted by Ahne et al.<sup>1</sup> and Hummel et al.<sup>25</sup> showed that women in general were more sensitive about the sense of taste compared with men. Mojet et al.<sup>12</sup> concluded that there was a direct relationship between the loss of sense of taste and aging and also men were subjected to

this phenomenon more than women.

Formaker and Frank<sup>5</sup> showed that sensitivity to perceive salty and sweet tastes decreased among patients suffering from BMS and they provided a hypothesis that activation of pain pathways may have an effect on neural and behavioral taste functions.

In this study, all those who suffered from taste disorder stated that this had been a gradual status which is similar to studies conducted by Delilbasi et al.,<sup>3</sup> Dangore-Khasbage et al.<sup>14</sup> and Delilbasi et al.<sup>4</sup> showed that in addition to aging, factors such as smoking, eating habits, and dental status may gradually reduce taste. A study conducted by Ziskin and Moulton<sup>26</sup> reported that 24% of postmenopausal women complained about abnormal taste such as salty, spicy and unpleasant tastes in the mouth to an extent that they became malnourished due to further problems and avoidance of eating. Aghahosseini and Akhavan Karbasi<sup>27</sup> showed that postmenopausal women complained about unpleasant taste in the mouth. According to available articles, it seems that there are various causes for the change in taste among women after menopause, including biological and psychological factors.

Liu et al.<sup>28</sup> showed that age, gender, ethnicity, education, family income, alcohol, asthma and malignancy were risk factors for smell dysfunction, whereas only ethnicity, heavy alcohol consumption and cardiovascular disease (CVD) history were associated with a higher prevalence of taste that is compatible with Rawal et al. study.<sup>29</sup>

Boesveldt et al.<sup>30</sup> showed that gustatory test scores were significantly correlated with age, education, and number of medications taken. The sense of olfaction provide human with valuable information on the environment. Olfactory disorder causes lots of problems in daily life no matter what the cause is.<sup>31</sup> Also, olfactory system is a warning for risks, such as spoiled food, leaking natural gas, air pollution and smoking; and the dysfunction of olfaction can be an early indication for serious diseases such as

Alzheimer's and Parkinson. The change in the sense of olfaction can happen in two ways: quantitative change in the form of hyposmia (reduction of ability to detect odors) or anosmia (the inability to perceive odor) and qualitative change in the form of troposmia (lack of matching between perceived and real odor) or phantosmia (the perception of an odor in the absence of any olfactory stimulus or olfactory hallucination).

Mackenzie in 1884 showed that the loss of the sense of taste is rare; however, the loss of the sense of olfaction is more prevalent.<sup>32</sup> Studies conducted by Goodspeed et al. in modern chemosensory clinic have proved these observations.<sup>33</sup> Also, studies conducted in flavor and aroma clinic in Pennsylvania and in the Monell-Jefferson clinic showed that while nearly 70% of patients visiting clinics complain about the loss of the taste, less than 10% of them suffer from this disorder; and finally, aging or factors related to aging may put more people at the risk of olfactory disorder.<sup>15,34</sup> This study showed that 2% of the group of postmenopausal women and 4% of old men were not able to detect the odor of isopropanol even in a concentration of 70%. There was a statistically significant relationship between detection of isopropanol and the strength of sense of olfaction among postmenopausal women and young women and also between old and young men. Also, 6% of postmenopausal women, 4% of young women and 2% of old men stated that they had felt changes in their sense of olfaction. However, this disorder has not had an effect on their daily activities.

To the best of our knowledge, there has been no research on the sense of olfaction among postmenopausal women and young women and its comparison with men of the same age.

The rate of loss of smell increases with age in men despite adjusting for differences in psychological and health conditions, suggesting that physiological factors as mediators.

Pinto et al.<sup>35</sup> showed that in elderly population, age dependent changes affecting taste were less than factors affecting olfaction. Boesveldt et al.<sup>30</sup> showed that olfactory test scores were significantly correlated with age, body mass index, depressive symptoms, sex and education.

However, in a chemosensory clinic, Cowart et al.<sup>36</sup> found that old people over 65 years reported phantogeusia and the reduction of taste significantly more than young and middle-aged patients but complained less about olfactory disorders.

## Conclusion

Taste dysfunction directly influences nutritional status. In this study, the strength of the sweet taste perception was significantly lower among women after menopause; however, there was no significant difference between the perception of other tastes among postmenopausal women and men.

## Limitations

Electrogustometry is an up to date method, although in this study, whole mouth taste method was used because of limitations.

## Conflict of Interests

Authors have no conflict of interest.

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