

Prevalence, Biochemical, and Genetic Analysis of Mutated Gene Related to Bitter Taste Perception for Phenylthiocarbamide in Sulaymaniyah Province, Iraq

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Abstract

Background: Phenylthiocarbamide (PTC) taste or any organic bitter compound is widely studied between nations. **Objectives:** The aim of this study was to analyze the prevalence of PTC taste sensitivity and its mutated gene frequencies among people in Sulaymaniyah, Iraq. **Materials and Methods:** PTC, thiourea, and sodium benzoate paper were used on the participants. Each participant was required to taste each paper differently; then, the results were recorded whether they were tasters or nontasters. **Results:** Analysis of data from the current study revealed that 70.4% of the Kurdish population is PTC tasters. Of them, 25 (8.3%) of participants were normal tasters, 124 (41.1%) were standard supertasters, 36 (11.9%) were recessive supertasters, and 116 (38.5%) of them were dominant supertasters. Smoking showed no effect on the taste perception in this study. However, the rate of female tasters was higher than male tasters. **Conclusion:** The analysis of data from the current study revealed that most of the Kurdish population is PTC tasters. However, the rate of female tasters was higher than male tasters. Further studies are needed to investigate genetic composition of the Kurdish population.

Keywords: Dominant supertasters, Kurdish population, normal tasters, phenylthiocarbamide, recessive supertasters, standard supertasters

INTRODUCTION

About 75% of people can taste phenylthiocarbamide (PTC), while the other 25% cannot taste it as it has been confirmed in many countries throughout the world. There is limited information on population genetics of the Sulaymaniyah regarding PTC or related toxic compounds taste perception. The gene mutation in TAS2R38 gene sequence makes an apparent protein which cannot achieve its biochemical function and makes human vulnerable for consuming some toxic materials due to loss of bitter taste sense. Recently, biochemical and genetic analysis had become a strong tool to identify gene mutation in different persons, and this could be used as a surveillance method to identify bad gene traits among the population. The ability to taste PTC, a bitter organic compound, which is described as a bimodal autosomal trait is widely used to know the heritable trait in both genetic and anthropological studies. Biochemists and geneticists aim to the study populations in terms of genetic variation. The gene

frequencies of alleles at segregating loci can be done through various quantifications. These phenomena characterize one population and distinguish with another.^[1-3]

The TAS2R38 gene encodes a taste receptor protein that interacts chemically with a receptor on the tongue, which is responsible to taste a type of bitter such as a chemical called PTC as well as numerous other sour and toxic substances, but contrary to longstanding scientific thought, they developed that ability through separate genetic mutations, according to new research led by the University of Utah and University of Washington geneticists Stephen Wooding, PhD., and Michael Bamshad, M.D.^[4] This protein is responsible for changing the taste sense of the chemical into a biochemical signal and

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Access this article online

Quick Response Code:



Website:
www.medjbabylon.org

DOI:
10.4103/MJBL.MJBL_50_18

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How to cite this article: Rahim HM, Majeed RK, Rostam NA. Prevalence, biochemical, and genetic analysis of mutated gene related to bitter taste perception for phenylthiocarbamide in Sulaymaniyah Province, Iraq. Med J Babylon 2018;15:201-4.

sending the signal through nerves into the brain. Different mutations due to evolution occurred in this gene in human lives, resulted in variation in taste ability to PTC compound.^[5]

Taste and smell senses affect food preferences and dietary habits, thereby directly influencing the eating behavior of an individual. As taste threshold increases with age, abnormality in taste function may contribute to poor dietary intake in the elderly.^[6] Bitter taste perception is a conserved chemical sense against the ingestion of naturally toxic substances in mammals.^[7] Nontasters of PTC chemical indicate the presence of mutation and mutant persons cannot differentiate some of the dangerous and toxic materials which threat life. The ability to taste or not taste PTC is described as a phenotype, an observable effect of the genotype.^[2,4]

To people who can taste it, PTC is very bitter and structurally similar to 6-n-propylthiouracil. PTC is a chemical compound which is naturally found in some vegetables such as cabbage and broccoli. A common thionamide group structurally relates PTC to thiourea, propylthiouracil, and goitrin. These four substances are also similar in their ability to interfere with the synthesis of thyroid hormone, an action that leads to thyroid hypertrophy, and the naturally occurring anti-thyroid substance l-goitrin; all members of this class of chemicals have anti-thyroidal activity and are not tasted by PTC nontasters. This means that PTC nontasters could develop thyroid problems because they cannot taste alkaloids as readily.^[8]

