Phenylthiocarbamide taste perception as a possible genetic association marker for nutritional habits and obesity tendency of people

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Abstract: Ability to taste Phenylthiocarbamide (PTC) a bitter molecule, is usually used to know the heritable characteristic in both genetic and physiological studies. So far, no research has yet attested whether PTC blindness relation with obesity and some nutrition behaviors of human. This study is the first attempt on a large scale to examine PTC sensitivity in healthy and overweight people in Turkish population to define in the perception of bitter senses which is associated with nutrition habits, body mass index, age, gender, and to be in stable weight. PTC taste perception was measured by tasting PTC solution filtered in a paper. The results showed that tasters were significantly more frequent (81,8%) than nontasters (18,2%) in all population. A higher proportion of nontasters were observed in the quite fat individual group (BMI ≥40kg/m^2). Alterations explained these differences in basic taste sensitivity, age, gender, BMI, individuals' family obesity situations, vegetarian nourishment. Increased frequency of nontasters allele is evident with obesity condition. This could be due to lack of preference for nutrition among nontasters. So the phenotypic variation in PTC sensitivity is genetic in origin; it may represent an association with obesity, dietary habits, regular weight, gender, and age.

Keywords: PTC taste sensitivity, obesity, taste genetics, nontaster PTC trait, food preference.

INTRODUCTION

Obesity occurs due to the existence of adipose tissues in amounts above the normal levels in the body. It depends on many factors such as decrease in physical activity, nutritional habits, age, gender, education level, marriage, number of births, parental education and genetics, and requires medical treatment. The most important findings supporting that heredity has a role in obesity, which is a multifactorial disease, were obtained from the studies carried out on monozygotic twins using Body Mass Index (BMI) (Altunkaynak and Özbek, 2006). However, the role of the genetic factors in obesity, which is spreading rapidly, has not been fully comprehended yet. It is necessary to combine linkage analyzes, positional cloning studies, large-scale family study groups, genotyping technologies, bioinformatics and molecular epidemiology studies in order to reveal the obesity genetics. The comprehension of gene-gene, gene-environment interactions lying behind the obesity tendency can be provided by using the genetic analyses of expression profiles and populations of obesity genes in people (Clement *et al*. 2002; Semerci, 2004). In addition, nutritional preferences and habits of people must be also taken into account while conducting studies on obesity. Because nutritional behaviors are shaped according to personal characteristics such as individual food preferences, cultural-family tendencies and nutrition-health information as they depend on many parameters like biological, anthropological, economic, physiologic, sociocultural aspects and domestic economy.

On the other side, the taste of foods and ratios of taste components in their contents are seen as the most important factors in food selections of consumers. However, the factor that mostly influences the food selection hasn't been comprehended completely. But it is generally thought that taste perception has a key role in individual food preferences and nutritional habits. It was found that some common polymorphisms in genes related to individual taste preferences. These polymorphisms can affect the food selections, health conditions, and chronic disease risks related to nourishment (Bailo *et al*., 2009). Individual preferences are possibly shaped by the influence of genetic and/or environmental factors. And genetic effects in taste preferences are researched by using from biology to behavior (induction) or from behavior to biology (deduction) methods. Induction

