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An Apprisal of Bitter Taste and Its Genetics in Human Population

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Abstract: *Bitter taste perception is a conserved chemical sense against the ingestion of naturally toxic chemical substances in human. Taste effects food preferences and dietary habits, thereby directly influencing the eating behaviour of an individual. Thus, bitter taste perception for phenylthiocarbamide(PTC) is a classically variable trait in human population. Variation in the ability to taste PTC is one of the most widely studied human genetic trait. The frequency of taster and non-taster allele is found to vary in different populations. The present paper deals with the distribution of PTC tasting ability as a marker to study the genetic structure among the local human population. This study was designed to investigate the association of PTC taster or non-taster with smoking/alcoholism preference and to find out the allele frequencies in the local population. This investigation was conducted during the year 2017 (February to July) involving a total of 409 study subjects divided into three different groups.*

Keywords: *Phenylthiocarbamide(PTC), Taste sensitivity, Population, Genetic variation, Allele frequency, Alcoholism, Smoking, Food preference, Chi square test of independence, Hardy-Weinberg equation.*

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I. Introduction

In 1931 Dupont Chemist A.L.Fox synthesized Phenylthiocarbamide(PTC) while researching artificial sweetners. He discovered accidently that some people found the chemical bitter, although he himself found it tasteless as chalk. This taste dimorphism later was found to be hereditary. Subsequently PTC perception is arguably one of the most studied human traits. PTC is a member of a large class of compounds which includes an N-C=S group[Fig 1], responsible for bitterness when placed in tongue. Bitter-taste perception for PTC is a classical variable trait in human population. The sensitivity to this compound has been believed to be a simple Mendelian recessive trait[Fig 2](Bartoshuk,2000; Fischer et al,1961) controlled by a dominant taster allele(T) and a recessive non-taster allele(t). Tasters have at least one dominant allele(TT or Tt) and non-tasters showing a double recessive genotype(tt). Kim et al have identified a small region on chromosome 7q, contain a gene that encodes a TAS2R bitter taste receptor. TAS2R receptor gene consisting of a single coding exon 1002 bp long, encoding a 333 amino acid, 7-transmembrane domain G-protein-coupled receptor, that responds to bitter stimuli. TAS2R receptor allow mammals to detect and avoid ingestion of toxic food(Drayna,2005). Alcoholism and smoking behaviour is associated with PTC insensitivity (Peeples 1962, DiCarlo and Powers 1998). Studies indicate that individuals with the strong tasters PTC gene variant were less likely to be smokers or alcoholic. This may indicate that people who find PTC bitter[Fig 3] are more likely than non-tasters to find the taste of cigarettes and alcohol bitter and be less likely to smoke or drink alcohol.

The thiocarbamides are known to be active goitrogenic substance, being inhibitor of thyroid function and some of these are naturally present in the edible plants of the Brassicaceae (Cabbage, Cdauliflower, Turnips, Brussel, Braccoli etc). Apart from goiter, several other diseases such as Diabetes,Tuberculosis, Mongolism, Duodenal and Gastric ulcers etc have been reported to be associated with the ability to taste PTC. A high incident of non-tasters has been reported in patients with nodular goiter, congenital athyreotic cretinism and dental caries.(Terry and Segall 1947; Chung,Witkop and Henry 1962; Harris,Kallmus and Trotter 1949; Kaplan,Fischer,Glanville et al 1964; Stanchev,Tsonev and Minchev 1985). These genetic traits is of epidemiologic and evolutionary interest and has been shown to correlate with a number of dietary preference and thus have important implications on human health. A person's threshold level for bitter taste influences his/her food preference; however, the food preferences do not influence a person's threshold level for bitter taste(Ly and Drewnowski). Of the four taste (bitter,sour,sweet and salty), bitter is the most aversive. Some of the factors that influence the bitter threshold level consist of disease. Therefore, PTC can be used as novel approach to explore the environment interachtions with the approach to explore the environment interactions with the disease conditions.

