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Differences in the Liking of Sweet Tastes of Different Sources (Natural and Artificial) among Older Adolescents in Slovenia

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ABSTRACT

The aim of this research paper is to investigate the recognition and liking of sweet tastes among older adolescents (19–21 years), and in doing so determine whether any differences exist in the liking of sweet tastes with respect to their differing sources (i.e. either of natural or artificial origin). With this aim in mind, data was obtained from sensory testing performed on a total of 101 participants between 19 and 21 years of age, of whom 60 were female and 41 male. Recognition of the basic tastes (i.e. sweet, salty, sour and bitter) was found to be good among most respondents and its success unrelated to gender. Furthermore, participants were found to demonstrate no difficulties with respect to the correct ordering of solutions of different intensities of sweetness (or, rather, of different concentrations of sucrose in water), regardless of gender. The most liked concentration among both men and women was 4.3%. Also established were differences in the liking of sweet tastes of different sources (i.e. natural and artificial). Participants were offered the most generally liked solution of sucrose in water (4.3%) as well as a number of table-top sweeteners prepared, in accordance with their packaging instructions, to be of comparable gustatory sweetness to the sucrose solution. In this endeavour, the selection of solutes was informed by the availability of table-top sweeteners among the five largest commercial producers, and involved those commercially sold under the names stevia, birch sugar, liquid sweetener (Na cyclamate, Na saccharin, thaumatin), sucralose, erythrol, fructose, Streusüße (sorbitol and saccharin). It was found that the most liked sweet tastes were those of sucrose and sucralose, while the taste of fructose was in third place albeit statistically significantly less liked than the tastes of sucrose and sucralose. Although the results of average values indicate that all kinds of sweet tastes are moderately liked, the liking of stevia and erythrol was found to be statistically significantly lower than the liking of sucrose and sucralose. From this, we conclude that artificial sweeteners are gaining in likeability, but even so, of the three most generally liked sources of sweet taste, two are natural sugars.

Key words: *sweet taste, liking of sweet taste, sucrose, artificial sweeteners, adolescents*

Introduction

The aim of this paper is to investigate the recognition and liking of sweet tastes among older adolescents, as well as their preferences for sweet tastes of natural or else artificial sources. In this, adolescents are considered to be a special sociological group.[1]

Adolescence presents an affective, turbulent, sensitive and sometimes unpredictable period within human development, and one that as a result of physical, psychological and physiological transformation allows for the formation and entrenchment of different patterns of behavior that are extremely sensitive to internal and external change. At the same time, the period presents the last step of the path to a calmer and more developmentally predictable adulthood.[2]

Healthy nutritional habits acquired during adolescence form the foundations of good health and further development later in life. A balanced diet plays a key role in the maintenance and promotion of good health throughout life.[3, 4]

In the Resolution on the National Programme of Nutrition and Physical Activity 2015–2025[5], it came to light that adolescents in Slovenia display poor nutritional habits (i.e. excessive average intake of energy, excessive intake of total fats and trans fatty acids, excessive intake of salt,

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insufficient intake of vegetables, physical inactivity, excessive consumption of sugary drinks, insufficient intake of water, and an inadequate number and inappropriate distribution of meals), resulting in an increase in the incidence of chronic non-infectious diseases among the population of adolescents.[4]

Kobal[6] distinguishes between the following stages of adolescence: early adolescence, lasting approximately from the 10th–11th to the 12th–14th year; followed by middle adolescence, approximately from the 15th to the 19th year, and late adolescence, from the 20th to the 22nd, 23rd or 24th year. The World Health Organization (WHO) defines "adolescents" as individuals in the age group between 10 and 19 years and "youth" as those in the age group between 15 and 24 years, while "young people" is used to cover the entire age range between 10 and 24.[7]

