

taste identification threshold. The obtained results were examined: the number of people identifying a given stimulus concentration was counted and, subsequently, the percentage was calculated.

Taste sensitivity minimum was established on the basis of sensitivity thresholds levels in the examined people. Those whose threshold values were lower or equal when compared to mean identification threshold values determined in individual examinations on the basis of individual arrangement of threshold values were regarded as people complying with sensory minimum criterion for a given taste.

In order to examine the influence of age on taste perception levels, the examined people of both sexes were divided into six age groups, which were further subdivided into smoker and non-smoker sub-groups.

For each sub-group values of taste identification thresholds were calculated as an arithmetic mean. The results were statistically prepared with t-Student test for independent data. Value $p < 0.005$ was assumed to be statistically relevant (Oktaba and Niedokos, 7).

RESULTS

Individual sweet taste threshold values for men were corresponding to a huge range of saccharose concentrations from 0.125 to 6.0%. The mean threshold value for the examined population of non-smoking men was 0.5%, and for smokers 0.75%. Similarly in women individual sweet taste threshold values ranged considerably from saccharose concentration of 0.0625 to 6.0%. However, for both smoking and non-smoking women the mean threshold value was 0.25%, lower in comparison to men. There were cases of total inability to perceive the sweet taste: this was the case with three men (two smokers and one non-smoker) and two non-smoking women.

Individual salty taste identification threshold values ranged from sodium chloride concentrations of 0.0125 to 3.0% for men. For both smokers and non-smokers the mean threshold value was 0.25%. Individual salty taste threshold values varied for women as well from NaCl concentrations of 0.0625 to 3.0%. The mean threshold value (0.25%) was not different for smokers and non-smokers. Salty taste was identified by all the examined people, both men and women, regardless of whether they smoked or not.

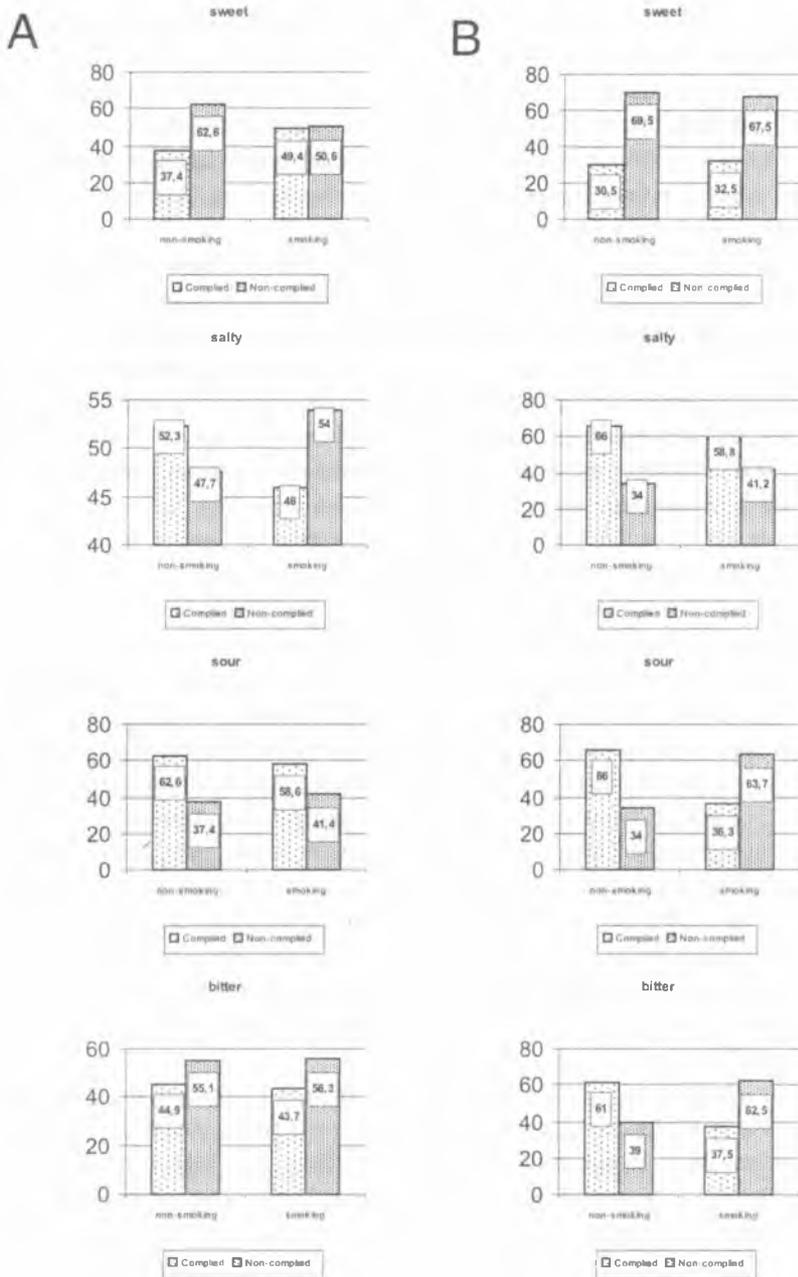
Differences in individual perception of sensitivity thresholds for acetic acid were very clear: from 0.0375 to 3.0% for men. Both smokers and non-smokers exhibited the same mean threshold value of 0.125%. In case of women, the range of acetic acid concentrations that were noticed was relatively broad – from 0.0125 to 1.0%. With non-smoking women the mean sensitivity threshold was 0.125% and with smokers it was lower – 0.0625%. All the examined people, regardless of their gender and whether they smoked or not, were able to perceive sour taste.