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studies mostly focus on chemicals in the form of thioureas such as Phenylthiocarbamide (PTC) and Propylthiouracil (PROP). PTC/PROP perception tests are the applications tha tare commonly conducted on people, give clues about the genetic structure and can be used as an endophenotypic marker in some situations (Padmawathi, 2013). These chemicals are felt tasteless by some people and bitter by others depending on their genetic structures. Most people are sensitive to these tastes. Phenylthiocarbamide (PTC) is also known as phenylthiourea and it is an organic compound that has the phenyl ring (Padmawathi, 2013). Its molecular weight is 152.218g/mole and it is defined by the chemical formula of $C_7H_8N_2S$. Perceiving some bitter substances like PTC, more precisely the taste of its N-C=S bond is an inherited feature controlled by autosomal genes and showing bimodal distribution according to the Mendel genetics (Daştan *et al*., 2015; Saldhana and Becok, 1959; Stern, 1960; Kameswaran, *et al*., 1974; Fisher *et al*., 1961; Bartoshuk, 2000; Blakeslee and Fox, 1932). Ability to perceive the tastes of PTC/PROP chemicals is related to the dominance of taste genes. Individuals who are quite sensitive to these substances are called supertasters and tasters they are of homozygote dominant (TT) and heterozygote (Tt) genotype respectively. Nontasters individuals who cannot perceive the taste of PTC, are of homozygote recessive (tt) genotype structure (Joiner and Perez, 2004; Bartoshuk *et al*., 1994; Duffy, 2004). Allelic variations that influence the ability of PTC/PROP taste perception are on chromosome 5 and 7 (Duffy, 2004; Bufe *et al*., 2005; Tepper and Nurse, 1997; Joiner and Perez, 2004). TAS2R38 (bitter taste receptor gene) polymorphisms that differ between the chromosomes of people code the functionally separate receptor types which directly influence the perception of bitter taste in compounds including N-C=S or various vegetables naturally carrying this group has very important aspects (Harris and Kalmus, 1949a). Consequently, polymorphisms observed in TAS2R38 will help these compounds be preferred or rejected because they will influence the bitterness perception of individuals. Anthropometric characters were used to explain racial categorizations for years. Besides, using genetic characters is much more advantageous in terms of understanding the dynamics of human population genetics. Today, many polymorphic genetic markers are used for the comprehension of human diversity (Padmawathi, 2013). There are a large number of studies in which data were obtained at the population scale regarding the PTC/PROP taste perception and the taste perception was compared to different personal characteristics, taste preferences, nutrient consumption, body weight, physical feature of the tongue, personality styles and disease conditions such as nodular goiter, diabetes, peptidic ulcer, depression, alcoholism and schizophrenia (Joiner and Perez, 2004, Moberg *et al*., 2005; Kitchin *et al*., 1959; Brand, 1963; Hollingsworth, 1963; Fisher *et al*., 1963; Kaplan *et al*., 1964; Henkin and Gills, 1977; Ullrich *et al*., 2004).The relations of these differences with food selection and PTC perception haven't been comprehended completely (Drewnowski and Hann, 1999; Prescott and Swain-Campbell, 2000). More studies are necessary to explain the relation between different factors. Besides, the methods are momentary and sensitive to the laboratory or the people; they require many samples. (Tepper *et al*., 2001). Deduction studies generally focus on family studies and try to find the relation between the food preferences of families and genetics. While some studies show that taste preference has a genetic base (Dicarlo and Powers, 1998; Pelchat and Danowski, 1992), others don’t refer to any genetic bases (Keller *et al*., 2002). The purpose of this study is to reveal and compare the relation between the perception and consumption of basic taste features, nutritional habits, obesity development depending on such habits and the perception of the PTC taste.

MATERIALS AND METHODS

Formation of the study group

1510 female and 990 male individuals, in total 2500 adults, volunteered for this study. All the participants were healthy and preferred from the individuals who had no mouth and nose diseases and no problems with the taste/smell perception and who were not going through treatment during the research. It was important that people had no diseases like chronic sinusitis, chronic lung diseases, diabetes, psychological disorders, tasting disorders or mouth dryness, etc. The study was started after the approval of Cumhuriyet University Local Ethics Committee (Decision number: 50/1552). Data regarding the PTC taste perception, gender, nutritional habits, tea-coffee drinking habits, height-weight characteristics and body mass index (BMI) of the people were collected in a regular survey form and assessed. For the BMI values of the individuals, the Body Mass Indexes were used, which are used by the Ministry of Health as well.