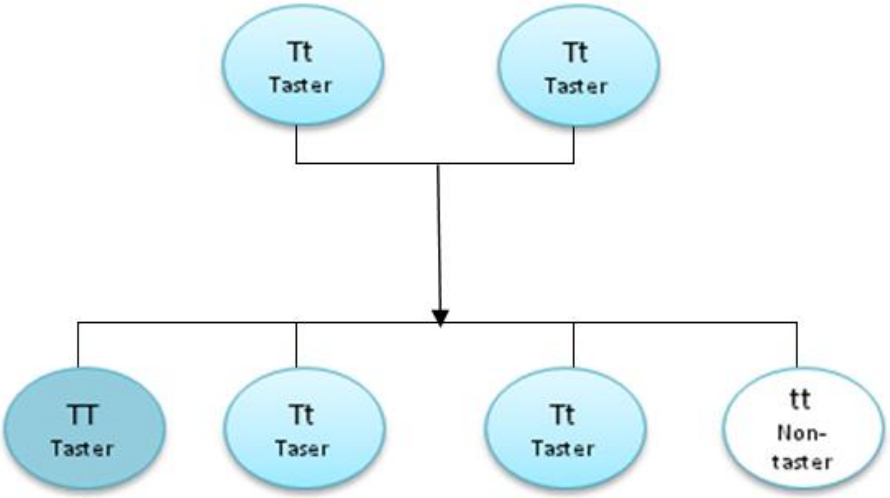

Fig 1 : Mendelian inheritance pattern of PTC tasting trait

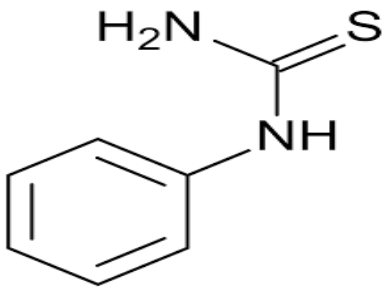

Fig 2 : Chemical structure of PTC

Fig 3 : A taster subject experience PTC during survey

II. Aims and Objectives

The ability o taste bitter compounds conveys a selective advantage in regard to human health and this ability is a dominant genetic trait. The test to determine PTC sensitivity is one of the most commonly used genetic tests on humans. The strong genetic basis for sensitivity to PTC has been used as a tool to trace family lineages and population migration patterns. This ability to taste PTC is described as a bimodal autosomal trait but in human populations show a tremendous variation in the frequency of tasters which ranges from 10% to 98%. The prevalence of taste blindness to taste bitter chemicals ranges from 3% in West Africa to 6-23% in China, 40% in India and 30% in US (Fenwick 1983). The present study was carried out to analyze the prevalence of PTC taste sensitivity among smokers and alcoholic persons and to determine the gene frequency in the local population.

III. Material and Method

The study was carried out in Purulia town, West Bengal, India among different locations choose at random during February 2017 to August 2017. A total of 400 study subjects were recruited considering the age group ranging from 15 to 45 years and further categorized into three groups. First two groups belong to male sex only and the third group belong both sexes. Blotting papers soaked in 0.05% PTC solution was used to assess the PTC tasters and non-tasters. At first with the consent of the subjects, they were requested to rinse their mouth twice with water and asked to taste the PTC paper. If the subject perceives bitter taste, the individuals is considered as taster and if the subject perceives the PTC paper as tasteless then he/she is considered as non-taster. Questionnaire was designed to collect information about smoking and Short Michigan Alcohol Screening Test (SMAST) for alcoholic involvement. The consent from subjects was taken before their participation in the study.

Statistical analysis was performed by Pearson Chi-square test of independence (2 x 2 contingency table) in QuickCalcs GraphPad statistical software to test association between test blindness and smoking as well as alcoholic habit. Allele frequency is measured by Hardy-Weinberg equation : $p^2 + 2pq + q^2 = 1$ ['p' is the frequency of dominant allele 'T' and 'q' is the frequency of recessive allele 't']. In order to estimate the frequency of the PTC tasting allele, the number of non-tasters(tt) must be counted. This is q^2. After determining q^2, p^2 can be calculated and finally the frequency of dominant allele and recessive allele can be determined.

Finding and Discussion

There is a significant higher incident of PTC tasters than non-tasters among the general population studied. A strong correlation exists between non-tasters and smoking and alcoholic condition in this study[Table 1 and 2]. This significant association with non-taster trait suggest that the inability to taste PTC is associated with a greater affinity to smoking and alcoholic habit. The non-tasters, who are less taste sensitive to the bitterness of cigarettes and alcohol are more at risk for heavy smoking and alcohol addiction which correlates with past studies. Although PTC is not available naturally, the ability to taste PTC strongly correlates with the ability to taste other naturally occurring bitter substances many of which are toxic and may have adverse health effects.

In the study it was found that percentage frequency of non-tasters were higher in smokers and alcoholics but it was less in control population. The frequency of 'T' allele in control population was 0.38, and the frequency of 't' allele was 0.62. My observation on PTC taste perception revealed that there is significant higher percentage frequency of tasters as compared to non-tasters among the local population which supports other studies.

	Smoker	Non-smoker	Alcoholic	Non-alcoholic	Control
Non-taster	37	24	28	19	77
Taster	18	34	17	32	123

Table 1 : Data collected during survey

PTC Perception	**Smoking**	
	Smoker	Non-smoker
Non-taster	37	24
Taster	18	34

X^2 = 6.613
(P=0.05,df=1,N=113)

PTC Perception	**Alcoholism**	
	Alcoholic	Non-alcoholic
Non-taster	28	19
Taster	17	32

X^2 = 5.006
(P=0.05,df=1,N=96)

Table 2 : 2x2 contingency table

IV. Conclusion

Virtually, all human populations studied to date display bimodality in sensitivity to PTC. This genetic trait is of epidemiological and evolutionary interest and has been shown to correlate with a number of dietary preferences and thus have important implication on human health. Acceptance and rejection of bitter fruits and vegetables, as well as sweet foods, added fats, spicy foods, nicotine and alcoholic beverages had an association with PTC taste sensitivity. The inability to taste PTC is associated with a greater susceptibility of nicotine and alcohol addiction. In contrast, the tasters were not susceptible for smoking, alcoholic addiction due to unpleasant taste sensation of alcoholic beverages and bitterness taste of cigarettes. In this current study higher incidence of tasters in local population is accordance with the Fisher hypothesis of natural selection and favours selection of a taster trait where inheritance pattern follows an autosomal dominant type.

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