



The relationships between phenylthiocarbamide taste perception and smoking, work out habits and susceptibility to depression

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ABSTRACT

Phenylthiocarbamide (PTC) is known as phenylthiourea and it is an organic compound that has the phenyl ring. Ability to perceive the tastes of PTC chemical is related to the dominance of taste genes. There are a large number of population studies regarding the PTC taste perception and different personal characteristics or disease conditions. The purpose of this study is to reveal and compare the relation between the PTC taste perception and work-out habits, smoking, alcohol consumption and tendency to the depression of people. A total of 2500 adults were volunteered to be included in this study. PTC taste perception was measured by tasting with PTC solution (10 mg/L) filtered in a paper. It showed that tasters were significantly more frequent (81.8%) than nontasters (18.2%) in all population. And in some parameters analyzed in this study, there are significant differences. The taste genetics show up with environmental factors and create the sense of taste, which develops the feeding behaviors. The taste perception resulting from food and beverages diversifies by genetic and environmental effects and the nervous system interprets this perception. This study is enlightening in terms of presenting that the taste perception of people affects their lifestyles and lead them to start and either continue or discontinue some habits.

Introduction

Phenylthiocarbamide (PTC) is an organic compound having a phenyl ring which is also known as phenylthiourea (Padmavathi, 2013). Detecting the bitter taste of some substances such as Phenylthiocarbamide, Propylthiouracil or in other words, detecting the taste of N-C=S bond is a genetic feature showing bimodal distribution which is controlled by autosomal genes in accordance with Mendel Genetics (Kalmus and Hubbard, 1960; Saldhana and Becok, 1959; Stern, 1960; Kameswaran et al., 1974; Fischer et al., 1961; Bartoshuk, 2000; Blakeslee and Fox, 1932). These chemicals, depending on their genetic make-up, are distasteful for some people while they give the bitter taste to others. The people, who are very sensitive to these substances, are called supertasters and tasters who have homozygote dominant (TT) and heterozygote (Tt) genotypes respectively. The people who cannot get the taste of these substances are named as nontasters and they have homozygous recessive (tt) genotypes (Joiner and Perez, 2004; Fox, 1931; Bartoshuk et al., 1994; Duffy, 2004).

The allelic variation affecting the status of detecting the PTC/PROP tastes are located over chromosomes 5 and 7 in general (Duffy et al., 2004; Bufe, 2005; Tepper and Nurse, 1997). Thus, TAS2R38 polymorphisms that differ between individuals encode the functionally distinct

receptor types, which directly affect the perception of bitter taste in the compounds containing N-C=S. PTC/PROP detection tests are commonly performed on people, which give clues about the genetic structure and can be used as an endophenotypical marker (Padmavathi, 2013). Several studies were conducted in different geographies across the globe regarding the perception of PTC taste with different groups and communities (Guo and Reed, 2001). Considering the studies at the level of whole population, it has been observed that the rate of PTC nontasters varies between 1.4% and 66.7% in different groups and societies. According to these studies, the lowest rate for nontasters were obtained from a sample group of 70 people in North America; whereas the highest rate for nontasters were obtained from a sample group of 114 people in India (Guo and Reed, 2001). As a result of the population studies, it has been shown that the rate of PTC/PROP tasters varies in different societies and even in different groups of the societies. Anthropometric characters have been used to describe racial classifications for many years. However, the use of genetic characters is much more advantageous in terms of understanding the dynamics of human population genetics. Today, many polymorphic genetic markers are used for better understanding of human diversity

(Padmavathi, 2013).

There are many studies conducted to obtain data related to PTC/PROP taste perceptions at population levels and to compare the disease cases and various personal characteristics regarding the perception of taste. It has been determined that there are differences between tasters and nontasters of these chemicals in terms of their personality styles and susceptibility to certain diseases like goiter, diabetes, peptic ulcer, depression, alcoholism and schizophrenia (Dicarlo and Powers, 2001; Fischer et al., 1963; Kaplan et al., 1964; Henkin and Gillis, 1977; Harris et al., 1949; Kitchin et al., 1959; Memoria 1959; Brand 1963; Hollingsworth 1963; Compton et al., 2007; Moberg, 2005). Further studies are needed to investigate the relationship with different health problems. The aim of this study is investigating the relationship between the PTC taste perception and smoking and alcohol consumption, which affect the human life negatively and cause a variety of diseases, and the depression problem that we often encounter in today's living conditions. On the other hand, the correlation between the PTC taste perception and tendency of people to have regular work out activities were examined. Eventually, within this study, the connection between lifestyles of people depending on their habits and their PTC taste perceptions has been presented.