The sensation of sweet taste is considered to be innately attractive to humans and an indicator of the nutritional capacity in nature.[8] However, the abundance of sugars in the modern diet has demonstrably contributed to increased body mass/obesity and the early onset of type II diabetes, i.e. adult-onset diabetes.[9] Compounded by the problem of caries, increasing numbers of artificial, energy-poor sugars, i.e. sweeteners, have been developed, and discussions of their impact on the human body over a long and regular period of consumption have begun to proliferate. Today, artificial sweeteners are present in numerous products, from food to personal care products and medications.[10] They are used in the highest proportions by patients (particularly diabetics) and people of excess weight. According to data available for 2016, over half of the population of Slovenia (56.3%) as well as 17.6% of adolescents in Slovenia are overfed and obese. Particularly concerning is the proportion of diabetics among the population, which increased by 29% from 2009 to 2018. Concurrently, the share of consumers who regularly use sweeteners (e.g. beverages with added sweeteners) has also increased.[11]

The mechanism that allows for the recognition of sweet tastes in humans is complicated. In general, the recognition of tastes of different modalities begins with tastants, water-soluble molecules that react with ingested liquids and saliva to generate tastes. These are recognised by taste receptor cells (TRCs), which are organised into gustatory clusters, nodular (papillary) structures embedded into taste buds in the areas of the tongue, palate and throat. Different TRC cells are geared towards recognising different individual taste modalities by first receiving a tastant input signal that then travels further towards afferent ganglion neurons and, passing to the central nervous system, converges to neurons in the solitary tract nucleus.[12]

It has been demonstrated on mice that for the recognition of sweet as well as bitter tastes specifically, the proteins known as semaphorin 7A and semaphorin 3A are crucial in this process of signalling between the TRC receptors and the hindbrain.[13] Evidently, there are TRC sensitive to sweet and those sensitive to bitter compounds. TRCs must form connections with specific ganglion neurons in order to faithfully transmit taste information to the brain. Two semaphorins, SEMA3A and SEMA7A, are especially enriched in bitter and sweet TRCs.[13]

In the primary gustatory cortex, both sweet and bitter neurons are organised into a spatial map in which the qualities of evoked individual flavours are expressed within different cortical fields.[14,15] As in the case of the other tastes, current views on neurotransmission that encodes sweet tastes specifically support the general model of separate populations of dopaminergic neurons that encode nutritional and gustatory values of sweet substances, allowing humans to give preference to the consumption of energy-rich substances.[16,17] TRC cells that detect stimuli typically described as evoking sensations of sweet taste express the heterodimers TAS1R2 and TAS1R3[18], which belong to G-protein-coupled receptors of class C (GPCR).[19]

Typically, what registers as "sweet" is a number of plant-derived carbohydrates found in nature. These include monosaccharides (isomers of $C_6H_{12}O_6$) such as glucose, fructose and galactose as well as disaccharides (isomers of $C_{12}H_{22}O_{11}$) such as sucrose, lactose and trehalose. Additionally, through TAS1R2 and TASR3 heterodimers, other, diverse compounds such as polyols (e.g. sorbitol, mannitol and xylitol), D-amino acids (e.g. D-tryptophan), proteins (e.g. thaumatin) and various synthetic substitutes for sugar, i.e. sweeteners (e.g. saccharin, sucralose, aspartame etc.) may also engender the recognition of sweet tastes.[16]

Non-caloric synthetic substitutes for sugars, i.e. sweeteners, have been developed partially in order to allow for weight loss and address the needs of diabetics. However, due to the above-described processes of encoding of sweet tastes during neurotransmission, as part of which people can sense and give preference to the consumption of energy-rich sweet substances[16,17], it is not clear that energy-depleted sweeteners can in fact have a substantial impact on weight loss.[17]

Sweeteners are defined as substances used for the sweetening of foodstuffs or as table-top sweeteners, and are considered additives.[20] If used as table-top sweeteners, manufacturers must provide the consumer with information regarding their safe use. All sweeteners approved in the European Union and contained in Regulation (EZ) No. 1333/2008 may be used as sweeteners (Table 1).[21]

Sweeteners may be classified according to their source, nutritional value, or intensity of sweetness.[22]