These genetic differences can be described as single-nucleotide polymorphisms (SNPs) – because – only one nucleotide within the DNA sequence of the TAS2R38 gene is changed. SNPs can be utilized to genotype individuals using a variety of methods involving sensitivity to taste PTC. If we consider the SNP at nucleotide 145 in the human TAS2R38 gene, heterozygotes can taste PTC but with less sensitivity than homozygous (CC or GG) “tasters.”^[2,9] The TAS2R38 gene accounts for up to 85% of the variation in the ability to taste PTC and is a good predictor of an individual’s in ability to taste it. However, the ability to taste PTC can be affected by other factors, such as other genes involved in taste perception, age, and smoking habits, among others.^[2] The aim of the present study is to find the frequency of PTC tasters among the Kurdish populations in Sulaymaniyah province.

MATERIALS AND METHODS

Sample collection

This cross-sectional, analytical, randomized study was done to find out PTC taste sensitivity and its threshold distribution among different people from different age groups and genders. The total number of samples in this study was 301 individuals. Among them, 170 were male and 131 were female from different age groups. A survey was conducted among healthy, normal, and unrelated individuals with the age range of 10–50 years, which were randomly selected from Sulaymaniyah province. Individual samples were selected from schools,

workplaces, offices, and households by door-to-door contact with the help of volunteers.

The method to distinguish tasters from nontasters adopted as per the sorting technique using HBARSCI Super Taster Kit according to the manufacturer guideline and the principles of PTC taste of Harris and Kalmus,^[10] because of their superiority in discerning the threshold of the individual with near perfection. Control, PTC, thiourea, and sodium benzoate were purchased from www.flinnsci.com.

Procedure

The mouth was rinsed with water before starting the experiment. A strip of control paper was placed on participant’s tongue and was left there for a few moments. The paper was not chewed or swallowed. Any taste or sensation that perceive was noted. Then, the paper was discarded in the waste container provided. The result was recorded. A small amount of water was drunken before continuing. A strip of PTC paper was placed on your tongue and was left there for a few moments. PTC is a chemical substance that is harmless when tasted in small amounts. Any taste or sensation that perceive was noted. The paper was discarded. The result was recorded. The mouth was rinsed with water then tastes the thiourea paper and classifies your bitter perception as taster or nontaster. The result was recorded. The mouth was rinsed with water, the sodium benzoate was tasted and recorded whether you perceive bitter, salty, and/or sweet (taster). Individuals also taste nothing (nontaster). It was recorded whether you are a taster or nontaster, if you are a taster describe the flavor. Individuals taste one or all three of the sensation.

- If the person cannot taste any difference, that means a normal taster
- If the person can only taste PTC, that means a standard supertaster
- If the person can taste PTC and Thoreau but not sodium benzoate, that means a recessive supertaster
- If the person can taste PTC, thiourea, and sodium benzoate, that means dominant supertaster.

RESULTS

Of 301 participants, 278 were tasted one or more of the test strips; only 23 participants did not taste any of them. The highest number of participants tasted benzoate (220), followed by PTC (212) tasters, then thiourea (167) [Figure 1].

A large number of tasters tasted both PTC and thiourea, while a smaller number tasted only one of them. However, the number of PTC tasters was higher than the number of thiourea tasters. Of the tasters, 232 participants tasted at least one of the bitter tastes, PTC, and thiourea. Of the bitter tasters, 51 participants tasted PTC, 19 participants tasted thiourea, and 162 participants tasted both. However, 69 participants were nontasters for both of them. Only a small number (19) of PTC nontasters tasted thiourea [Figure 2].

Of the total number of participants, 220 were sodium benzoate tasters and 81 were nontasters. Of which, 57 of sodium