Methodology

Establishment of the Working Group

A total of 2500 adults (1510 female, 990 male) were volunteered to be included in this study from locals of Sivas and also the students of Sivas Cumhuriyet University. All participants were selected from healthy people, who don't have any upper respiratory infections, any treatment during the study and any problems related to taste/odor perception. Furthermore, the people with chronic sinusitis, chronic lung disease, diabetes, psychiatric disorders and taste disorders or dry mouth problems were excluded from the study. The study was initiated after receiving the approval of Cumhuriyet University Local Ethical Committee (decision number: 50/1552). The PTC perception, gender, eating habits, tea and coffee drinking habits, height, weight characteristics, age, information, regular exercise habits and body mass index (BMI) of the people were collected in a regular survey form and evaluated. The Body Mass Indexes were used, which are also used by the Ministry of Health, for BMI values of individuals.

Preparation of PTC Solution

In this study, the PTC solution was prepared by making some updates on the Harris and Kalmus (1949) method (Harris and Kalmus, 1949). PTC solution (10 mg/L) was absorbed into the filter paper (Zhao et al., 2003). On the other hand, since the responses of the people to PTC/PROP solutions may be relative, NaCl solution was used as the control solution; because the response of people to NaCl solution is always same. Therefore, tap water and NaCl solutions are used as control solutions in many studies to examine the taste

perceptions. PTC and NaCl solutions were prepared in tap water and on the hot plate by dissolving the dust chemicals in the solution with continuous stirring. The solution was stored at +4°C until it is used and kept in the room temperature before use (Tepper et al., 2001; Scott, 2004).

Applying the Taste Test

Some questions were asked to the participants such as whether they have smoked, eaten any food or drunk anything one hour prior to the taste test; if they have done one of these, the test was postponed for an hour. The methods used in the studies of Azevedo et al. (1965) and Tepper et al. (2001) were preferred while conducting experimental practices on people (Tepper et al., 2001; Azevedo et al., 1965). People were asked to rinse their mouth with tap water before starting the experiment and the same procedure was performed after each practice. After applying the PTC absorbed filter paper on the tongue for 30 seconds, their perceptions were asked if they have received any taste or any bitter taste. During the experimental practices, the individuals have stayed in a quiet environment without seeing each other. For those who did not mention any certain taste, the experiment was repeated in the next day. The individuals, who said that they did not taste anything and perceived the taste of NaCl, were classified as PTC nontasters. Those who perceived the taste of PTC solution were classified as PTC taster individuals.

Data Analysis

SPSS ver 22.0 software packages were employed for the purpose of statistical analyzes of the data obtained. Chi-square analysis was performed between individual characteristics and perceptions of PTC.

Results

A total of 2500 volunteers participated in our study, in which we have investigated the relationship between the perception of PTC taste and the lifestyle habits of people depending on some habits. The age of participants ranged from 15 to 65. PTC taste test was applied and the ratio of the individuals who can detect the PTC taste in our sample group has been identified according to the data obtained. According to these data, 81.8% of the people included in our study could detect the taste PTC, whereas the remaining 18.2% couldn't detect it. These rates are 83.4% and 16.6% in females and 79.4% and 20.6% in males, respectively (Table 1). Similar to the previous studies, it has been seen that the females are more sensitive in detecting the taste of PTC compared to the males (Duffy, 2004).