Material and Methods

The participants involved in the study were 101 older adolescents (aged 19–21), over the period from October 2018 to May 2019. Out of 101 respondents, 60 were female (59.4%) and 41 male (40.9%). The largest proportion of respondents come from the Osrednjeslovenska (Central Slovenian) statistical region. The latter is, as indicated by its name, central as well as the most densely populated,

TABLE 1

LIST OF SWEETENERS PERMITTED IN THE EUROPEAN UNION22

E420	Sorbitol (ii) Sorbitol syrup	E960	Stevioside
E421	Mannitol	E961	Neotame
E950	Acesulfame K	E962	Aspartame-acesulfame salt
E951	Aspartame	E964	Polyglycitol syrup
E952	Cyclamic acid and its sodium and calcium salts	E965	Maltitol Maltitol syrup
E953	Isomalt		
E954	Saccharin and its sodium, potassium and calcium salts	E966	Lactitol
E955	Sucralose	E967	Xylitol
E957	Thaumatin	E968	Erythritol
E959	Neohesperidin DC	E969	Advantame

the largest in terms of population, and the second largest in terms of area within Slovenia. In accordance with to the latest available data, in 2018, over a quarter of the population of Slovenia (26%) was resident in the Central Slovenian statistical region. The difference between the number of men and the number of women in the region was the largest nationally: women predominated, and there were almost 10,000 more than men. The average age of the population was also the lowest nationally (41.9 years), while the population density was the highest (233 inhabitants per square kilometre).[23]

For the purposes of the research, we performed the following sensorical tests:

Test of basic tastes recognition (in accordance with ISO standards)

This test was intended to test participants' ability to recognise the four basic tastes: sweet, salty, sour, and bitter. Testing was performed using test solutions of standard substances (SIST ISO 3972:2013): citric acid in order to form a sour solution (0.43 g/L), caffeine to form a bitter solution (0.195 g/L), sodium chloride to form a salty solution (1.19 g/L) and sucrose to form a sweet solution (5.79 g/L).[24]

Test of ranking by intensity of sweet taste (across five offered concentrations)

Participants were required to rank five different concentrations of sweet taste from least sweet to sweetest. They were given solutions (50 ml) of table sugar (sucrose) in water, and asked to rank them according to the perceived intensity of the sweet taste. One sample solution consisted of only water, while the rest involved differing concentrations of sucrose (of 2.4%, 4.3%, 7.7%, 13.7% g/100 g).

Test of preference of sweet taste (across five offered concentrations)

Respondents were required to rank five different concentrations of sweet taste with respect to liking. The solutions represented different concentrations of sucrose in water (only water, 2.4%, 4.3%, 7.7%, 13.7% g/100 g), and there were five different descriptors of likeability: "I do not like it at all," "I do not like it," "I might like it, I might not like it," "I like it," and "I like it very much."

Test of preference for different kinds of sweet taste (natural and artificial)

Participants were instructed to taste solutions of sweet taste of different origins and rank them against each other with respect to liking, rating each on a scale from 1 to 5, with a score of 1 corresponding to "like least" and a score of 5 to "like most." The respondents then received eight different solutions of sweet taste and expressed their liking for each on the scale from 1 to 5, with different sweet-tasting solutions allowed to receive the same grades if desired. The selection of solutions was based on the products offered by the five largest commercial producers of sugars and sweeteners in Slovenia, sold under the names: table sugar (sucrose), stevia, birch sugar, liquid sweetener (Na cyclamate, Na saccharin, thaumatin), sucralose, erythritol, fructose, Streusüße (sorbitol and saccharin).

Subjects were offered a solution (50 mL) of sucrose in water (4.3%) as well as alternative solutions (also 50 mL each) prepared, in accordance with the packaging instructions, to be of comparable gustatory sweetness to the solution of sucrose. Solutions, i.e. concentrations, were as follows: sucrose 43 g/L, stevia 6.2 g/L, birch sugar 43 g/L, liquid sweetener (Na cyclamate, Na saccharin, thaumatin) 3.5 ml/L, sucralose 4.3 g/L, erythritol 55.9 g/L, fructose 24.8 g/L, Streusüße (sorbitol and saccharin) 43 g/L.