Preparation of the PTC taste testing

In this study, the PTC solution was prepared by modifications in the method of Harris and Kalmus (1949b). During the PTC application, 10mg/L of PTC solution was prepared and absorbed by the filter paper (Zhao *et al*., 2003). The whole of study conducted by Daştan *et al*. (2015) has been used in the establishment of sample group, preparation of the PTC solution, applying the taste testing, analyzing and evaluating the data obtained.

Participants were asked whether they had smoked, eaten or drunk anything until the last hour before the taste testing; if they did any of them, the test was postponed one hour. The foods were categorized in a detailed way like vegetable, fruit, sweet, meat-fish, etc. so that the nutritional habits of people could be comprehended while

Table 1: Comparison of Genders and PTC Perceptions

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

Table 2: Comparison of BMI and PTC Taste Perceptions

Body Mass Index Values			PTC		Total	*P* Value
			Tasted	Not tasted		
BMI	< 18.5	Count	145	155	300	*P* = 0.001
		% Within BMI	48.3%	51.7%	100.0%	
	18.5 - 24.9	Count	1106	85	1191	
		% Within BMI	92.9%	7.1%	100.0%	
	25 - 29.9	Count	526	0	526	
		% Within BMI	100.0%	0%	100.0%	
	30 - 34.9	Count	268	87	355	
		% Within BMI	75.5%	24.5%	100.0%	
	35 - 39.9	Count	0	100	100	
		% Within BMI	0%	100.0%	100.0%	
	> 40kg/m^2	Count	0	28	28	
		% Within BMI	0%	100.0%	100.0%	
Total		Count	2045	455	2500	
		% Within BMI	81.8%	18.2%	100.0%	

Table 3: Comparison of Family Obesity Story and PTC Tasting Ability

			PTC		Total	*P*-Value
			Tasted	Not tasted		
Family Obesity Story	Yes	Count	667	184	851	*P* = 0.001
		% Within Family Obesity Story	78.4%	21.6%	100.0%	
	No	Count	1378	271	1649	
		% Within Family Obesity Story	83.6%	16.4%	100.0%	
Total		Count	2045	455	2500	
		% Within Family Obesity Story	81.8%	18.2%	100.0%	

Table 4: Comparison of Regular Weight and PTC Taste Perceptions

			PTC		Total	*P*-Value
			Tasted	Nottasted		
Regular Weight	Stable	Count	1697	382	2079	*P* = 0.616
		% within Regular Weight	81.6%	18.4%	100.0%	
	Variable	Count	348	73	421	
		% within Regular Weight	82.7%	17.3%	100.0%	
Total		Count	2045	455	2500	
		% within Regular Weight	81.8%	18.2%	100.0%	

the survey was filled up. It was graded how often foods such as cabbage, broccoli, spinach, and soybeans were consumed.

The methods, which were used in the studies of Azevedo *et al*., 1965 and Tepper *et al*., 2001, were preferred during the experimental applications. People were asked to gargle with tap water before beginning the experiment, and the same process was held before each application. After the application of the filter paper on the tongue, they waited for 30 seconds and then requested to notify their perceptions. Afterward, they were asked if they tasted anything or bitterness.

Table 5: Comparison of Taste Sense and PTC Tasting Ability

			PTC			*P*-Value
			Tasted	Not tasted	Total	
Tastes	Sweet	Count	729	185	914	*P* = 0.273
		% Within Tastes	79.8%	20.2%	100.0%	
	Salty	Count	372	69	441	
		% Within Tastes	84.4%	15.6%	100.0%	
	Bitter	Count	395	81	476	
		% Within Tastes	83.0%	17.0%	100.0%	
	Sour	Count	426	91	517	
		% Within Tastes	82.4%	17.6%	100.0%	
	Fatty	Count	123	29	152	
		% Within Tastes	80.9%	19.1%	100.0%	
Total		Count	2045	455	2500	
		% Within Tastes	81.8%	18.2%	100.0%	