Individual bitter taste threshold values for men ranged from quinine concentrations of 0.00025 to 0.125%. The mean threshold value, both for smokers and non-smokers, was 0.0025%. Individual bitter taste threshold values for women ranged from quinine concentrations of 0.00025 to 0.125%. The threshold value was 0.0025% for non-smokers and 0.00125% for smokers. There were several cases of total inability to perceive bitter taste: this was the case with four non-smoking men and two smoking men. All women were able to identify this taste regardless of their addiction.

In the examined population a considerable group of people complied with the norms of sensory minimum criterion, i.e. their taste identification thresholds were lower or equal when compared to mean values determined on the basis of individual examination results. The percentage of people who complied with the sensory minimum for individual taste depends on gender and cigarette smoking. Generally, among smokers, and especially women, the percentage of people with high sensitivity for salty, sour and bitter tastes was lower in comparison to non-smokers. However, in case of sweet taste sensory minimum was achieved more often by smokers of both sexes (Fig. 1).

Sweet taste identification threshold values in individual age groups were very diversified both for men and for women (Fig. 2). Generally, people from the youngest and two oldest groups were least sensitive for sweet taste. Smoking men exhibited generally higher sensitivity for sweet taste in comparison to non-smokers. Identification thresholds of this taste were lower in smokers by 31.7% and 2.7% respectively in two youngest age groups. At the age of 26-31 sweet taste identification threshold was slightly higher (1.7%) for smokers. But in the remaining age groups smokers exhibited lower threshold again (11.4%, 17.0% and 40.1% respectively). The differences observed were statistically irrelevant (Fig. 2). Smoking women from the youngest age group and from 32-40 and 51-60 age groups showed higher sweet taste identification thresholds (by 15.9%, 302.4% and 5.9% respectively). These changes were statistically irrelevant. In the remaining three age groups sweet taste identification threshold for smoking women were lower when compared to non-smokers by 46.3% ($p < 0.01$), 7.9% (ns) and 18.8% respectively (Fig. 2). In almost all the cases sex differences were not statistically relevant. Only in the case of men aged 20-25 who smoke cigarettes sweet taste identification threshold was relevantly higher with $p < 0.01$.

Salty taste identification thresholds varied clearly in both genders depending on the age groups. For smoking men, generally, taste sensitivity was lowered. In two youngest and three oldest age groups NaCl sensitivity threshold was higher by 2.5%, 92.6% ($p < 0.001$), 22.2%, 24.5% and 15.5% respectively (Fig. 3). Smoking women of the youngest age group were characterized by the identification threshold 195.8% higher ($p < 0.001$) in comparison to non-smokers of the same age. In the next age group, salty taste identification threshold was slightly (4.2%) lower than in case of non-smokers. The remaining age groups exhibited irrelevantly higher identification thresholds (of 10.7%, 16.7%, 60.0% and 35.5% respectively) (Fig. 3). The differences between male and female sensitivity for salty taste were, in almost all the cases, statistically irrelevant. The only exceptions were



