Genetic Sensitivity to 6-N-Propylthiouracil (PROP) As a Screening Tool for Obesity and Dental Caries in Children

Amitha M Hegde* / Akhilesh Sharma **

Purpose: *Dental caries and childhood obesity epidemics are multifactorial complex disease and children's dietary pattern is a common underlying etiologic factor in their causation. Dietary preferences and taste are genetically determined. In the present study children were identified who are at greater risk for developing dental caries and obesity so as to institute preventive measures at an early stage.* ***Materials:*** *Among 500 children belonging to the age group of 8-12 years of both sexes PROP sensitivity test was carried out. Body mass index was determined and the caries experience was recorded. A Questionnaire was prepared and given to the parents of the children to evaluate their dietary habits. The results were subjected to statistical analysis using prevalence test, ANOVA test and chi-square test.* ***Results:*** *We found that the non taster children had higher caries experience and body weight respectively as compared to children who were super-tasters and medium tasters. Super-tasters tended to be sweet and fatty food dislikers and non-tasters tended to be likers.* ***Conclusions:*** *The PROP test proved to be a useful tool in determining the genetic sensitivity levels of the bitter taste and could be used as a useful screening tool to identify children at risk of developing obesity and dental caries.*

Keywords: *PROP; Taste perception; Caries experience; Dietary preferences; body weight.*
J Clin Pediatr Dent 33(2): 21–26, 2008

INTRODUCTION

A broad range of economic, social, cultural and behavioral variables, including food availability, influences food choices. However, the desire to select one food over another is more closely linked to taste and other sensory properties of foods. For many individuals, taste is the driving force behind food consumption.[1-4]

Obesity is the most common nutritional disorder in children, and the prevalence of the disease has increased dramatically over the past 3 decades. Currently, 25% of children are overweight or obese.[5] Presumably, the dietary patterns that promote obesity in young children are similar to those in adults, but this has yet to be demonstrated. Identifying obesiogenic dietary patterns in children is critical for understanding the development of this disease and for designing novel approaches to slow its progression.[6]

Individual variation in taste and food preferences may be genetically influenced.[7] The ability to taste bitter thiourea compound such as 6-n-propylthiouracil [PROP] is inherited. PROP tasters are more sensitive to many oral sensations, including bitter and sweet tastes and the sensation of fats.[8] PROP tasters generally dislike or show ambivalence to foods with high concentration of these taste qualities, where as nontasters tend to prefer them.[9] PROP status influences food selection and dietary habits, which could ultimately impact body weight.[7]

PROP is a medication used in the treatment of Grave's disease (hyperthyroidism), and the therapeutic dosage is 150 to 200 mg daily for adults and 50 to 150 mg daily for children aged 6–10 years. However, PROP can be tasted at very low concentration and the filter paper used for taste research contains only approximately 1.6 mg of PROP.[10]

The subset of population who rate PROP paper as intensely bitter are identified as supertasters. A super taster child is able to perceive stronger bitter and sweet tastes as compared to medium and nontasters.[11,12] Anatomically, supertasters also have a higher density of fungiform papillae and taste receptors on the anterior portion of the tongue than medium tasters and nontasters.[11,13,14,15]

The importance of taste for children is reflected in recent dietary trends. A significant proportion of children's daily energy comes from highly palatable foods such as sweet-fat snacks (cookies, doughnuts, quick breads, etc.), soft drinks,

* Dr. Amitha M Hegde, Professor and Head, Department of Pedodontics and Preventive Children Dentistry, A.B. Shetty Memorial Institute of Dental Sciences

** Dr. Akhilesh Sharma, Post Graduate Student, Department of Pedodontics and Preventive Children Dentistry, A.B. Shetty Memorial Institute of Dental Sciences

Send all correspondence to: Dr. Amitha M Hegde, Professor and Head of the department, Department of Pedodontics and Preventive Children Dentistry, A.B.Shetty Memorial Institute of Dental Sciences, Derlakatte, Mangalore – 575018, Karnataka , India

Fax: 0824 – 2204572.

E-mail: amipedo@yahoo.co.in
akhilhere@yahoo.com

and discretionary fats. Intakes of less palatable choices such as fruits, vegetables, and whole grains are lower than recommended.[16]

Studies have found that high sugar intake reflects a preference for sweet substances among majority of the children. However, the physiological mechanisms that affect a child's craving for sweets are not well documented.[17,18] Inherited behavior and taste thresholds may play an important role in the frequency of carbohydrate intake. Genetic sensitivity to taste may be associated with the preference for or rejection of some foods by children.[19]

Thus the present study was conducted to determine the relationship between body mass index (BMI), dietary preferences, caries experience and different taste sensitivity to 6-N-propylthiouracil in children.