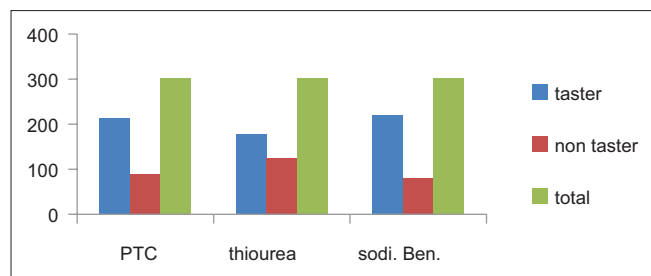


Figure 1: Total number of tasters and nontasters for all test strips

nontasters tasted at least one of bitters. The total number of smokers participated in this study were 75 participants, together with 226 nonsmokers. Of them, 18 (24%) smokers and 71 (31.4%) nonsmokers were PTC nontasters. Of 75 smokers, 32 (42.6%) were thiourea nontaster, 102 (78.3%) of nonsmokers were thiourea nontasters. Among sodium benzoate nontasters, 30.8% were smokers and 69.2% were nonsmokers. These results indicate that smoking showed no effect on tasting any of the strips. We tested the total number of nontasters for each test strip according to gender. Among PTC nontasters, 46 were male and 43 were female. Of the thiourea nontasters, 69 were male and 52 were female. Of the total number of benzoate nontasters, 54 were male and 27 were female.

Further genotypic analysis to determine “supertaster” among the Kurdish population revealed that 25 (8.3%) of participants were normal tasters, 124 (41.1%) of participants were standard supertasters, 36 (11.9%) were recessive supertasters, and 116 (38.5) of them were dominant supertasters.

The most powerful predictor to select food is taste sense. There are differences in food taste sense between different age groups, for instance, infants prefer to taste the sweet food and they reject bitter food. Human tastes, in general, can be divided into five different types: sour, sweet, bitter, umami, and salty which are considered practical for survival and nutrition.^[11] The most important taste sense is the taste for bitter, as it has a great role in protecting human from toxic substances.^[12]

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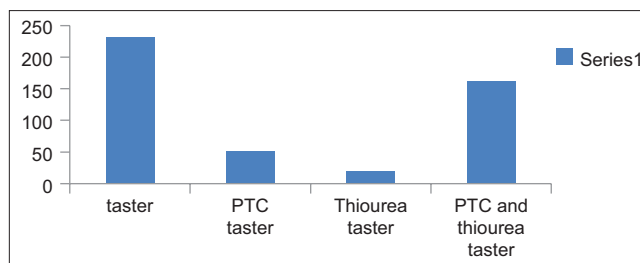


Figure 2: The relation between phenylthiocarbamide and thiourea

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DISCUSSION

The most powerful predictor to select food is taste sense. There are differences in food taste sense between different age groups, for instance, infants prefer to taste the sweet food and they reject bitter food. Human tastes, in general, can be divided into five different types: sour, sweet, bitter, umami, and salty which are considered practical for survival and nutrition.^[11] The most important taste sense is the taste for bitter, as it has a great role in protecting human from toxic substances.^[12]

There is a great variation in sensitivity to compounds that taste bitter, and PTC is a good example. The first finding about differences between individuals who taste or do not taste PTC was in 1931.^[13] It is found that TAS2R38 on chromosome 7 is responsible for responding to bitter taste.^[14,15]

The main objective of this study was to investigate the threshold distribution and determine the gene frequencies of dominant and recessive alleles for PTC taste sensitivity in Sulaymaniyah province. The present study provides brief information on the distribution of PTC tasters and nontasters in Sulaymaniyah. It has been confirmed throughout the world that 70% of people are tasters to PTC and 30% of people are nontasters.^[3,16] As it has been mentioned in this study, 41% were standard supertasters, which mean that they tasted PTC, while 11.9% were recessive supertasters, which mean that they could taste both PTC and thiourea. Moreover, 38.5% was dominant supertasters, which indicate that they tasted all of the taste strips (PTC, thiourea, and sodium benzoate).

In our investigation, we found out that the ratio of taster among females is much higher than that in the males, which supports findings from other studies.^[17,18] It has been revealed that the tasters have more taste buds than nontasters.^[19] One of the major roles that PTC tasting plays is that generally PTC tasters can taste more fattiness in food, while nontasters cannot feel the difference between low- and high-fat foods, which could cause obesity. Some studies in anthropology and genetics also found that tasting PTC could affect food selection, which consequently affects metabolism and physiology of individuals.^[20] In addition, investigating the differences between smokers and nonsmokers in tasting PTC and other

toxic substances in our project revealed that 24% smokers and 31.4% nonsmokers were PTC nontasters.

CONCLUSION

The analysis of data from the current study revealed that most of the Kurdish population is PTC tasters. Few of the participants were normal tasters, and few numbers were standard supertasters. In addition, some of them were recessive and dominant supertasters. Smoking showed no effect on the taste perception. However, the rate of female tasters was higher than male tasters. Further studies are needed to investigate the genetic composition of the Kurdish population.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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