A – men; B – women

Fig. 1. Percentage of people complying with sensory minimums of examined tastes

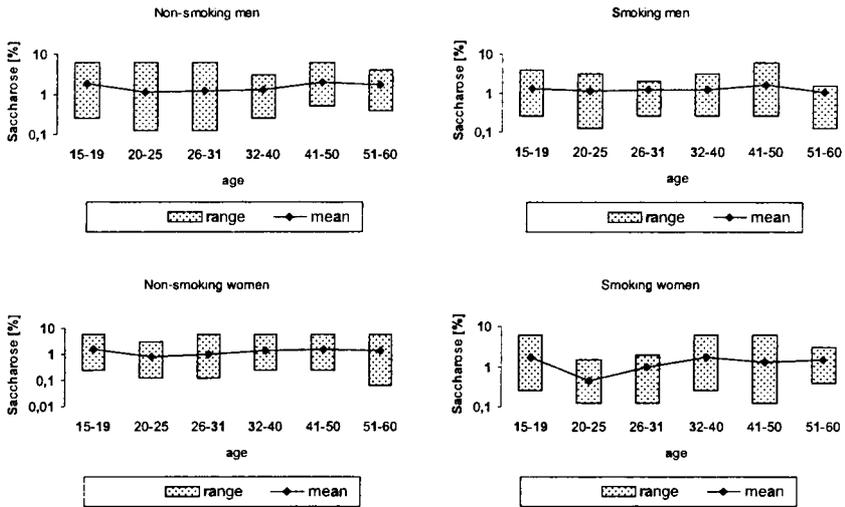


Fig. 2. Sweet taste identification threshold for smoking and non-smoking men and women

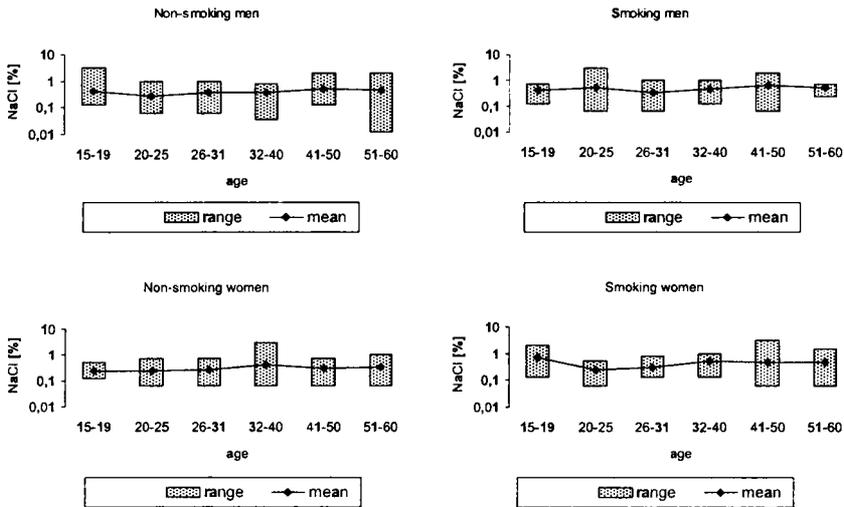


Fig. 3. Salty taste identification threshold for smoking and non-smoking men and women

young non-smoking men, whose identification threshold was statistically relevantly higher ($p < 0.001$) when compared to non-smoking women of the same age.

The sensitivity for sour taste differed relatively greatly in individual groups of men and women (Fig. 4). Smoking men from the two youngest age groups were characterized

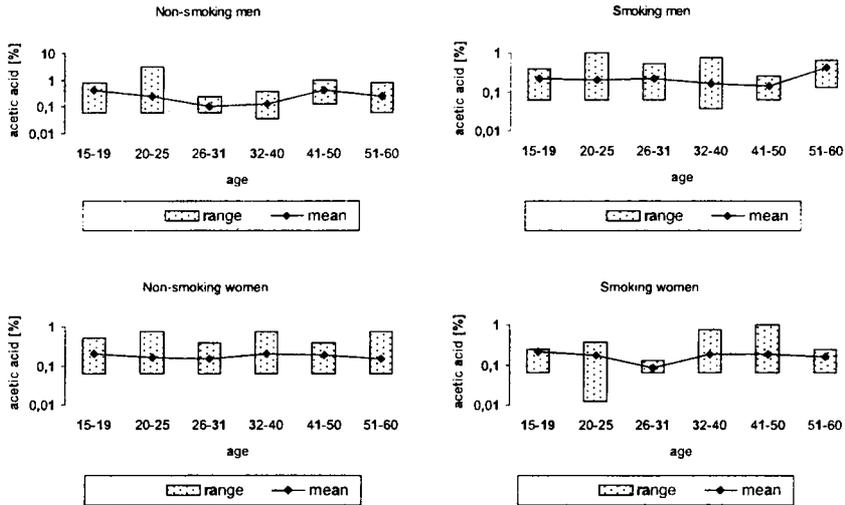


Fig. 4. Sour taste identification threshold for smoking and non-smoking men and women