Considering the PTC perception levels of the individuals, who drink alcohol regularly and never drink, 83.3% of the individuals, who don't drink alcohol, can detect the taste of PTC, whereas this rate is 76.6% for those who drink alcohol regularly (Table 2). According to Pearson Chi-square analysis, the difference between two groups is important ($P \leq 0.05$). When individuals based on their smoking habits included in the study, the rate of

those who can detect the taste of PTC is 83.1% among non-smokers, which is higher than the rate of smokers. According to the data we have obtained, the ratio of PTC tasters are higher in non-smokers and is significant ($P \leq 0.05$) (Table 3).

According to the individuals, whom we have conducted the study of the PCT taste perception with, based on their family members whether any first-degree relatives are diagnosed with depression, the data obtained were found to be very significant ($P \leq 0.05$). According to this, the rate of those, who have a first-degree relative diagnosed with depression, was 87.3% in terms of detecting the taste of PTC. Accordingly, it has been seen

that the frequency of PTC tasters is higher it those, who have a first-degree relative diagnosed with depression (Table 4).

When we compared the PTC perception of the individuals by grouping them based on their regular work out activities; their PTC perception frequencies are close to each other. The rate of those who can detect the taste of PTC was 80.9% in the group with regular work out activities, whereas this rate was found as 82% in the other group who do not work out regularly. According to Pearson Chi-square test result, the difference between the groups $P = 0.591$ indicating that it is not significant ($P \geq 0.05$) (Table 5).

Table 1 Comparison of gender and PTC perception of individuals

Individuals			PTC		Total	P Value
			Tasted	Not Tasted		
Gender	Female	Count % within Gender	1259 83.4%	251 16.6%	1510 100.0%	P=0.012
	Male	Count % within Gender	786 79.4%	204 20.6%	990 100.0%	
Total		Count	2045	455	2500	
		% within Gender	81.8%	18.2%	100.0%	

Table 2 Comparison of alcohol consumption and PTC perception of individuals

Individuals			PTC		Total	P Value
			Tasted	Not Tasted		
Alcohol	Yes	Count % within Alcohol	432 76.6%	132 23.4%	564 100.0%	P=0.001
	No	Count % within Alcohol	1613 83.3%	323 16.7%	1936 100.0%	
Total		Count	2045	455	2500	
		% within Alcohol	81.8%	18.2%	100.0%	

Table 3 Comparison of smoking habits and PTC perception of the individuals

Individuals			PTC		Total	P Value
			Tasted	Not tasted		
Smoking	Yes	Count % within Smoking	628 79.0%	167 21.0%	795 100.0%	P=0.013
	No	Count % within Smoking	1417 83.1%	288 16.9%	1705 100.0%	
Total		Count	2045	455	2500	
		% within Smoking	81.8%	18.2%	100.0%	

Table 4 Comparing those who have relatives diagnosed with depression and their PTC perceptions

Individuals			PTC		Total	P Value
			Tasted	Not Tasted		
Depression Disease Story	Yes	Count % within Use of Depression Drugs	316 87.3%	46 12.7%	362 100.0%	P=0.003
	No	Count % within Use of Depression Drugs	1729 80.9%	409 19.1%	2138 100.0%	
Total		Count	2045	455	2500	
		% within Use of Depression Drugs	81.8%	18.2%	100.0%	

Table 5 Comparing the PTC perception and regular work out activities of the individuals

Individuals			PTC		Total	P Value
			Tasted	Not Tasted		
Work Out	Yes	Count % within work out	369 80.9%	87 19.1%	456 100.0%	P=0.591
	No	Count % within work out	1676 82.0%	368 18.0%	2044 100.0%	
Total		Count	2045	455	2500	
		% within work out	81.8%	18.2%	100.0%	

Table 6 PTC perception frequencies of individuals based on their ages

Individuals			PTC		Total	P Value
			Tasted	Not tasted		
Age	Young Group 14-29	Count	1786	431	2217	P=0.001
		% within Age Group	80.6%	19.4%	100,0%	
	Middle Age Group 30-49	Count	196	13	209	
		% within Age Group	93.8%	6.2%	100,0%	
	Elders 50<	Count	63	11	74	
		% within Age Group	85.1%	14.9%	100,0%	
Total		Count	2045	455	2500	
		% within Age Group	81,8%	18.2%	100.0%	

