PHENYLTHIOCARBAMIDE (PTC) TASTER STATUS IN SOUTH INDIAN ADULT MEDICAL STUDENTS

Sachin Rathod[1], Pallavi Jawale[2], Suresh Babu Kondaveeti[3], Chitra Pillai[4]

[1]Assistant Professor, Department of Physiology, K. D. Medical College, Mathura, Uttar Pradesh.
[2]Assistant Professor, Department of Physiology, MIMER Talegaon, Pune, Maharashtra.
[3]Assistant Professor, Department of Biochemistry, SMC, Unnao, Lucknow, Uttar Pradesh.
[4]Additional Professor, Department of Physiology, T. N. Medical College, Mumbai, Maharashtra.

ABSTRACT

BACKGROUND

The objective of this study was to determine Phenylthiocarbamide (PTC) taster status in adults who are studying medicine and its relationship with anthropometric variables such as Body Mass Index (BMI), Body Fat Percentage (BFP) and pleasantness of sugar, salt, and fat. A total of 112 subjects rated the intensity of Phenylthiocarbamide and sodium chloride (NaCl) solutions using the labelled magnitude scale. For pleasantness evaluation, it was used with concentrated lemon juice (sugar) and mashed potato (salt and fat). The subjects were classified as non-tasters (n=32), medium-tasters (n=31) and super-tasters (n=49). In this study, no relationship was found between phenylthiocarbamide taster status and age, sex, weight, body mass index, and pleasantness. Although genetic markers may influence the degree of liking of certain foods, one must consider that the mechanisms influencing eating behaviour in humans are complex, and that psychological, social, and economic factors play a key role in response to food.

KEYWORDS

Phenylthiocarbamide, Body Mass Index, Body Fat Percentage, Pleasantness.

HOW TO CITE THIS ARTICLE: Rathod S, Jawale P, Kondaveeti SB, et al. Phenylthiocarbamide (PTC) taster status in South Indian adult medical students. J. Evid. Based Med. Healthc. 2016; 3(51), 2618-2622. DOI: 10.18410/jebmh/2016/574

INTRODUCTION: Food intake habits depends on physiological, psychological, social, and genetic factors that influence meal timing, food preference, quantity of food intake, and food selection. Food preference and food intake depends precisely on its taste, thereby directly influencing eating habits. However, not all humans perceive taste in exactly the same way. The density of taste papillae on the tongue, genetic differences in taste receptors or sensitivity of taste receptors, constituents of saliva, and other factors all contribute to an individual's taste perception and subsequent food preferences.

Fox et al., in 1931 synthesised a bitter chemical compound and named it as phenylthiocarbamide (PTC).[1] which has been widely used for genetic and anthropological studies.[2] Within and between human populations, the bitter-taste perception is a classically variable trait.[3] According to Mendelian law, the inability to taste PTC is a simple recessive trait.[4-8] wherein the individuals with two recessive alleles (tt) are non-tasters for PTC and individuals with one dominant allele (Tt) or two dominant alleles (TT) are tasters for PTC. The prevalence of taste blindness (i.e. a lack of sensitivity to or an inability to taste bitter chemicals) ranges from 3 % in West Africa to 6–23% in China and 40 % in India; 30 % of the white North American populations has taste blindness.[9] Kim et al., have identified a small region on chromosome 7q harbours, a gene that encodes a member of the TAS2R bitter taste receptor family.[2]

Financial or Other, Competing Interest: None.
Submission 01-06-2016, Peer Review 10-06-2016,
Acceptance 20-06-2016, Published 27-06-2016.
Corresponding Author:
Dr. Suresh Babu Kondaveeti,
Assistant Professor, Department of Biochemistry,
Saraswati Medical College, Unnao, Lucknow, Uttar Pradesh.
E-mail: sureshbabu_kondaveeti@yahoo.com
DOI: 10.18410/jebmh/2016/574