The following statistical methods were used in the research: calculations of frequency (incidence) and proportion; calculations of proportions for questions with multiple possible answers; calculations of descriptive statistics and mean values: arithmetic mean (M), median (ME), standard deviation (SD), range (Min, Max), coefficients of asymmetry and of flatness (verification of normal distribution), chi-square test (Pearson's or equal probability test), t–test for independent samples, Mann-Whitney U test, Pearson's correlation coefficient and Spearman's correlation coefficient.

All presented graphs were formatted in MS Excel 2010, and the data were analysed with the aid of the programme SPSS (IBM SPSS Statistics).

Results

Recognition and distinguishing of basic tastes

From the share of participants who correctly recognised tastes (Table 2), it is evident that most respondents correctly recognised almost all tastes. The lowest proportion of correct answers is visible in the test of the recognition of bitter taste no. 2 (64.4%) – this was a bitter taste of the same concentration as bitter taste no. 1 that appeared after participants were presented with the latter and with water (67.3%). An interesting trend also emerged from the review of proportions by gender – a higher proportion of women (than men) correctly recognised both sweet- and both salty-tasting solutions, while a higher proportion of men (than women) correctly recognised both bitter- and both sour-tasting solutions as well as water.

TABLE 2

RESULTS OF TESTS OF RECOGNITION OF BASIC FLAVOURS (% OF RESPONDENTS WHO CORRECTLY IDENTIFIED EACH TASTE)

Recognition of Basic Tastes	Total	Gender	
		Women	Men
sweet 1	94.1 %	95.0 %	92.7 %
sweet 2	90.1 %	93.3 %	85.4 %
salty 1	93.1 %	93.3 %	92.7 %
salty 2	84.2 %	86.7 %	80.5 %
bitter 1	75.2 %	75.0 %	75.6 %
bitter 2	64.4 %	63.3 %	65.9 %
sour 1	91.1 %	90.0 %	92.7 %
sour 2	80.2 %	78.3 %	82.9 %
water	67.3 %	66.7 %	68.3 %

Participants successfully completed the test of recognition of basic tastes if they correctly recognised at least seven flavours. From the results, it is evident that the majority (76.2%) did so, while a weak quarter (23.8%) did not.

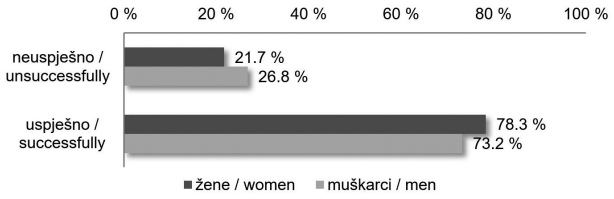

Fig. 1. Results of recognition of basic tastes with respect to gender.

From the results of shares by gender (Figure 1), it is evident that among those who successfully completed the test, there was a slightly higher proportion of women (than men) while among those who did successfully complete the test there was a slightly higher proportion of men (than women). Results of the chi-square test, however, indicate that there are no statistically significant differences in terms of successful completion of the test between the genders ($\chi 2 = 0.358$, $p = 0.549$). It is therefore possible to conclude that the recognition of basic tastes is fairly good in most respondents, and that the success of recognition is not related to gender.

Ranking by intensity of sweet taste

From the results (Table 3), it is evident that the participants did not have difficulty correctly ranking the sweet tastes with respect to intensity, as most respondents, regardless of gender, correctly classified different intensities thereof.

TABLE 3

TEST OF RANKING BY INTENSITY OF SWEET TASTES (% OF RESPONDENTS WHO CORRECTLY RANKED TASTES)

Evaluated solutions of sweet taste	Total	Gender	
		Women	Men
not sweet at all (water without sucrose)	99.0	100.0	97.6
slightly sweet (2.4% sucrose solution in water)	88.1	90.0	85.4
medium sweet (4.3 % sucrose solution in water)	85.1	85.0	85.4
sweet (7.7 % sucrose solution in water)	90.1	90.0	90.2
very sweet (13.7 % sucrose solution in water)	91.1	95.0	85.4

Liking of sweet taste (or of solutions, of different concentrations, of sucrose in water)

As it was determined that the recognition of basic tastes in most respondents is good and that respondents also experience no difficulties correctly classifying tastes by intensity, it was of interest to determine which concentrations of solutions of sweet taste participants prefer, i.e. mark with "most like" of the five solutions offered, one of only water and the others of 2.4%, 4.3%, 7.7%, 13.7% concentrations of sucrose in water.