The volunteers, who were included in the study to identify the PTC perception frequencies, were grouped under three classes according to their ages. As it can be seen on table 6, those who are between 14-29 years of age have formed the group of “Young”, while the age group of 30-49 refers to “Middle age” people and those who are over the age of 50 were classified as “Elders”. The PTC detection rates are 80.6%, 93.8% and 85.1% for these groups, respectively. According to Pearson chi-square analysis, these rates are very significant statically with the value of P=0.001. Especially the PTC perception frequency of middle age group is clearly higher that the frequencies of other groups with a rate of 93.8%. The lowest PTC perception frequency was seen in the “Young Age” group (Table 6).

Discussion

In this study, the correlation between detection of taste of PTC chemical and various habits of the individuals such as regular work out activities, use of alcohol and cigarette in their lifestyles and also depression stories of their members have been investigated. This is the most comprehensive research conducted in this area. The results are consistent with the studies of Saldanha (1962) regarding conducted in Portugal, Azevedo et al. (1965) conducted in Brazil and the results of Turkey mentioned in the study of Guo and Reed (2001) (Azevedo et al., 1965; Saldanha, 1962). According to the studies conducted so far, the distribution of PRC/PROP taste blindness (the ability and lack of detecting the taste of bitter chemicals) is as follows: 2.3-36.5% (Africa), 5.1-23% (China), 4.8-66.7% (India), 2.0-27.5% (Asia), 4.1-20.0% (Turkey), 49.3-50.0% (Australia), 6.9-36.8% (Europe) and 0-43.0% (USA), respectively (Guo and Reed, 2001; Tepper and Nurse, 1998; Saraswathi et al.,

2011; Tepper, 1998; Guo et al., 1998; Enoch et al., 2001). When the results compared with the results of a study mentioned in the book of Demirsoy (1998), which was conducted with 3643 people in Turkish community, it can be seen that the frequency of the taster individuals is higher in this study. According to the previous study, the percentage of the PTC taster individuals is 70.2%, whereas this rate is 29.8% for nontasters (Demirsoy, 1998). There are differences between the values in different communities depending on ethnic differences, variations in the experimental group and homogenization of the participant profile. One of the crucial points in this study is not making a distinction between the tasters and supertasters as it was not done by Whittemore (1986, 1990). Those who can detect the taste of PTC were considered as a single group and the others who cannot detect the taste of PTC were considered as another group. It is not a good idea to classify the tasters as supertasters (homozygous TT) and tasters (Tt) since no specific research was conducted with individuals on the level of genes related to the perception of PTC.

In the comparison of the females and males in terms of PTC perceptions; the PTC perception frequencies of the females are considerably higher than the PTC perception frequencies of males. This result is consistent with a variety of research conducted before (Bartoshuk, 1994; Harris and Kalmus, 1949; Sisodia and Rao, 1968).

In this study, alcohol consumption was one another parameter that we have investigated its relationship with detecting the taste of PTC. According to the data, difference of PTC perception sensitivity between those who drink alcohol and don't drink alcohol is found statically significant (P≤ 0.05). According to the results of previous studies, the supertasters of PTC don't like drinking alcohol that much and it has been thought that

they feel the oral burning and irritation of alcohol more severe than others (Bartoshuk et al., 1994). Therefore, in the population, it has been believed that the PTC tasters protect themselves against alcoholism. In contrast, it has been believed that since the nontasters have more insensitive against oral irritation and the bitter taste, they are more prone to alcoholism (Driscoll et al., 2006; Lanier et al., 2005; Prescott and Swain-Campbell, 2000). According to a study conducted with 3500 twin individuals in the United States, it has been reported that the taste heredity is controlled by direct and indirect mechanisms. Detecting the bitter taste of PTC/PROP is a phenotypic marker of a genetic variation on taste perception (Fox, 1931; Duffy, 2004; Harris and Kalmus, 1949). The previous studies have presented opposite results regarding the relationship between PTC/PROP perception and alcoholism.