Table 6: Comparison of Vegetarian Nourishment and PTC Tasting

			PTC			*P*-Value
			Tasted	Not tasted	Total	
Vegetarian Nourishment	Little	Count	743	199	942	*P* = 0.013
		% Within Vegetarian Nourishment	78.9%	21.1%	100.0%	
	Normal	Count	573	111	684	
		% Within Vegetarian Nourishment	83.8%	16.2%	100.0%	
	Plenty	Count	729	145	874	
		% Within Vegetarian Nourishment	83.4%	16.6%	100.0%	
Total		Count	2045	455	2500	
		% Within Vegetarian Nourishment	81.8%	18.2%	100.0%	

Table 7: PTC Perception Frequency of Individuals as per Age

			PTC			*P*-Value
			Tasted	Not tasted	Total	
Age Degree	Young age 14-29	Count	1786	431	2217	*P*=0.001
		% Within Age Degree	80.6%	19.4%	100.0%	
	Middle age 30-49	Count	196	13	209	
		% Within Age Degree	93.8%	6.2%	100.0%	
	Old 50<	Count	63	11	74	
		% Within Age Degree	85.1%	14.9%	100.0%	
Total		Count	2045	455	2500	
		% Within Age Degree	81.8%	18.2%	100.0%	

Individuals were kept in a quiet environment without seeing each other during the experimental applications. Next day, same applications were carried out on people again, who didn't state a certain perception. People who said they didn't taste anything and who perceived the NaCl taste used as a reference more intensively were categorized as PTC nontasters. And the ones who perceived the taste of the PTC solution were classified as PTC tasters. SPSS 22.0 packaged software was used for the statistical Analyzes to assess the obtained data, and Chi-Square analysis was applied between the individual characteristics and PTC perceptions.

RESULTS

2500 volunteers in total participated in our study where we researched the relation between the perception of the PTC taste and the tendency for individual nutritional habits, and therefore obesity. Ages of the participants varied between 15-65. The data about their weight, height, age, gender, nutritional habits and whether there was anyone in their families going through obesity treatment were regularly recorded in survey forms. Later, PTC taste testing was applied, and the ratios of the people who perceived the PTC taste in our sample group were set according to the obtained data. Accordingly, it was seen that 81.8% of the individuals in our research group could perceive the PTC taste but 18.2% couldn't. These ratios were 83.4% and 16.6% among women, respectively 79.4% and 20.6% among men. It is observed that women are more sensitive to the perception of the PTC taste (table 1). Thus, this status supports some previous studies (Duffy, 2004). Statistically, the difference found in the perception of the PTC taste between female and male individuals was significant according to the Chi-Square analysis performed on SPSS 14.0 packaged software ($p \leq 0.05$).

The differences were found significant according to the results of the Chi-Square analysis when we produced statistics to assess the relation of PTC perceptions by classifying the individuals in our study group as per the body mass index ($p \leq 0.05$) (table 2). According to the BMI scale used by the Ministry of Health of the Republic of Turkey, it is seen that all of the individuals from the slightly fat category (25-29.9kg/m^2) and the 92.9% of the individuals from the normally fat category (18.5-24.9 kg/m^2) could perceive the PTC taste (table 2).

It was found that the ratio of intermediately fat individuals (between BMI 30-34.9kg/m^2) was lower with 75.5%. It was seen that heavily fat (between BMI 35-39.9kg/m^2) and quite fat (BMI $\geq$40kg/m^2) individuals weren't sensitive to PTC. And the ratio of PTC perception was 48.3% in thin individuals (BMI $\leq$ 18.5kg/m^2). It is observed that the ratio of PTC perception is higher with 83.6% in individuals who don't have an obesity story in the family while this ratio is 78.4% in individuals with a first-degree obesity story in their families (table 3). It is understood through the Chi-Square analysis that the existing difference between the people who have a first-degree obesity story in the family and who don't is statistically ($p \leq 0.05$) important (table 3). No significant difference was found when it was checked whether there was any difference between the people's perceptions of PTC taste, who had a regular and stable weight and who often had problems with gaining and losing weight ($p \geq 0.05$). Frequencies of PTC taste perception were respectively 81.6% and 82.7% in people who had a stable weight for a long time and who lost and gained weight continuously; and the difference between them was insignificant (table 4).