In the group of 101 subjects, 42.6% of participants preferred the concentration of **4.3%**, 20.8% the concentration of 7.7%, and similar proportions of participants liked the concentrations of 2.4% (15.8%) and 13.7% (13.9%). The fewest participants (6.9%) opted for the taste of water (without any additional sweet taste) as their "favourite concentration". The concentration of sweet taste of 4.3% was the most popular among women (46.7%) as well as among men (36.6%). In the second place was the concentration of 7.7%, again both for women (20%) and for men (22%). In the third and fourth places for women were the concentrations of 2.4% (13.3%) and 13.7% (13.3%), while the concentration of 2.4% was the third most popular for men (19.5%) and the concentration of 13.7% (14.6%) only in fourth. Among those who opted for water without any added taste as the preferred solution were 6.7% of women and 7.3% of men.

All in all, it is possible to conclude that the most liked concentration of sweet taste among the respondents was the 4.3% solution of sucrose in water.

Liking of sweet tastes of different origins (from natural and artificial sugars):

In the investigation, it was of interest to examine whether there exist differences in the liking the sweet tastes of different sources (i.e. natural or artificial) among participants, under the assumption that two natural and common sugars in our diet (fructose and sucrose) would not necessarily be recognised as the most appealing. With the aid of calculations of coefficients of asymmetry and flatness, it was verified that, in this, the data obtained from the participants could be treated as approximately normally distributed, thus, the average value of liking (M) for each type of taste could be calculated (Table 4).

It is evident from the review of averages that the most liked sweet tastes were those of sucrose (M=3.26) and sucralose (M=3.26), while fructose (M=3.03) was in third place. Artificial sweeteners are gaining in popularity, but even so, two types of natural sugars were among the three most liked kinds of sweet tastes. However, the calculations of average values indicated that all types of sweet tastes are moderately liked (rounded value M=3), and only stevia (M = 2.37) and erythritol (M = 1.98) were on average less liked as tastes. With the aid of a t–test, it was verified that the average value of the third most liked kind of sweet taste is indeed statistically significantly different (p=0.041) from the first and second most liked. The taste of fructose is therefore statistically significantly less liked than the taste of sucrose and sucralose. With the aid of a t–test, it was also verified that the average value of the two least liked sweet tastes was statistically significantly different (p=0.000) from the first and second most liked tastes. The taste of stevia and erythritol are therefore also statistically significantly less liked than those of sucrose and sucralose.

TABLE 4

AVERAGE EXTENT OF LIKING OF SWEET TASTES (MIN 1–MAX 5)

Solutions of different sweet tastes	N	M	SD
Sucrose	101	3.26	1.163
Sucralose	101	3.26	1.128
Fructose	101	3.03	1.118
Streusüße (sorbitol and saccharin)	101	2.93	1.505
Liquid sweetener (Sodium cyclamate, sodium salt of saccharin, thaumatin)	101	2.75	1.170
Birch sugar (xylitol)	101	2.71	1.211
Stevia	101	2.37	1.065
Erythritol	101	1.98	1.249

Legend: N – number of participants, M – average degree of liking, SD – standard deviation.

Discussion and Conclusion

The investigation determined that the recognition of basic tastes is good in older adolescents, and success is unrelated to gender. If only sweet taste is singled out, it may be concluded that the vast majority of participants in the sensorical study correctly recognised sweet tastes, had no difficulty determining the order by intensity of sweet tastes, and most liked sweet tastes (sucrose solutions) in the concentration of 4.3%, the medium value among the concentrations offered (as well as closest to common concentrations of commercially available flavoured water).[25]

It was determined that the most liked sweet tastes among adolescents are those of sucrose and sucralose, while the taste of fructose is in the third place, statistically significantly less liked than that of the first two tastes. Although results of average values indicate that all types of sweet tastes are moderately liked, stevia and erythrol are also statistically significantly less liked than sucrose and sucralose.