by an irrelevantly lower sour taste identification threshold by 44.8% and 17.3% respectively. Smokers aged 26–31 and 32–40 showed identification thresholds higher by 107.7% ($p < 0.05$) and 33.3% respectively in comparison to non-smokers. At the 41–50 age group identification threshold was relevantly lower (by 64.3% with $P < 0.05$) in comparison to non-smokers. In the oldest group identification threshold values were higher than in non-smokers by 84.0% (Fig. 4). In case of smoking women from the two youngest age groups sour taste identification threshold was irrelevantly higher (by 5.4% and 4.3% respectively). In the next three age groups smokers were characterized by lower identification threshold by 44.1% ($p < 0.05$), 6.7% and 3.3% respectively. In the oldest group smoking women exhibited slightly higher identification threshold (by 2.6%) when compared to non-smokers of the same age. Statistically relevant sex differences in sour taste sensitivity were observed in non-smokers from 15–19 and 41–50 age groups (in both cases $p < 0.01$) and in smokers from 51–60 age group ($p < 0.001$).

The experiment showed great diversity in bitter taste identification thresholds in various groups (Fig. 5). Smoking men from the youngest and oldest age groups exhibited an irrelevantly lower quinine identification threshold (by 73.3% and 18.6% respectively). In the remaining four age groups smokers had identification thresholds higher by 116.3%, 524.0%, 75.7% and 83.9% respectively. The observed differences turned out to be statistically irrelevant (Fig. 5). Smoking women from 15–19, 26–31, 32–40 and 51–60 age groups appeared to have bitter taste identification threshold lower by 29.5%, 53.3%, 50.5% and 23.8% respectively in comparison to non-smokers. However, these differences did not reach statistical relevance levels. In case of smoking women from 20–25 and 41–50

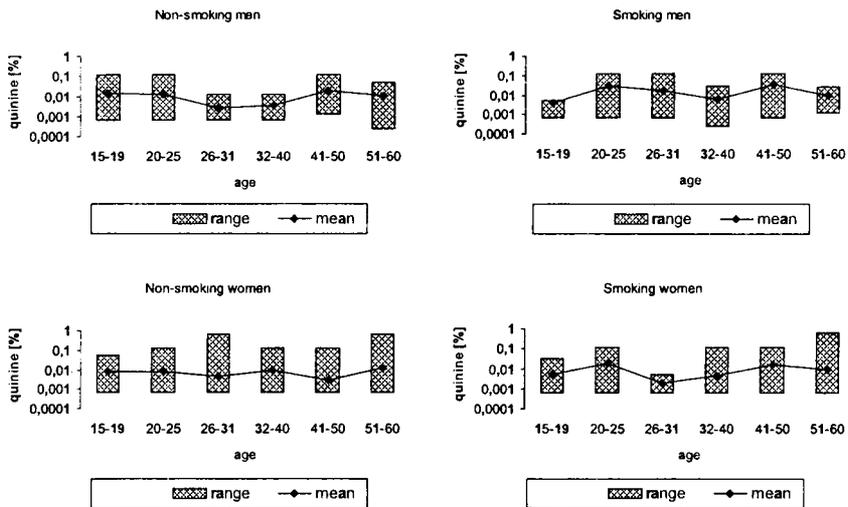


Fig. 5. Bitter taste identification threshold for smoking and non-smoking men and women

age groups quinine identification level was irrelevantly higher than in non-smokers by 117.4% and 416.7% respectively (Fig. 5). In almost all the instances, sex differences were statistically irrelevant. Only in the case of non-smoking men aged 41–50 identification threshold for this taste was relevantly higher in comparison to non-smoking women of the same age ($p < 0.05$).

DISCUSSION

The conducted research showed that individual sensitivity thresholds vary to a great extent as regards concentrations of the tested taste substances.

It appears that the observed diversity of taste sensitivity is connected with a smaller or bigger number of receptors in individual people.

According to Kiechajov (4), each man has a certain taste threshold that is usually unstable and changes even within one day depending on changes in the body. The author claims that numerous exogenous factors can influence taste perception to a great extent as they might change not only the activity of taste analyzer but also its morphology.