No high and significant difference was found when the main tastes mostly liked and consumed by people were categorized, and the differences in their PTC perceptions were checked. According to the nutrients consumed by people more frequently, similar values were obtained about the frequencies of individuals' PTC taste perceptions, who were nourished with sweet, salty, bitter, sour substances or all of them. These values range between 79.8%-84.4% and an 81.8% frequency of PTC taste perception was obtained in total. Pearson Chi-Square value obtained among groups was found as $p=0.273$,and this doesn't point toany difference (table 5).

In this study, we also researched the frequencies of PTC perceptions by making a categorization in terms of the vegetarian nutritional habits of the participants according to their consumption frequencies of vegetables like broccoli, spinach, cabbage, soy etc. Accordingly, people who often ate or never ate vegetables like broccoli, cabbage, etc. were divided into three basic groups such as little, intermediate and plenty as per their vegetarian nutrition ratios. When the frequencies of PTC perceptions in these three basic groups were checked, the PTC perception frequency was found as 78.9% in people who generally didn't like or eat vegetables of this kind. But this ratio was 83.8% in people consuming those vegetables intermediately and 83.4% in consumers eating them very often (table 6). Intergroup statistical differences are important according to the Chi-Square results ($p=0.013$) when all the groups are analyzed statistically on the SPSS program ($p \leq 0.05$). At this point, it is seen that the frequency of PTC perception is higher in people who eat in a vegetarian way intermediately and a lot, and consume vegetables like cabbage, broccoli, soy, etc.

The Age Classification Index of Turkish Elder Sciences and Technologies Foundation (TUYEV) was used while determining the PTC perceptions frequencies by categorizing the participants within age groups. Therefore, voluntary participants were grouped into three categories according to their ages. As seen in table 7, people aged between 14-29 formed the "Young" group, 30-49 the "Middle" age group and above 50 the "Old" group. Ratios of PTC taste perception in these groups are respectively 80.6%, 93.8% and 85.1%. When Pearson Chi-Square analysis is applied according to these ratios, it is seen that intergroup PTC perception frequencies are quite important with the value of $p=0.001$ ($p \leq 0.05$). Especially the PTC perception frequency in the middle age group is evidently different from the other groups with a 93.8% value. And the PTC perception frequency was found as lowest in the individuals of the "Young age" group (table 7).

DISCUSSION

This study is one of the extensive, largest-scale research made so far, in which the nutritional habits of individuals and their tendencies for gaining weight due to these habits are compared and so many parameters are researched together with the perception of the PTC chemical. Within this frame, it was tried to set forth that there were relations between some vegetables such as broccoli, cabbage, spinach, soy etc., which are bitter for some people and therefore not preferred, and the perception of the PTC taste. In this sense, a serious research was made, which tried to reveal the relation between the general lifestyles and PTC perception status of individuals. It was also tried to present whether there was a relation between the obesity existence related to the first-degree relatives and PTC perceptions of the participants.