The high likeability of sucralose as well as the medium likeability of all types of sweet tastes lead the investigators to consider that among the adolescent participants in the study, there may be a high incidence of prior, long-term consumption and consequent habituation of artificial sweeteners.

Artificial sweeteners are evidently gaining in appeal, and have found their place in a wide range of products where they are less frequently used individually (mostly sucralose and steviol glycosides)[26] and more frequently in mixtures of different sweeteners.[27] This is because blends of different sweeteners have tastes more similar to that of sucrose, and when they overlap, undesired flavours of individual sweeteners are dissipated. They also usually work in synergy and therefore lesser amounts are needed; daily intakes are lower, as are the prices. Among adolescents, consumption of non-alcoholic beverages with blends of artificial sweeteners predominates; these include acesulfame K, aspartame, saccharins and cyclamates. The most common combination is that of acesulfame K and aspartame, of which the sweetness is up to 35% higher than when used individually. Saccharin and cyclamate are also frequently added to products, primarily because of their low cost.[27]

Among all categories of pre-packaged foods and beverages, artificial sweeteners most often appear in the categories of energy and sports drinks, soft drinks, and in powders intended for the preparation of beverages.[28]

Also common is Xylitol (birch sugar), particularly due to its function of preserving the oral cavity, as it does not cause caries since the bacteria in the oral cavity cannot ferment it and there is no drop in pH in the mouth[11, 29–,31], which has been confirmed by EFSA[32] in its two claims: "chewing gum, sweetened with 100% xylitol, has been shown to reduce dental plaque, with a large amount of dental plaque being a risk factor for caries in children" and "consumption of foods or beverages containing sweeteners instead of sugar helps preserve tooth mineralisation."

Artificial sweeteners may help reduce energy intake when used as a substitute for sugar in energy-rich foods and beverages. The benefits are more often apparent in drinks in which sugar is the main energy-rich ingredient. In other foods, the benefits are lesser, as the volume previously occupied by sugar is frequently simply replaced with another macronutrient. Still, in people whose natural sugar products were replaced with artificial sweeteners, it has been found that energy intake has decreased even when food intake was not limited. However, investigations of this sort often uncover very different reductions in energy intake, mainly depending on research design (type of sweetener used, type of food or beverage, existence of energy intake limitations etc.).[29] In spite of some evidence to this effects, the EFSA rejected the claim that sweeteners contribute to the loss of body mass (BMI). This is partly the consequence of a lack of sufficient evidence that sugar causes obesity, as well as the fact that the evident benefits of sweeteners have only been demonstrated to apply to the category of beverages.[11,33]

Although sweeteners are used to control BMI, some research has shown that sweeteners used for this purpose can also have a negative effect. Sweeteners may, for example, interfere with learnt control over energy intake, increase an individual's desire for sweet tastes (leading to overeating), or lead to a conscious overcompensation of "saved calories." However, such hypotheses have not been confirmed with certainty, so further research is needed in this area before any definitive claims can be made.[11, 34]

Apart from all this, the artificial sweetener sucralose, which is highly liked among older adolescents, has been the subject of a number of extensive safety assessments (studies of long-term exposure, reproductive and developmental effects, neurotoxicity, genotoxicity and carcinogenicity) by competent agencies around the world, which have concluded that it is safe to use in food and beverages.[35] Although some research has suggested possible risks due to carcinogenicity, a meta-analysis of studies up to 2016[11] has shown that even for intakes higher than the ADI (the acceptable daily intake in mg/kg of body weight/day), sucralose has no association with cancer development.[36] Several studies have also pointed out that sucralose may be affected by increased insulin secretion, changes in the perception of sweet tastes, increased or decreased appetite, and altered intestinal microflora. As this has only been shown in animal and case studies, there is insufficient evidence to generalise such effects to the population.[35] However, recent studies in humans also suggest that sucralose may have implications for reduced insulin sensitivity when ingested along with carbohydrates.[37] Researchers report that combining the two may alter the metabolisation of carbohydrates and reduce sensitivity to sugar and sweet taste.[11]