MATERIALS AND METHOD

A total number of 500 healthy children belonging to the age group of 8–12 years of both sexes who reported to the department of Pedodontics and Preventive Children Dentistry, A.B. Shetty Memorial Institute of Dental Sciences, Mangalore were a part of this study. PROP sensitivity test was carried out. Body mass index was determined. A Questionnaire was prepared and given to the parents of the children to evaluate their dietary habits and the caries experience was recorded.

A single trained and calibrated examiner performed a comprehensive clinical examination with the assistance of one recorder. The caries experience (DMFS/dfs index) was recorded using visible light; mouth mirror and CPI probe.[20] All the teeth were examined for coronal surface caries and restorations. The number of decayed, missing and filled surfaces (dmfs/DMFS) in the coronal portion of each tooth was determined. Both primary and permanent dentitions were included.

Body weight was measured using a balanced beam scale and height was measured using stadiometer. Children were measured wearing light clothing and without shoes. Body mass index (BMI) was calculated using the formula weight in kilograms (Kg) divided by height in meter square (m^2). The BMI percentile for age and sex were plotted on the growth chart developed by CDC 2000 standards.[21]

A food frequency questionnaire (35 items) was prepared and was given to the parents of the children to know their child's dietary habits[22] and their sweet, and fatty foods preferences. Older children completed the questionnaire by themselves while the parents of the younger children were asked to fill the questionnaire.

The PROP test was carried out by another trained examiner with the help of one recorder. At no point in the study was this examiner aware of the caries scores and BMI status of any of the study participants. The pure sample of PROP was obtained from the pharmaceuticals (Macleod's, Mumbai) and the PROP strips were prepared.[23,24]

Following data collection, filter paper containing PROP was placed on the dorsal surface of the subject's tongue for 30 seconds to determine the genetic ability to taste a bitter or sweet substance.[6] It was ensured that the subjects abstained from consumption of any form of diet at least two hours prior to the PROP testing. When the bitter taste was at a maximum, the subject would rate the intensity of bitterness on the Green's scale.[25]

(Figure 1) and would be classified into groups of Supertasters (>60), Medium tasters (12-60) and Nontasters (<12) respectively. All clinical examinations and PROP testing were carried out at the same time of the day (mid-morning) throughout the study. All the cross sectional data were entered into a data base on Microsoft Excel and were subjected to statistical analysis using prevalence test, ANOVA test and chi-square test. Analysis was done using SPSS software version 11.

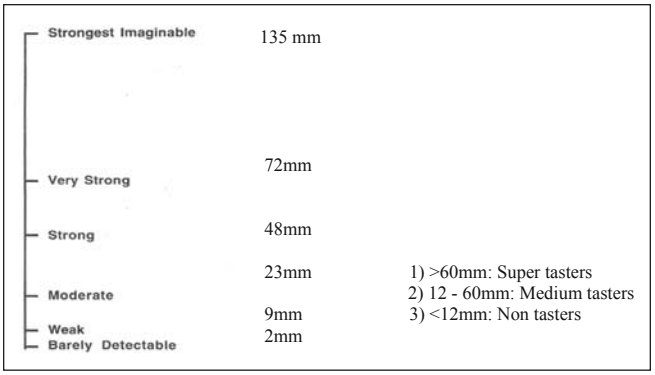

Figure 1. Green's Labeled Magnitude Scale

RESULTS

The sample population comprised of 500 school children aged 8–12 years. Of the 500 children 255 were males and 245 were females. Of the total population 190 (38%) were medium tasters, 180 (36%) were super tasters and 130 (26%) were non tasters. No statistical significant differences were observed in the male to female ratio among tasters and non-tasters.

The mean BMI among the Super tasters was 18.01, medium tasters 18.18 and for non tasters 19.85. The non tasters had a higher mean BMI than super tasters and medium tasters. Inter group comparison using students Neuman's keuls test showed that there was highly significant difference in the mean BMI between supers taster and non tasters and between medium tasters and non tasters. The difference in the BMI was not significant between the super and medium tasters. This was significant at the .05 level.