A major locus on 7q35-q36 and a secondary locus on chromosome 16p have been localised by genome scan for PTC taster gene.[10] Bufe et al[11] demonstrated that alleles of hTAS2R38 codes for functionally different receptor types that directly affect perception of bitterness containing compounds. There are many diseases associated with variations in taste perception. However, researchers suggested that lipid metabolism involved in the aetiology of congenital heart diseases may be affected by tasting ability.[12] A preference for sweet and high-fat food was observed to decrease with increasing perception of bitter taste.[13] and further research highlighted relations between bitter compound–tasting ability and body mass index (BMI; in kg/m2), adiposity levels, and risk factors for cardiovascular disease.[14,15]

The availability of genetic markers for tasting ability may offer insight into individual's risk of predisposition to childhood obesity or obese traits. Hence in the present study we made an attempt to analyse the interaction between PTC taster status and onset of obesity in adult medical students, Mumbai, Maharashtra.

MATERIALS AND METHODS: The study is a cross-sectional randomised study among adult medical students from urban areas of Mumbai city. A total number of 300 adults age ranged from 18-25 years from a Medical College, Mumbai city was selected for this study during years 2011-2012. The body weight was measured without shoes using a measuring scale, and height to the nearest centimetre was taken. Body Mass Index (BMI) was calculated as weight in kilograms divided by height (in meter squared). The adults whose weight was more than 85th percentile (weight or BMI) for the age and sex were considered as overweight/obese.[16]

Physical activities were recorded with the help of questionnaire specially designed for them. The informed written consent was taken from volunteers and also from Institutional Ethical Committee (IEC). Adults for control group were selected based on the BMI calculation, growth charts and family without any history of obesity, hypertension and diabetic conditions. Food preference was recorded based on the questionnaire specially designed for this study. Information about socioeconomic factors and medical history of the family was recorded. Modified method of Harris and Kalmus.[8] was used to assess the PTC taster and non-taster phenotype.

With their consent, the subjects were asked to taste the PTC solution of different concentrations 0.25%, 0.025% and 0.0025% and the results were recorded in the pro-forma. PTC super tasters, tasters and non-tasters were recorded based on their taste sensitivity at different dilutions, non-tasters (n=32), medium-tasters (n=31) and super-tasters (n=49). Lemon juice and mashed potato were chosen because these types of food are familiar to the population, and both are convenient vehicles to manipulate the intensity of several attributes.

Sensory analysis was carried out in the morning with an interval of at least 2 hours between the last meal and the test. The tests were performed at the Physiology Laboratory of TN Medical College, Mumbai Maharashtra, India, Statistical analysis was performed using SPSS statistical software 18.0. Logistic regression was performed to assess the association of tasting ability with different variables and obesity as covariates. Case–control status was used as a dependent variable and obesity as covariates. Results are reported as odds ratios from a model with variables. The results were presented as frequency, mean, standard deviation, and minimum and maximum values.

Comparisons of the means of anthropometric variables and gender among the three taster groups were performed using the Kruskal-Wallis test. The Student-Newman-Keuls test was used to determine group differences in mean ratings. Nonparametric analyses of repeated ordinal categorical data were performed to verify the relationship between PTC taster status and pleasantness.[17] (SINGER; POLETO; ROSA, 2004). A value of p <0.05 was used as criterion for statistical significance.

RESULTS: A total of 112 individuals, majority of men (72%), aged between 18 to 25 years participated in the study (Figure 1). Age, weight, and BMI were similar across all groups. There were no statistically significant differences between age, weight, and body mass index in relation to PTC taster status or gender (p = 0.06), as can be seen in Table 1. A total of 68% of individuals had some degree of sensitivity, with the majority being super-tasters (42%) and in minor number of non-tasters (24%), as shown in (Figure 2).