Overall, sweeteners can be useful for certain groups of the population, i.e. they serve their purpose effectively. The problem of excessive sugar intake among adolescents[38], however, cannot be solved by simply replacing sugar with sweeteners. Industry initiatives aimed at launching increasing varieties of non-alcoholic drinks without sweeteners (for example, flavoured water) [38] and presenting water as an alternative to sweet drinks may be more positive.

Hafner[11] considers how many soft drinks commercially available between the years 2017 and 2019 contain at least one sweetener and finds an increase from 13.2% in 2017 to 15.5% in 2019. The most commonly employed sweeteners in 2017 are acesulfame K, aspartame and cyclamates, while in 2019, the use of sucralose is increased. This is also reflected in the proven high likeability of sucralose among adolescent participants in the present investigation. It can be concluded that, among other things, it is the steeply increased use of sucralose, in particular, in soft drinks by 2019 that probably influenced the high likeability of sucralose among the participants in the present investigation, who were all tested in a similar time period. Perhaps this could be defined as a state of habituation, wherein the taste of sucralose becomes a "familiar taste" and at one point becomes more palatable than the taste of fructose – which the investigators consider to have concerning implications.

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RAZLIKE U SKLONOSTI SLATKIM OKUSIMA RAZLIČITIH IZVORA (PRIRODNIH I UMJETNIH) MEĐU STARIJIM ADOLESCENTIMA U SLOVENIJI

S A Ž E T A K

Cilj ovog istraživačkog rada je istražiti prepoznavanje i sklonost slatkim okusima kod starijih adolescenata (19–21 godina) i pritom utvrditi postoje li razlike u sklonostima slatkim okusima s obzirom na njihove različite izvore (tj. prirodnog ili umjetnog podrijetla). S tim ciljem, podaci su dobiveni senzornim testiranjem provedenim na ukupno 101 sudioniku u dobi od 19 do 21 godine, od kojih je 60 bilo djevojaka i 41 mladić. Utvrđeno je da je prepoznavanje osnovnih okusa (tj. slatko, slano, kiselo i gorko) dobro među većinom ispitanika, a uspješnost u tomu nije povezana sa spolom. Nadalje, utvrđeno je da sudionici ne pokazuju poteškoće s ispravnim redoslijedom otopina različitog intenziteta slatkoće (ili, bolje rečeno, različite koncentracije saharoze u vodi), bez obzira na spol. Omiljena koncentracija među muškarcima i ženama bila je 4,3%. Također su utvrđene razlike u sklonosti slatkim okusima različitih izvora (tj. prirodnih i umjetnih). Sudionicima je ponuđena najopćenitija otopina saharoze u vodi (4,3%), kao i niz stolnih zaslađivača pripremljenih u skladu s njihovim uputama za pakiranje, koji su okusne slatkoće usporedive s otopinom saharoze. U tom nastojanju odabir otopljenih tvari bio je utemeljen na dostupnosti stolnih zaslađivača među pet najvećih komercijalnih proizvođača, a uključivao je one koji se komercijalno prodaju pod nazivima stevija, brezin šećer, tekući zaslađivač (Na ciklamat, Na saharin, taumatin), sukraloza, eritrol, fruktoza, Streusüße (sorbitol i saharin). Utvrđeno je da su najdraži slatki okusi saharoze i sukraloze, dok je na trećem mjestu okus fruktoze, iako statistički značajno manje privlačan od okusa saharoze i sukraloze. Iako rezultati prosječnih vrijednosti pokazuju da su sve vrste slatkih okusa umjereno privlačne, pokazalo se da je sklonost steviji i eritrolu statistički značajno niža od saharoze i sukraloze. Iz ovoga zaključujemo da su umjetni zaslađivači možda sve popularniji, ali od tri općenito najdraža izvora slatkog okusa, dva su prirodni šećeri.