The dietary preferences among the PROP tasters showed an inverse relationship. Super tasters had disliking to sweet and fatty foods and non tasters had a liking to sweet and fatty foods. Medium tasters showed ambivalence to sweet and fatty foods. 80.6% of super tasters did not prefer sweet and fatty foods and 73.6% of non tasters preferred sweet and fatty foods. Among medium tasters, 25% preferred and 15.7% did not prefer sweet and fatty foods. As the taster status moved from super tasters to non tasters there was an increase in the sweet and fatty food preferences among the

children. This was found to be statistically very highly significant.

The super tasters had a mean DMFS value of 1.06, medium tasters 1.92, and non tasters had a value of 3.63. The mean dfs values in super tasters was 1.43, medium tasters 2.5 and non tasters had 5.28. Non tasters had higher mean caries experience. The values were found to be statistically very highly significant.

The highest DMFS score in super taster category recorded was 9, in medium tasters it was 16 and non tasters it was as high as 20.

The highest dfs score in super taster category recorded was 10, in medium tasters it was 29 and among the non tasters it was as high as 40.

After calculating the BMI percentile, two hundred and ninety-two (58.4%) children were in the 5th - 85th percentile range suggesting of having normal weight for their age and sex, whereas, forty-three (8.6%) children were below 5th percentile and were underweight. One hundred and eleven (22.2%) children were overweight ranging between 85th–95th percentile and another fifty-four (10.8%) children were obese and were above 95th percentile.

Taster status among children showed that 34.6% and 20.8% of non tasters were overweight and obese compared to 17.8% and 6.7% of super tasters respectively. 50% of the obese children and 40% of the overweight children were non tasters which was statistically very highly significant.

DISCUSSION

The present study included 500 healthy children, who were subjected to the PROP paper test and classified into super tasters, medium tasters and non tasters. The distribution of taster status in our study population showed that they were distributed equally. This is in accordance with a similar study in Indian population and American population[7] but in one section of American population[10] the numbers of non tasters were found to be significantly lower (11%).

The children in the super taster and non taster category could be identified easily as they would either find the taste of PROP extremely bitter or absolutely tasteless "as good as an ordinary paper" respectively but the child falling into medium category where it was neither too strong nor too weak were difficult to categorize, hence the medium tasters might contains both strong and moderate readings.

It has been found that super tasters have less preference for food products with stronger taste compared to non tasters. The super tasters are found to perceive bitter or sweet taste in lower concentration than non tasters, who may require higher concentration to perceive taste in food products. Thus the non taster children may have a higher concentration and higher frequency of sugar intake compared to children who are super tasters or medium tasters, and are therefore more susceptible to dental caries and overweight.[28]

Even in our study we found that the overall caries experience was higher in the non tasters compared to super tasters and medium tasters, which is in accordance to Brent, P.J. Lin.[10] Verma P[24] *et al* and Rupesh *et al*.[27]

Childhood obesity has reached epidemic levels in developed countries. Twenty five percent of children in the US are overweight and 11% are obese. The prevalence of childhood obesity is increasing since 1971 in developed countries[29] and the influence is slowly reflecting on the developing countries like India, which was found to be alarming in the present study with 22% of children belonging to the overweight group and another 10.8% belonging to the obesity group. It was also observed that around 50% of the children who are either obese or overweight were non tasters and they preferred sweet and fatty foods. Studies[7,8] have found an inverse relation between PROP sensitivity and body weight. Tepper and Ullrich had reported that non taster with unrestrained