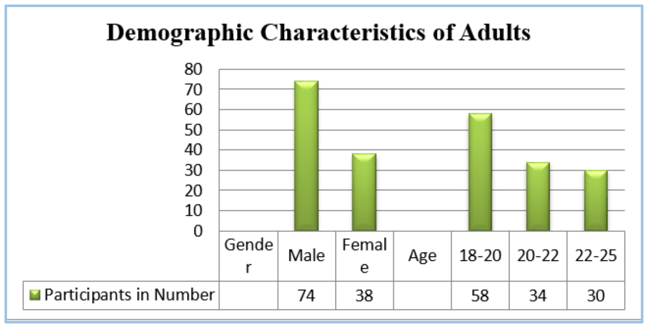

Table 1: Anthropometric Data by PCT Taster Status (Non Tasters, Medium Tasters and Super Tasters)

Anthropometric Data	Non Tasters		Medium Tasters		Super Tasters		P-Value
	Mean±SD	**Min-Max**	**Mean±SD**	**Min-Max**	**Mean±SD**	**Min-Max**	
Age (Y)	20 ±5.0	18-25	18±3.5	19-22	22±25	21-25	0.72
Weight (KG)	68.0±12.0	48-80	60±80	46-82	63±21	68-87	0.86
BMI	26.1±5.4	18.5-33	27.3±3.4	21-6.5	28±7.5	28-10	0.72

P<0.05, S.D=Standard Deviation, Min=Minimum, Max=Maximum

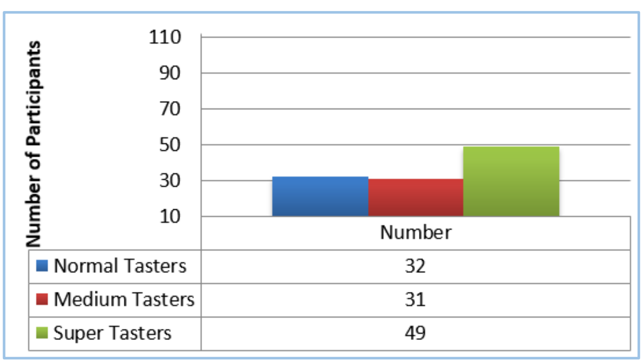

Fig. 2: Showing the Distribution of Study Population by PTC Status

The logistic regression analysis was done at all combination to establish specific relation of food habit and overweight/obesity, the odds ratio were significant for all the variables like consumption of junk food, bakery product, meat and chicken, fat and oily food at least 4 days/week. The 95% confidence intervals for the effect of unhealthy food habits on overweight/obesity were significant. This analysis suggests that the high caloric unhealthy food habit is one of the possible risk factor in causing overweight/obesity.

Variables (Criteria's)		
Odds ratio (95% C. I)	Univariate	P value
Rice daily	2.655 (1.489;4.439)	0.002*
Wheat daily	0.613 (0.389; 0809)	0.022
Vegetable daily	0.352 (0.160; 0.554)	0.001*
Meat & chicken >3 days/week	5.333 (3.313;8.618)	0.001*

Bakery product >3 days/week	5.182 (2.546; 8.760)	0.001*
Junk food >3 days/week	9.500 (5.458;18.208)	0.001*
Fat and oily food >3 days/week	4.042 (1.864; 6.564)	0.001*

***Table 2**: Logistic Regression Analysis of Food Habit in Overweight/Obese and Control Population (C. I. =Confidence Intervals)*

* = significant

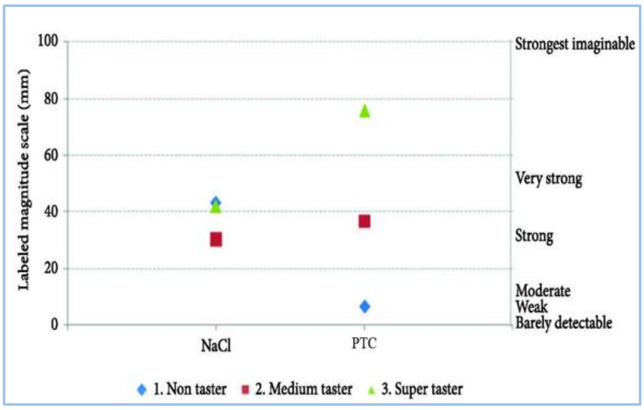

Fig. 3: Shows the Classification of Individuals by Level of Sensitivity to PTC

The upper limit of the confidence interval for non-tasters was 8.0 mm, approximately "weak" on the scale; the lower limit for the super-tasters was 69.9 mm, corresponding to "very strong", while medium-tasters fell between these values. Significant differences were found among the three groups ($p < 0.01$).