Out of 2500 volunteers who participated in the study, the ratio PTC tasters is 81.8%. This is a result close to that of the Portuguese study by Saldanha (1962) and the Brazilian study by Azevedo *et al*. (1965) and is similar to the study of Guo and Reed (2001). Bitterness perception is quite variable in human populations. It has been witnessed in researches carried out so far that the distribution of PRC/PROP taste blindness is different like 2.3-36.5% (Africa), 5.1-23% (China), 4.8-66.7% (India) and 2.0-27.5% (Asia), 4.1-20% (Turkey) (Saraswathi *et al*., 2011; Tepper and Nurse, 1998; Tepper, 1998; Guo *et al*., 1998). The PTC perception frequencies we obtained from the subjects of our study are a bit higher than the results obtained from Turkish societies in previous study (Demirsoy, 1998), and lower than the results found for the previous data (Enoch *et al*, 2001) obtained from the societies of India (Kameswaran *et al*, 1974), Asia and Australia (Saldhana and Becok, 1959).PTC tasters can also be categorized as supertasters or normal tasters on their own. Supertasters are the individuals who feel the PTC substance much more intensely and define it as “too bitter, like poison”. According to the X^2 analysis, the ratio of supertasters in our study group is 32.8%, the ratio of tasters is 48.9% and the ratio of nontasters is 18.2%. These ratios can be counted as close to bimodal distribution frequency as 25%, 50% and 25% as expected in the society. Depending on the ethnic differences, variations in the experimental group and homogenization of the participant profile, there can be differences in the values of different societies. One of the important points in this study is that no distinction was made between the super tasters and tasters as Whittemore (1986; 1990) did in his studies. PTC tasters were approached as only one group, and PTC nontasters were separated as a second group. It is not a good idea to make a separation according to just PTC perception among taster individuals as supertasters (Homozygote TT) or tasters (Tt), because no research was conducted on individuals regarding the perception of the PTC in terms of genes (Joiner and Perez, 2004).

When the PTC perception frequencies in terms of genders are compared, it is seen that PTC perception frequencies of women are generally higher and much more than those of men. Thus, gender can also change the taste anatomy. Women can carry a number and variety of taste buds on their tongues unlike men (Bartoshuk *et al*., 1994; Driscoll *et al*., 2006). Therefore, PTC perception of women can be more intense and sharp (Harris and Kalmus 1949b)**.** It was seen that there was an important differentiation in the PTC perception frequencies of the people depending on their weight, when their BMI and PTC perceptions were compared. It is noticed that almost all the people who have normal weights and who are slightly fat are PTC tasters. However, it was observed that all of the people, who were too fat (obese), couldn’t taste the PTC chemical. The PTC perception frequency of very thin individuals with a value of 48.3% is lower than the values of PTC tasters in the society. In this sense, it is possible to mention about a relation between the BMI and PTC perception in our study. According to the results of some previous studies, the people with a weak PTC/PROP perception had a high BMI value (Beverly and Ullrich, 2002).

As a result of the differences in nutritional preferences and consumptions of the people, defenselessness may occur against the health problems like gaining too much weight, BMI increase, obesity and some cancer types (Purkin *et al*., 2000). There can be a relation between the sensitivity for tasting a specific bitterness in the PTC chemical, eating and drinking habits of individuals and therefore obesity together with the control of taste genes. The perception quality of PTC tasters can be different when it comes to the tastes in foods and beverages. It was observed in various studies that the people who could perceive the taste of chemicals like PTC/PROP could notice the sweet, salty, bitter, sour or other tastes in foods and beverages at very low amounts more clearly than the people who were insensitive to them, and they could distinguish these tastes very well (Prescot and Swain-Campbell, 2000; Prutkin *et al*., 2000). It was also found that the number of taste buds on the tongues of PTC/PROP “nontasters” was low, and moreover, there were more papillae in shape of mushroom on the tongues of PTC supertasters and they could feel the irritation caused by acidic or basic, etc. tastes and the sense of touching more than the others (Prutkin *et al*., 2000). Consequently, it is thought that the PTC/PROP tasters carry 1 or 2 dominant genes, and therefore they have many mushroom-shaped papillae, as the perception of PROP bitterness is explained with the PTC/PROP gene (Kim *et al*., 2003). Thus, it was found that their nutritional behaviors were in the tendency to increase gaining weight and obesity and raised the risk of many cardiovascular diseases depending on their nutritional habits (Duffy, 2004). Briefly, there are still undiscovered sections in this field. Our study almost confirms these data. Hence, individuals with normal healthy weights have almost 100% PTC perception frequency while there are almost 100% nontasters among quite fat people in our sample group (table 2). Meanwhile, there are many nontasters without PTC perception among the people who have an obesity story in their families (21.6%) (table 3). The ratio of nontasters among individuals who don’t have an obesity story in their first-degree relatives is 16.4%,and the statistical difference between both of the values is important ($p \leq 0.05$).