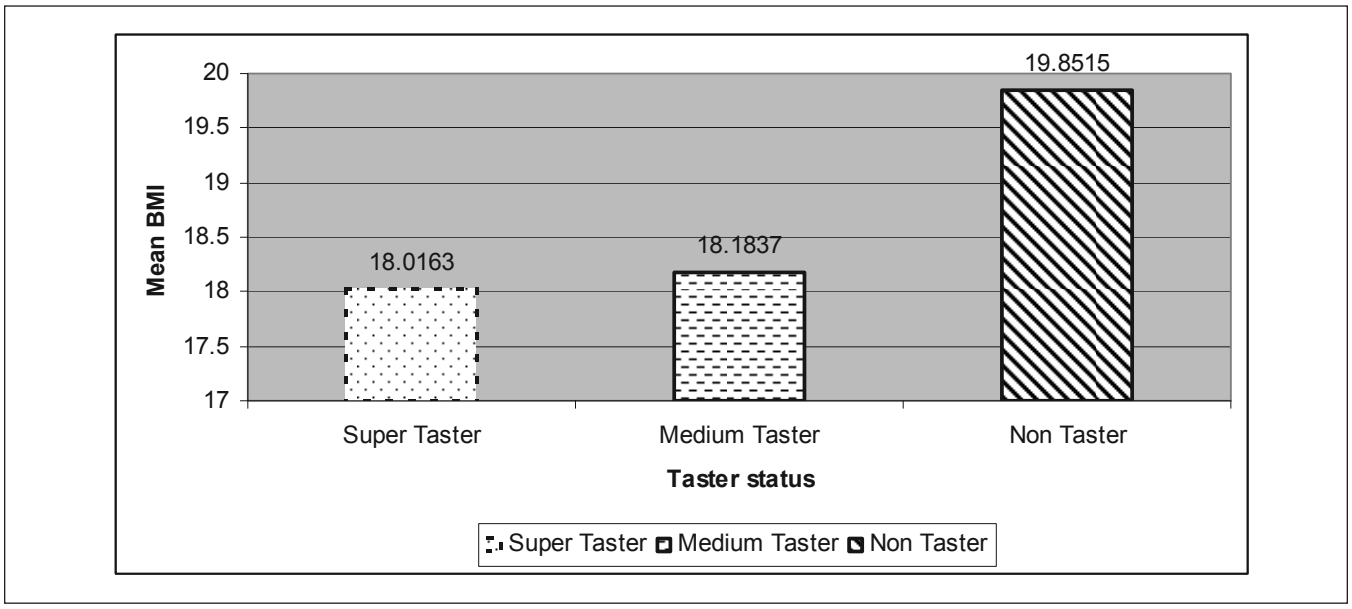

Figure 2. Bar diagram showing the mean BMI among the taster group

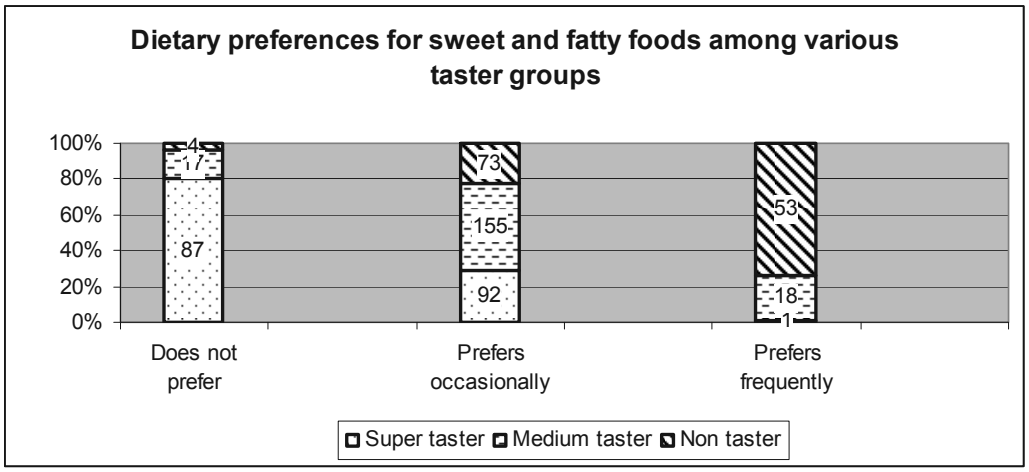

Figure 3. Cluster bar diagram showing Dietary preferences for sweet and fatty foods among the various Taster groups