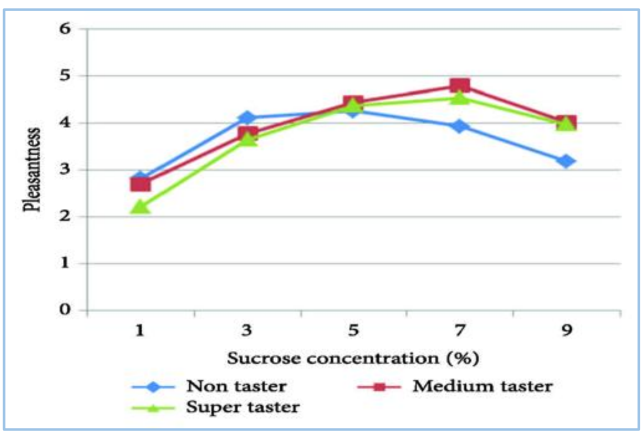

Fig. 4: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Sucrose Concentration in Lemon Juice by Taster Status

There was no significant interaction effect between PTC taster status and concentration of sucrose ($p=0.14$), salt ($p=0.46$), and fat ($p=0.84$); however, non-tasters preferred the 5% sugar orange juice assigning a mean pleasantness of 4.4, whereas medium- and super-tasters scored the 8% concentration with the highest values of 4.9 and 4.8, respectively, as shown in Figure 4.

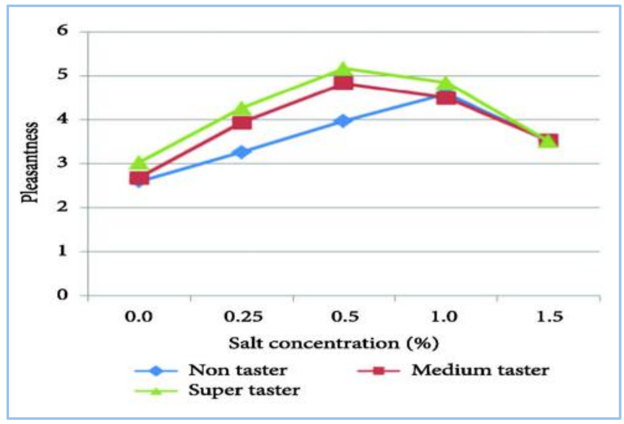

Fig. 5: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Salt Concentration in Mashed Potato by Taster Status

Regarding salt, non-tasters attributed the highest score (4.6) to the 1 % concentration. Medium- and super-tasters preferred the 0.5 % sample with a mean pleasantness of 4.8 and 5.2, respectively (Figure 5). For the 1 % concentration, lowest scores were given regardless of taster status.

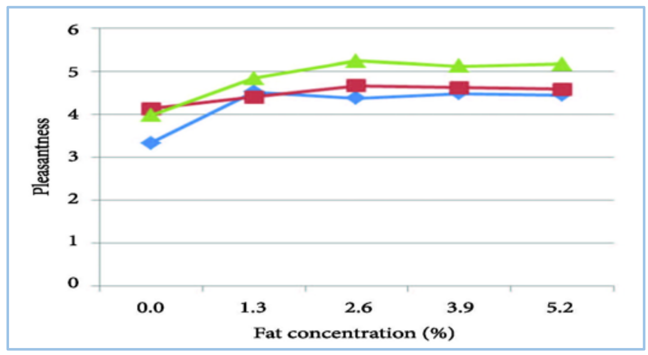

Fig. 6: Mean Rated Pleasantness on a Seven-Point Category Scale as a Function of Fat Concentration in Mashed Potato by Taster Status

With regard to fat, mean pleasantness responses for the non-tasters were highest for the 1.3% mashed potato (4.6), whereas medium- and super-tasters assigned the highest values to the 2.6% concentration (4.8 and 5.4, respectively), as shown in Figure 6. The most preferred samples were less clear considering the similarity of the three groups at all concentrations of 1.4% and above.