When we classify the participants in our study according to the food tastes they like and consume more, it is seen that the ratios of people who can perceive the PTC in each group like sweet, salty, sour, bitter lovers, etc. are close to each other and the statistical difference is insignificant ($p \geq 0.05$, table 5). But it stands out that the ratio of nontasters in the group which consumes more sweet and fatty foods is a little higher than the other groups. This supports the finding of the fact that the PTC/PROP nontasters consume more fatty-sweet foods when compared to previous studies (Duffy, 2004). Foods of this kind give too sweet or fatty sense for PTC tasters, and, therefore, they are not consumed (Duffy *et al*., 1996; Drewnowski, 1977). However, quite opposite results were obtained in some other studies (Drewnowski *et al*., 1997; Yackinous and Guinard, 2001). These different results possibly arise from methodological differences. It is also seen in our study that the PTC perception frequencies of people, who are in thetendency to consume bitter nutrients, are high (83%) as well. Although some previous studies support this result, others contradict it (Beverly and Ullrich, 2002).

In a study made by Saraswathi *et al*. (2011), the relation between the sensitivity of PTC taste perception, eating habits in the childhood obesity of early period and BMI was researched. According to the results of this study, PTC nontasters among the obese children had a ratio of 72%. It was thought that the PTC nontasters ate too much of everything and therefore had obesity because they did not have a food preference. Results of our study are similar to those of this study even though ours was conducted on adults. The ratio of nontasters among the obese people is 100% in our study. The fact that the ratio of nontasters among very thin people is high (51.7%) can be explained in the way that they do not have a taste preference, and accordingly, they don't like eating so much.Thus, eating habit is a complexed body of behaviors such as eating time, eating amount, food preference, food selection etc., which is influenced by many factors like physiological, psychological, social and genetic effects. Taste perception influences food preference and the amount of food intake. However, people generally don't have the same taste perception (Saraswathi *et al*., 2011). Together with the determination of widespread PTC perception existence in the world, the idea of using this feature as a potential genetic marker has been arisen, which can explain the formation of food preferences, dietetic habits, their body weights and therefore the adipose tissue (Gandhi *et al*., 2012; Bailo *et al*., 2009).It was put forth in some studies made so far that people sensitive to PTC have a tendency not to like the green vegetables such as green tea, grapefruit juice, soy, cabbage, spinach and broccoli - because they find them more bitter and eat them more rarely compared to nontasters (Beverly and Ullrich, 2002; Kaminski *et al*., 2000; Dinehart *et al*., 2006; Feeney *et al*., 2011). According to some studies, PTC nontasters like acidic fruits, and cruciferous vegetables less (Drewnowski *et al*., 1999; 2000; Breen *et al*., 2006). No relation was found between eating habits, being/not being vegetarian and PTC perception in some studies (Breen *et al*., 2006). The ability of perceiving bitterness and sweetness is variable. These variations are genetic as to some resources (Breen *et al*., 2006; Krondl *et al*., 1983; Falciglia and Norton, 1994). PTC and PROP compounds were often used to test this situation (Dinehart *et al*., 2006). But according to the explanation, obtaining contradictory results in studies resulted from the fact that people preferred to eat some tastes due to health requirements although they didn't like them(Duffy and Bartoshuk, 2000). Because people nowadays consume the foods and beverages they don't like, because they are good for health. This prevents decisions made only with taste perception. Maybe that's why differences are found between taste preferences consumed by people in studies.It was observed in our study that PTC-sensitive people consumed more cruciferous vegetables like broccoli and cabbage (table 6). Vegetables belonging to Cruciferous family (Cruciferae) are from the main groups of nutrients with theanti-cancer feature (Jerzsa-Latta *et al*., 1990; Steinmetz and Potter, 1996; Drewnowski and Gomez-Carneros, 2000). Even though they have very good effects on health, they are not eaten by many people because they are thought to have bitter and bad tastes. Self-protection adaptation of people against dangerous, harmful and even poisonous substances is considered within the evolutionary process as the reason for their dislike for bitterish tastes and non-preference of foods perceived as bitterish (Rozin and Vollmecke, 1986). Being too sensitive about the perception of bitter tastes leads to the severe refusal of the foods with those tastes (Drewnowski and Gomez-Carneros, 2000). After it was revealed that the sensitivity related to the perception of the bitter taste of chemical substances like PTC and PROB was defined genetically, the existence of N-C=S groups, which give bitterness to PTC and PROP chemicals, was found also in the structure of the bitter compounds originating naturally in cruciferous vegetables (Dinehart *et al*., 2006; Drewnowski *et al*., 2000; Bartoshuk 2000; Yackinous and Guinard, 2001). However, contradictory results were obtained, which revealed the effect of the perception sensitivity to bitter tastes in PTC/PROB chemicals on the preferability of cruciferous vegetables as food. Even though it is accepted that the aromas of foods may have an influence on their consumption, it couldn't be shown clearly that the primary reason behind the non-preferability of these vegetables was the bitterness caused by their own N-C=S groups. Thus, theexistence of the effects by different mechanisms are considered (Duffy and Bartoshuk, 2000; Jerzsa-Latta *et al*., 1990; Montmayeur and Matsunami, 2002).