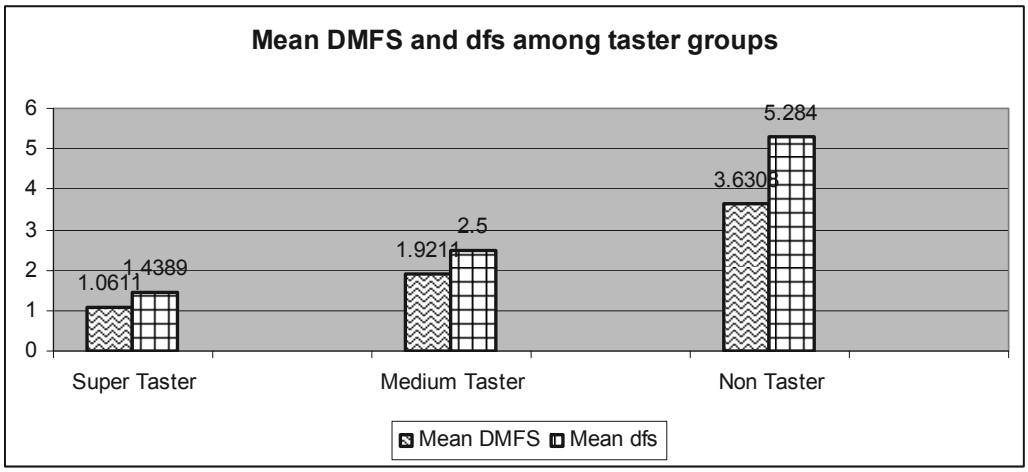

Figure 4. Bar diagram showing the mean DMFS and dfs among the taster group

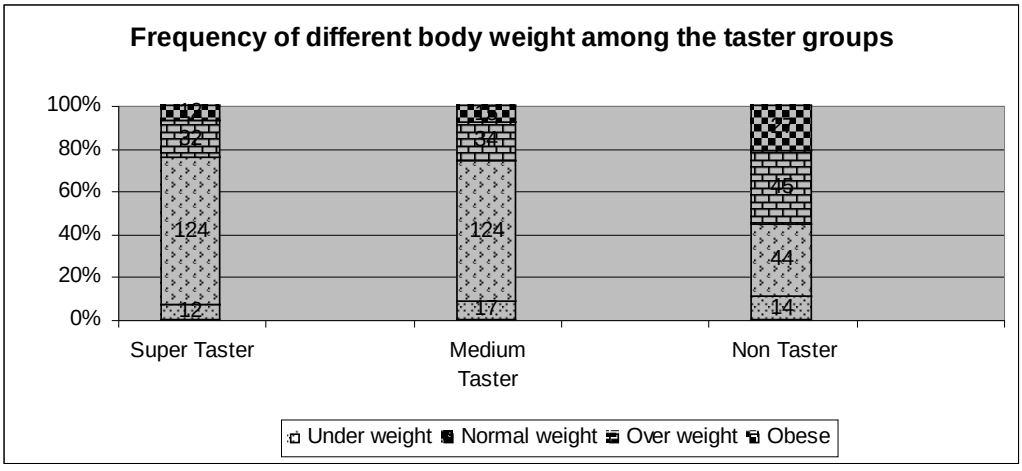

Figure 5. Bar diagram showing the frequency of different body weight among the taster groups

eating habits had higher BMI compared to restrained eaters.[30]

People who are categorized as non tasters have also been observed to have lower perception to the bitter taste of saccharine, potassium chloride; sodium benzoate and potassium benzoate and to the sweetness of sucrose, saccharin and neohesperidine dihydrocalcone compared to tasters [28,31,32]

CONCLUSION

There is a strong association between dental caries experience, BMI, dietary preferences and PROP sensitivity. The genetic sensitivity levels to bitter taste of PROP in the form of PROP paper test can be used to differentiate between super tasters, medium tasters and non tasters.