DISCUSSION: The LMS scale used in this study has a finite upper limit and provides individuals, especially super-tasters, with greater freedom of expression. Labelled scales allow better discrimination of levels of sensitivity.[18-20] The cut-off points found for classifying PCT taster status in our sample were similar to those described in the literature found values of 77 mm for super-tasters and 9 mm for non-tasters.[21] The distribution of phenotypes found in the present study was also consistent with that reported in the literature showing that although the frequency of non-tasters varies according to race and ethnicity, approximately 30% of the population have this characteristic.[1,22]

Earlier studies found out a high incidence of non-tasters among patients with nodular goitre.,[23,24] congenital athyreotic, cretinism .[25,26] and dental caries.[27] Sharma et al[28] has reported a higher frequency of non-tasters in epileptic twins. In the present study, the prevalence of PTC taster status is high in case of non-obese adults when compared to overweight/obese. Recent studies showed that people who can taste PTC (Taster) are more sensitive to salt, sweet foods, sharp tasting foods, spicy foods, and alcohol. Tasters are also better in discriminating between high and low fat foods, such as various types of salad, etc. Anatomical studies reported that tasters actually have more taste buds than non-tasters.[29]

Keller et al stated that non-tasters like high fat diet more than low fat diet, whereas tasters show the lack of preference for food.[30] Bartoshuk et al reported that the taste of sucrose is more intensively sweet to tasters than to non-tasters and tasters have high sensitivity to sweetener such as saccharin and neohesperidin dihydrochalcone .[31] Food pattern and eating habits of the adults involves the information of the type of diet, frequency of non-vegetarian consumption, nature of food, frequency of consumption of stuff food, nutrient intake, etc. Even in our study, we found more non-tasters who are overweight/obese compared to tasters, which once again emphasises on the choice of food and its relation with obesity in general population when the PTC taster and non-taster were subjected for logistic regression analysis, the effect of adolescent obesity was not diluted showing an increase in odds by 20% and 39% per extra year in tasters and non-tasters respectively.

Bitter, sweet, and umami tastes are mediated by G-protein-coupled receptors (GPCRs). Bitter taste receptors are encoded by 25-30 TAS2R genes, located on chromosomes 12p13, 7q34, and 5p15.[32] the ligand specificity of TAS2Rs appears to be quite broad, consistent with their roles in detecting thousands of bitter-tasting compounds. One of these, TAS2R38 has been extensively characterised in vitro, in vivo, and in human populations, and is responsive to the bitter stimuli phenylthiocarbamide (PTC), propylthiouracil (PROP), and to thiocyanates–bitter compounds found in brassica vegetables such as Brussels, sprouts and broccoli. Single nucleotide polymorphisms (SNP) located within a linkage disequilibrium block of these genes account for the association of taste, food preference and increase in weight.[33]

The statistically significant variation also holds good for consumption of balance diet, high caloric diet and physical exercise in obese adults and healthy adults. These results support that sensation in choice of food is very much diminished in non-tasters. Tasting ability is also likely to be influenced by many other sensory and proprioceptive pathways, and the probable result is that no single genetic marker has a great effect. In particular, other pathways are likely to include olfactory contributions to food preference, although digestive and cognitive factors may complicate the overall system and modify the ability to perceive bitter taste.[34]