Individual values of sensitivity thresholds for stimulus substances and minimum sensory values obtained in this work showed that there are numerous individuals within the examined group who identify given tastes at concentrations definitely higher than mean threshold values. It might be supposed that these were the cases of hypogeusia. Several instances of complete inability to perceive sweet and bitter tastes were also observed

within the tested population. As has already been mentioned in the introduction, taste disorders such as hypogeusia or ageusia can have numerous causes. Taste deficits can be related to, among other things, excessive use of spices, activity of some drugs or congenital tongue disorders. Taste sense disturbances can occur after severe virus infections, they are also often associated with other illnesses, including diabetes, multiple sclerosis, tongue or sinus tumours or cerebral circulation disorders (Tilgner and Baryłko-Pikielna, 14; Pietruski, 9).

Taste disturbances, including even a complete loss of this sense, can occur in case of people working in unfavourable micro-climatic conditions. Then, the nature of taste damage is secondary as a result of disappearance of mucus layer (Borsuk et al., 2). The taste is weakened when the level of trace elements (such as copper, nickel or zinc) in bodies is lowered (Schneider, 11).

In the present research it was not possible to determine causes of hypogeusia and ageusia as the examined people were not questioned about illnesses incurred, present health, taken drugs or food habits.

This research showed that cigarette smoking influences taste sensitivity of the examined people only to a little extent. The obtained results correspond to the results of Tilgner and Baryłko-Pikielna's experiments (14). These authors have discovered that there are only slight differences in taste perception between cigarette smokers and non-smokers while the number of people who comply to sensory minimums is similar in both smoking and non-smoking groups.

There are also bibliographical data showing that cigarette smoking markedly decreases taste sensitivity (Pietruski, 8; Schoenborn et al., 10). Schoenborn's et al. (10) experiment involving groups of smoking and non-smoking students aged 21 to 23 proved that cigarette smoking greatly increases taste receptors' activity thresholds. In case of smokers, these thresholds were higher by 68.3%, 35.3% and 22.6% at the tip, center and basis of the tongue respectively in comparison to non-smokers; they were also statistically relevant. The author suggests that this marked decrease of taste sensitivity in smokers is caused by the toxic influence of products of dry distillation of tobacco on taste receptors. These substances are inhaled while smoking.

It seems that the reason for the above-mentioned differences as regards the influence of cigarette smoking on taste sensitivity may be various methods of its determination. In the case of this research as well as Tilgner and Baryłko-Pikielna's experiment (14) a method of stimulus substance concentrations was used while the research conducted by Pietruski (8, 9) and Schoenborn (10) was based on electrogustometry.

Test solutions used in typical, organoleptic taste examination method are applied onto the wet side of the tongue; then they spread and reach areas which are not being examined thus stimulating other receptors situated in the mucus layer of the oral cavity. It is known that taste impressions depend not only on the stimulation of taste buds but also on smell, touch, temperature or even pain impressions. The spreading stimulus substance can, additionally, stimulate nerve IX (Pietruski, 8, 9). Therefore, even people with

huge taste sensitivity deficits can, using this method, identify stimulus substances by means of other kinds of perception. To give an example, it is possible to identify sugar solution thanks to the impression of stickiness perceived by deep sensation of the tongue, which in this area is possible thanks to the tongue nerve devoid of taste fibre. The same is the case with bitter solutions, especially those of higher concentrations. They make an impression of "contraction" and therefore can be identified even by people with considerable taste deficits.

Electrogustometry is based on taste impressions caused by direct current of very small intensity when the active electrode touches the tongue. It is a more objective method: it allows to determine taste perception thresholds in any selected part of the tongue. At the same time, deep sensation nerve ends are not irritated (Pietruski, 8).

The conducted experiment showed no clear dependence between identification threshold of the four basic tastes and age. The obtained results are confirmed by the research of such authors as Kluyskens and Vandenhove (5), Moszyński (6), who did not observe a marked decrease of taste sensitivity of elderly people. It should be noticed, however, that bibliographical data dealing with dependencies between taste sensitivity and the age of the examined people are not unambiguous. Trygg (15) has the most extreme opinion: according to him, thresh identification threshold does not depend on age. However, there exist numerous experiments, conducted both by means of the traditional organoleptic method and electrogustometry, which prove that taste sensitivity decreases with age and the increase of identification thresholds for individual taste substances is not parallel (Hinchcliffe, 3; Tilgner and Baryko-Pikielna, 14; Wójcik, 16).