REFERENCES

1. Mela DJ. Determinants of food choice: relationships with obesity and weight control. Obes Res, 9 (suppl): 249S–55S, 2001.
2. Nestle M, Wing RR, Birch L, et al. Behavioral and social influences on food choice. Nutr Rev, 56 (suppl): S50–74, 1998.
3. Blundell JE, Gillett A. Control of food intake in the obese. Obes Res, 9 (suppl): 263S–70S, 2001.
4. Drewnowski A. Taste preferences and food intake. Annul Rev Nutr, 17: 237–53, 1997.
5. Strauss RS, Pollack HA**.** Epidemic increase in childhood overweight, 1986-1998. *JAMA*, 286: 2845–8. 2001.
6. Birch LL, Fisher JO**.** Development of eating behaviors among children and adolescents. *Pediatrics*, 101: 539–49, 1998.
7. Keller K L and Tepper B J**.** Inherited Taste Sensitivity to 6-*n*-Propylthiouracil in Diet and Body Weight in Children**.** Obesity Research 6 June Vol. 12 No. 904–912, 2004.8. Tepper BJ and Nurse RJ. PROP taster status is related to fat perception and preference. Annals of the New York Academy of Sciences, 855: 802–804, 1998.
9. Keller KL, Steinmann L, Nurse RJ, Tepper BJ. Genetic taste sensitivity to 6-n-propylthiouracil influences food preference and reported intake in preschool children. Appetite, 38: 3–12, 2002.
10. Lin BP. Caries experience in children with various genetic sensitivity levels to the bitter taste of 6-n-propylthiouracil (PROP): A pilot study. Pediatr Dentist, 25: 37–42, 2003.
11. Bartoshuk LM, Duffy VB, Miller IJ. PTC/PROP tasting: Anatomy, psychophysics and sex effects. Physiol Behav, 56: 1165–71, 1994.
12. Pickering GJ, Simunkova K, Di Battista D. Intensity of taste and astringency sensations elicited by red wines is associated with sensitivity to PROP (6-n propylthiouracil). Food Qual Prefce, 15 :147–54, 2004.
13. Bartoshuk LM, Duffy VB, Lucchina LA, Prutkin J, Fast K. PROP (6-n-propylthiouracil) supertasters and the saltiness of NaCl. Annal New York Acad Sci, 855: 793–6, 1998.
14. Duffy VB, Davidson AC, Kidd JR, Kidd KK, Speed WC, Pakstis AJ, et al. Bitter receptor gene (TAS2R38), 6-n-propylthiouracil (prop) bitterness and alcohol intake. Alcoholism. Clini Exp Res, 28: 1629–37, 2004.
15. Yackinous CA, Guinard JX. Relation between taste status, taste anatomy and dietary intake measures for young men and women. Appetite, 38: 201–9, 2002.
16. Munoz KA, Krebs-Smith SM, Ballard RB, Cleveland LE**.** Food intake of US children and adolescents compared with recommendations. Pediatrics, 100: 323–9, 1997.
17. Lehl G, Bansal K, Sekhon R. Relationship between cariogenic diet and dental caries as evaluated from a 5-day diet diary in 4–12 yr old children. J Indian Soc Pedod Prev Dent, 17: 119–121, 1999.
18. Jamel H, Sheiham A, Watt R.G. and Cowell C.R. Sweet preference, consumption of sweet tea and dental caries; studies in urban and rural Iraqi populations. International Dent J, 47, 213–217, 1997.
19. Downer MC. Caries experience and sucrose availability: an analysis of the relationship in the United Kingdom over 50 yrs. Community Dent Health, 16: 18–21, 1999.
20. World Health Organization. Oral health survey; basic methods. 4th Ed Geneva: World Health Organization; 1997.
21. Centers for disease control and prevention. Growth charts body mass index for age percentiles, boys and girls. Available at: http://www.cdc.gov/bmi/bmi-means.htm. Accessed July 13, 2005.
22. Per Axelson. Diagnosis and risk prediction of dental caries. 2001 Vol II quintessence publishing co. inc, Sweden; 156–168.
23. Zhao L, Kirkmeyer S.V, Tepper B.J. A paper screening test to assess genetic taste sensitivity to 6-n-propylthiouracil. Physiology & Behavior, 78: 625–633, 2003.
24. Verma P, Shetty V, Hedge AM. Propylthiouracil (PROP) – A tool to determine taster status in relation to caries experience, streptococcus mutans levels and dietary preferences in children. J Clin Pediatr Dent, 31(2): 113–117, 2006.
25. Green BG, Shaffer GS, Gilmore MM.A semantically Labeled Magnitude Scale of oral sensation with apparent ratio properties. Chem. Senses, 18: 683–702, 1993.
26. Peterson J, Philips M: salt liking and intake: Potential relationships with genetic variations in taste. http://ugradresearch.ucovv.edu/fur2000.html.
27. Rupesh S, Nayak UA. Genetic sensitivity to the bitter taste of 6-n propylthiouracil: A new risk determinant for dental caries in children. J Indian Soc Pedod Prev Dent, 24: 63–68, 2006.
28. Anliker JA, Bartoshuk L M, Ferris AM, Hooks LD. Children's food preferences and genetic sensitivity to the bitter taste of PROP. Am J Clin Nutr, 54, 316–320, 1991.
29. Dehghan M, Akhtar-Danesh N and Merchant A T. Childhood obesity, prevalence and prevention. Nutrition Journal, 4: 24. 2005.
30. Tepper B.J, Ullrich N.V. Influence of genetic taste sensitivity to 6-n-propylthiouracil (PROP), dietary restraint and dis inhibition on body mass index in middle-aged women. Physiology & Behavior, 75: 305–312, 2002.
31. Gent JF, Bartoshuk LM. Sweetness of sucrose, neohesperidin dihydrorochalcone, and saccharin is related to genetic ability to taste the bitter substance 6-*n*-propylthiouracil. *Chem Senses*, 7: 265–72, 1983.
32. Drewnowski A, Henderson S.A & Barratt-fornell A. Genetic Sensitivity to 6-*n*-Propylthiouracil and Sensory Responses to Sugar and Fat Mixtures. Physiology & Behavior, Vol. 63, No. 5, pp. 771–777, 1998.