The present study shows that overweight/obese adults were less likely to consume food like wheat, vegetable and fruits in their daily food which are highly nutritive whereas high consumption of bakery product, junk food, meat, chicken, fat and oily food in their diet was evident. As majority of overweight/obese adults being non-sensitive to salt, sweet foods, sharp tasting foods, spicy foods and high fat diet, they consume more bakery products, junk food and typically incorporate all of the potentially adverse dietary factors in a large portion size. Additionally, these foods tend to be low in fibre, micronutrients and antioxidants which is responsible for weight gain.[35]

Among non-obese adults, majority of them are PTC tasters and are very sensitive to some tastes especially bitter, sour, salty and sweet, etc. Hence, they avoid or restrict such foods. We also recorded the consumption of junk food, bakery food products in non-obese group are occasional or rare, and they showed high percent of physical activities. Increased frequency of non-taster allele is evident in adults with overweight/obese condition resulting in lack of preference for taste sensitivity in non-tasters. As phenotypic variation in PTC sensitivity is genetic in origin, this may represent a surrogate risk factor for the development of adolescent obesity.

CONCLUSION: PTC taster status was identified in the sample of Indian Adult Medical students who are in subjects evaluated. This study found no relationship between the level of sensitivity to PTC and age, sex, weight, BMI, and pleasantness. Although the genetic markers may influence the degree of liking and consumption of certain foods, one must consider that the mechanisms influencing eating behaviour in humans are complex and that psychological, social, and economic factors also play a key role in response to food. However, it is imperative that sensory response to foods be taken into account in nutrition education and intervention strategies. It is important to consider that there are no studies for the Indian adult population regarding PTC taster status, which reinforces the need for further research in this area which may be of use to public health workers improving the understanding behind the factors that drive food choices in prevailing adolescent obesity and its related diseases.

ACKNOWLEDGEMENTS: The authors are grateful to the Management TN Medical College, Mumbai Maharashtra, India for providing required facilities to carry out this study. The authors are also thankful to the volunteers who have participated in the study.

REFERENCES

1. Fox AL. Taste blindness. Science 1931;73:14.
2. Kim UK, Jorgenson E, Coon H, et al. Positional cloning of the human quantitative trait locus underlying taste sensitivity to phenylthiocarbamide. Science 2003;299(5610):1221-1225.
3. Tepper BJ, Nurse RJ. PROP taster status is related to fat perception and preference. Ann N Y Acad Sci 1998;855:802-804.
4. Kim UK, Drayna D. Genetics of individual differences in bitter taste perception: lessons from the PTC gene. Clinical Genet 2005;67(4):275-280.