When the participants were divided into groups as per the age index of TUYEV and the differences in PTC perceptions were checked within our study, it was seen that the PTC perception was at the highest ratio (93.8%) in the "middle age"(30-49) group and at the lowest ratio (80.6%) in the "young age" group and this status was found statistically significant ($p \leq 0.05$, table 7). Although not so many studies were conducted on this topic, we can suggest that an exact taste perception occurs depending on the full taste bud formation on the tongues of the people in the middle age group. In this case, taste buds aren't fully formed and taste perception isn't developed in young or old people or the nature and functions of the taste buds are damaged and, therefore, taste perceptions weaken due to old age.

CONCLUSION

Taste genetics emerges with environmental factors and comprises the tasting sense; this develops nutritional habits. Obesity causes the risk of some cancer types and cardiovascular diseases in unhealthy nourishments. Tasting perception resulting from foods and beverages varies genetically and with environmental effects, and the nervous system interprets this perception (Duffy, 2004). Our study is informative because it shows that the taste perception influences eating and drinking preferences of people and some foods are liked and others are not. Generally, taste of a substance depends on its chemical composition. Substances with different chemical structures may give the same or different taste. For example; many substances with different chemical structures may give bitterness sense.

Additionally, when we evaluate our study made through optimization as per the studies in the literature in terms of the method used and sample group, it can be said that it is sufficient to determine the taste perception of people and compare it with various parameters for applying a taste testing to the population by preparing only one PTC solution and get it absorbed by the filter paper. It is an advantageous method that is quick, simple, and economical and expresses perceptions more clearly (Tepper *et al.*, 2001). We believe that we kept the PTC perception obviously stable by using the NaCl standard in the study. Thus, similar methods were used in other studies of the literature (Dicarlo and Powers, 1998; Tepper *et al.*, 2001; Prutkin *et al.*, 2000; Prescott *et al.*, 2004; Bartoshuk *et al.*, 1996). Individuals were assured of their perceptions by having them make comparisons with only tap water beside the NaCl solution in order to confirm their taste perceptions.

It is an important point that a part of the results obtained from this study presented some contradictions while supporting some of the previous researches (Guo and Reed, 2001). Results may have been found important or unimportant by mistake due to unreliable statistical capacities. A limited number of the samples can lead to variations in statistics. Therefore, high-scale studies are needed owing to the effect of random selection and population dynamics. This study differs from the existing studies due to the high number of samples, even though, a methodology and statistics similar to many previous studies were used (Moberg *et al.*, 2005).

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