The conducted research showed that taste perception is, to some extent, dependent on gender. Generally, women exhibit greater taste sensitivity than men. The difference might be of hormonal nature. It is confirmed by Hinchcliffe, who described decreased taste sensitivity of women during maternity period. Bibliographical data do not clearly point, however, to the dependence on taste sensitivity and sex. Tilgner and Baryko-Pikielna (14) describe considerable differences in sensitivity thresholds levels between men and women as regards sweet, salty and sour tastes. They did not observe, however, any changes of bitter taste. Hinchcliffe (3) and Kluyskens and Vandenhove (5) did not notice any differences in taste perception caused by sex. Also Wójcik's experiments (16) pointed to no relevant differences in taste identification levels between men and women despite using both traditional and electrogustometric methods of taste sensitivity determination.

It appears that the discrepancies mentioned above concerning the influence of age and sex on taste sensitivity can be linked to great individual differences mentioned earlier and lack of stability of taste identification thresholds described by Kiechajov (4). In order to explain this phenomenon one needs to conduct research in which the influence of numerous endo- and exogenous factors that influence the activity of taste analyzers would be reduced to minimum.

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SUMMARY

In this work we have ventured to establish the dependencies between taste sensitivity for four basic tastes: sweet, salty, sour and bitter and endogenous factors such as sex and age and one exogenous factor, namely cigarette smoking. 471 randomly selected people, including 194 men and 277 women of different age were examined. Individual taste sensitivity was determined in the examined group, by means of saccharose, sodium chloride, acetic acid and quinine solutions. This examination showed that individual sensitivity limits range greatly to encompass varying concentrations of given taste substances. Values of individual sensitivity thresholds for stimulus substances and sensory minimum values obtained in this work showed that a substantial part of the examined people identified individual tastes at concentrations to a great extent exceeding mean threshold values. It can be supposed that those were cases of hypogeusia. There were also some instances of ageusia – a complete lack of sensitivity for sweet and bitter tastes. It was showed that cigarette smoking influences taste sensitivity of the examined people to a small extent. The changes observed were diversified and, in the majority of cases, statistically irrelevant. It can be assumed that taste receptor deficits caused by toxic compounds present in cigarette smoke are compensated by other senses. The conducted research pointed to no particular connection between identification thresholds of four basic senses and the age of the examined people. It can be caused by great diversification of individual threshold values. The research shows that, to a certain extent, taste sensitivity depends on gender. Generally speaking, women exhibit greater taste sensitivity in comparison to men. It seems that these differences are of hormonal nature.

Percepcja smakowa u palaczy tytoniu

W pracy podjęto próbę określenia zależności między wrażliwością smakową na cztery podstawowe smaki: słodki, słony, kwaśny i gorzki a takimi czynnikami endogennymi, jak płeć i wiek oraz czynnikiem egzogennym – paleniem tytoniu. Przebadano 471 losowo wybranych osób, w tym 194 mężczyzn i 277 kobiet w różnym wieku. U badanych osób określono indywidualną wrażliwość smakową metodą organoleptyczną, stosując roztwory sacharozy, chlorku sodu, kwasu octowego i chininy. Przeprowadzone badania wykazały, że indywidualne progi wrażliwości zawierają się w bardzo szerokich granicach stężeń testowanych substancji smakowych. Rozkład indywidualnych wartości progów wrażliwości na substancje bodźcowe i wartości minimum sensorycznego, uzyskany w niniejszej pracy, wykazał, że w badanej populacji znaczny odsetek stanowiły osoby identyfikujące poszczególne smaki przy stężeniach znacznie przekraczających przeciętne wartości progowe. Można przypuszczać, że były to przypadki hipogeusii. W przebadanej populacji zanotowano też kilka przypadków ageusii – całkowitej niewrażliwości na smak słodki i gorzki. Wykazano,

że palenie tytoniu w niewielkim stopniu wpływa na wrażliwość smakową badanych osób. Odnotowane zmiany były niejednokierunkowe i w większości przypadków statystycznie nieistotne. Można sądzić, że upośledzenie receptorów smaku przez toksyczne składniki dymu tytoniowego jest rekompensowane przez inne rodzaje czucia. Przeprowadzone badania wykazały brak wyraźnej zależności między progami identyfikacji czterech podstawowych smaków a wiekiem. Brak ten może wynikać ze znacznego zróżnicowania indywidualnych wartości progowych. Uzyskane dane wskazują na to, że wrażliwość smakowa w pewnym stopniu uzależniona jest od płci. Ogólnie biorąc, kobiety charakteryzują się większą wrażliwością smakową aniżeli mężczyźni. Wydaje się, że odnotowane różnice mają podłoże hormonalne.