5. Reed DR. Progress in human bitter phenylthiocarbamide genetics. In: Prescott J, Tepper BJ. eds. Genetic variation in taste sensitivity. New York: Marcel Dekker 2004:43-62.
6. Wooding S, Kim UK, Bamshad MJ, et al. Natural selection and molecular evolution in PTC, a bitter-taste receptor gene. Am J Hum Genet 2004;74(4):637-646.
7. Hartmann G. Application of individual taste differences towards phenylthiocarbamide in genetic investigations. Ann Eugen 1939;9(2):123-135.
8. Harris H, Kalmus H. The measurement of taste sensitivity to phenylthiourea (PTC). Ann Eugen 1949;15(1):24-31.
9. Drayna D, Coon H, Kim UK, et al. Genetic analysis of a complex trait in the Utah genetic reference project: a major locus for PTC taste ability on chromosome 7q and a secondary locus on chromosome 16p. Hum Genet 2003;112(5-6):567-572.
10. Bufe B, Breslin PAS, Kuhn C, et al. The molecular basis of individual differences in phenylthiocarbamide and propylthiouracil bitterness perception. Curr Biol 2005;15(4):322-327.
11. Ueda T, Ugawa S, Ishida Y, et al. Identification of coding single-nucleotide polymorphisms in human taste receptor genes involving bitter tasting. Biochem Biophys Res Commun 2001;285(1):147-151.
12. Duffy VB, Bartoshuk LM. Food acceptance and genetic variation in taste. J Am Diet Assoc 2000;100(6):647-655.
13. Duffy VB, Lucchina LA, Bartoshuk LM. Genetic variation in taste: potential biomarker for cardiovascular disease risk? In: Prescott J, Tepper BJ, eds. Genetic variations in taste sensitivity measurement significance and implications. New York: Marcel Dekker 2004:197-229.
14. Pasquet P, Frelut ML, Simmen B, et al. Taste perception in massively obese and in non-obese adolescents. Int J Pediatr Obes 2007;2(4):242-248.
15. CDC growth charts: United States advance data from vital and health statistics. No.314 National Center for Health Statistics Atlanta 2000.
16. Singer JM, Poleto FZ, Rosa P. Parametric and nonparametric analysis of repeated ordinal categorical data. Biometrical Journal 2004;46(4):460-473.
17. Essick GK, Chopra A, Guest S, et al. Lingual tactile acuity taste perception and the density and diameter of fungiform papillae in female subjects. Physiology Behavior 2003;80(2-3):289-302.
18. Kirkmeyer SV, Tepper BJ. Understanding creaminess perception of dairy products using free-choice profiling and genetic responsivity to 6-n-propylthiouracil. Chemical Senses 2003;28(6):527-536.
19. Prescot J, Tepper BJ. eds. Genetic variation in taste sensitivity. New York: Marcel Dekker 2004:89-104.
20. Goldstein GL, Daun H, Tepper BJ. Adiposity in middle-aged women is associated with genetic taste blindness to PCT. Obesity Research 2005;13(6):1017-1023.
21. Tepper BJ. Nutritional implications of genetic taste variation: the role of PROP sensitivity and other taste phenotypes. Annual Review of Nutrition 2008;28:367-388.
22. Kitchin FD, Howel-Envas W, Clarke CA, et al. PTC taste response and thyroid disease. Brit Med J 1959;1(5129):1069-1074.
23. Facchini F, Abbati A, Campagnoni S. Possible relations between sensitivity to phenylthiocarbamide and goiter. Hum Biol 1990;62(4):545-552.
24. Sheppard TH, Gartler SM. Increased incidence of non-tasters of phenylthiocarbamide among congenital athyreotic cretins. Science 1960;131(3404):929.
25. Fraser GR, Cantab MB. Cretinism and taste sensitivity to phenylthiocarbamide. Lancet 1961;277(7184):964-965.
26. Chung CS, Witkop CJ, Henry JL. A genetic study of dental caries with special reference to PTC taste sensitivity. Am J Hum Genet 1964;16:231-245.
27. Sharma K. Genetic epidemiology of epilepsy: a twin study. Neurology India 2005;53(1):93-98.
28. Volkers N. Gene for bitter taste could be due to smoking and eating behavior. InteliHealth New Service 2003.
29. Keller KL, Steinmann L, Nurse RJ, et al. Genetic taste sensitivity to 6-n-propylthiouracil influences food preference and reported intake in preschool children. Appetite 2002;38(1):3-12.
30. Bartoshuk LM, Davidson A, Kidd J. et al. Supertasting is not explained by the PTC/PROP gene. Chem Senses 2005a;30:A87.
31. Grimm ER, Steinle NI. Genetics of eating behavior: established and emerging concepts. Nutrition Reviews 2011;69(1):52-60.
32. Sausenthaler S, Rzehak P, Wichmann HE, et al. Lack of relation between bitter taste receptor TAS2R38 and BMI in adults. Obesity (Silver Spring) 2009;17(5):937-938.
33. Timson NJ, Christensen M, Lawlor DA, et al. AS2R38 (phenylthiocarbamide) haplotypes, coronary heart disease traits and eating behavior in the British women's heart and health study. American Journal Clinical Nutrition 2005;81(5):1005-1011.
34. Kurihara K. Glutamate: from discovery as a food flavor to role as a basic taste (umami). Am J Clin Nutr 2009;90(3):719S-722S.
35. Hu FB, van Dam RM, Liu S. Diet and risk of type II diabetes: the role of types of fat and carbohydrate. Diabetologia 2001;44(7):805-817.