Until now, various studies were conducted on the subject of a possible connection between PTC/PROP perceptions of individuals and their susceptibility to smoking. In general, it has been believed that the individuals who have a sensitivity of PTC perception don't consume substances such as cigarette and coffee that cause bitter taste and feeling of irritation in the mouth. It has been also presented that since the PTC nontasters cannot detect the bitter taste and dissatisfaction caused by smoking, they are in a tendency of smoking more cigarettes and they are at risk (Enoch et al., 2001). The results of this study support this information. In fact, the PTC perception frequency of nonsmokers is 83.1%. This rate was found as 79% in smokers. The difference between these groups is statically significant ($P \leq 0.05$) and this can be considered as evidence showing that there is a relationship between the tendency to be addicted to nicotine and PTC perception. The use of cigarette seems to be growing rapidly in younger generations. The regular smoking habit begins almost before adolescence period. Therefore, protection methods must be provided by identifying the causes make these children addicted to nicotine.

One another subject, in which the relationship with PTC perception of the individual is investigated, is the existence of a relative diagnosed with depression. In our study, similar to the previous studies, the relationship between PTC perception and having a first-degree relative diagnosed with depression was investigated. The results that we have obtained are extremely interesting. The difference between these two groups in terms of PTC perception frequency is statically significant ($P \leq 0.05$). The results that we have obtained are consistent with the results of some studies conducted previously, in which the relationship between depression and PTC has been investigated (Dicarlo and Powers, 1998). However, there are also some other studies suggesting that there are a few cases supporting the relationship between the PTC taste buds and family-basis depression, which contradict with our study. For sure, these are propositions depending on the probability and not every single person, who has a family member diagnosed with depression, is a PTC taster. In addition, as a result of food preferences, PTC

tasters can be vulnerable to major health problems such as cancer, depression and schizophrenia. In fact, there is evidence suggesting that PTC tasters are more anxious and nervous during personality formation compared to nontasters (Mascie-Taylor et al., 1983). Based on these personality results, Whittermore (1986, 1990) has stated that since PTC tasters have a tendency of being more anxious and nervous, they are more vulnerable to depression compared to nontasters (Whittermore, 1986, 1990). On the other hand, the gender and age variables should also be considered while evaluating the relationship between depression and PTC perception.

In this study, the relationship between regular work out habits of the individuals and their PTC perception has been investigated and no correlation has been identified between these two parameters. In fact, the PTC perception frequencies of both groups either work out or don't work out regularly, are close to each other and statically insignificant ($P \geq 0.05$).

Considering the method and sample group that we have created by optimizing in accordance with the studies in the literature; preparing a single PTC solution and conducting the taste test on people by absorbing the solution into a filter paper is sufficient in order to identify and compare the taste perception of individuals. It is an advantageous way in terms of providing the perceptions in a clear, quick, simple and affordable way (Tepper et al., 2001). In the study, we believe that we have stabilized the PTC perception by using the NaCl standard. In fact, similar methods were also used by some other studies in the literature (Dicarlo and Powers, 1998; Tepper et al., 2001; Bartoshuk et al. 1996; Prutkin et al., 2000; Prescott et al., 2004). Again, to ensure individuals' perception of taste, tap water is also used as well as NaCl solution to provide better comparisons.

In addition, it is also an important point that although the results of this study is consistent with the results of several studies conducted before, there are contradictions with some other studies (Guo and Reed, 2001). Due to the unreliable statistical factors, the results may be found as significant or insignificant by mistake. The small number of samples may also lead to varied statistics. Therefore, large-scale studies are needed due to the effect of random selection and population dynamics. Although this study has employed similar methodologies and statistics with many previous studies (Guo and Reed, 2001; Moberg et al., 2005; Moberg et al., 2007) it differs from others in terms of the methodology used and the higher number of the samples.

As a result, the taste genetics show up with environmental factors and create the sense of taste, which develops the feeding behaviours. Obesity may cause some types of cancer and creates the risk of cardiovascular disease. The taste perception resulting from food and beverages diversifies by genetic and environmental effects and the nervous system interprets this perception (Duffy, 2004). This study is enlightening in terms of presenting that the taste perception of people affects their lifestyles and lead them to start and either continue or discontinue some habits.

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