

## **Association between Phenylthiocarbamide (PTC) Taste Perception and Falciparum Malaria Infection in Osogbo, Southwestern Nigeria**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author CI designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors YO and EOA managed the literature searches, collection of data, the analyses of the study, read the first draft of the manuscript. All authors read and approved the final manuscript.*

**Original Research Article**

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### **ABSTRACT**

**Aim:** To examine the association between the ability to taste PTC and falciparum malaria infection.

**Study Design:** A cross sectional study.

**Place and Duration of Study:** Ladoke Akintola University of Technology Teaching Hospital, Osun State General Hospital and Department of Biomedical Sciences, Ladoke Akintola University of Technology, College of Health Sciences, Osogbo, Nigeria between March and November 2012.

**Methodology:** A total of 567 individuals (276 males and 291 females) of age  $\geq 16$  years participated in this study after clinical examination and informed consent was obtained. The participants consisted of three groups. The first group consisted of 242 patients with symptomatic malaria. The second group consisted of 151 individuals with asymptomatic malaria while the third group (control group) consisted of 174 apparently healthy individuals without malaria as of the time of investigation. A sample of 2mL of blood was withdrawn from each participant for examination of malaria parasite. Thick and thin Giemsa stained blood smear were prepared for malaria parasite identification. Tasters and non-tasters were determined among the participants using phenylthiocarbamide (PTC) taste strips.

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**Results:** The number of tasters among symptomatic malaria subjects (81.8%) and asymptomatic malaria subjects (80.1%) was significantly higher than controls (70.1%). There were significant differences between symptomatic malaria subjects and controls ( $\chi^2=7.81$ ,  $p=0.005$ ), between asymptomatic malaria subjects and controls ( $\chi^2=4.30$ ,  $df=1$ ,  $p=0.038$ ) but insignificant difference between symptomatic and asymptomatic malaria subjects ( $\chi^2=0.17$ ,  $df=1$ ,  $p=0.678$ ).

**Conclusion:** Our findings show that among this study population, falciparum malaria is more associated with tasters than non-tasters.

*Keywords: Phenylthiocarbamide taste perception; falciparum malaria infection.*

## 1. INTRODUCTION

Genetic variation among humans is important in classifying and comparing them. Phenylthiocarbamide (PTC) tasting ability is generally referred to as a simple genetic trait governed by a pair of alleles, dominant T for tasting and recessive t for non-tasting. Persons with genotypes TT and Tt are tasters, and persons with genotype tt are non-tasters. Tasters are individuals who can taste PTC while non-tasters are those who cannot taste it. The ability to taste PTC has been strongly correlated with the ability to taste naturally occurring bitter substances [1]. Also, the ability or inability to taste PTC has been associated with some disorders or diseases. For instance, non-tasters are said to be more susceptible to epilepsy [2], nodular goiter [3], congenital arthritic cretinism [4] and dental caries [5] while diabetes, tuberculosis, mongolism, mucoviscidosis, duodenal and gastric ulcers have been reported to be associated with the ability to taste PTC [6-8]. While studying the distribution and frequency of PTC tasters and non-tasters in this locality, we decided to examine its relationship with malaria which is hyperendemic in the study area, Osogbo, Nigeria. Although some studies have shown that the ability or inability to taste (PTC) is associated with some infectious diseases, we are however not aware of any report on the relationship between PTC taste perception and malaria infection. The aim of this study was to examine the association between PTC taste perception and symptomatic and asymptomatic malaria subjects in Osogbo, Southwestern Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Subjects

The study was carried out in Osogbo, Southwestern Nigeria. Participants were drawn from patients attending malaria clinics of Ladoke Akintola University of Technology Teaching Hospital, Osogbo, Osun State, Nigeria and Osun State General Hospital, Asubiaro, Osogbo, Osun State, Nigeria and apparently healthy persons who visited these facilities for blood donation or routine investigation.

### 2.2 Subjects

A total of 567 individuals (276 males and 291 females) of age  $\geq 16$  years participated in this study after clinical examination and informed consent was obtained. The individuals were divided into three groups. The first group consisted of 242(42.7%) symptomatic malaria patients. The second group consisted of 151(26.6%) individuals with asymptomatic malaria

while the third group consisted of 174(30.7%) apparently healthy individuals without malaria as of the time of investigation.

### 2.3 Sample Collection and Laboratory Investigations

A sample of 2mL of venous blood was collected from each participant into ethylenediaminetetraacetic acid (EDTA) bottle for examination of malaria parasite. Thick and thin blood films stained with 3% Giemsa were examined for identification of malaria parasite. At least 200 microscopic fields were examined before declaring a smear as negative.

Phenylthiocarbamide (PTC) taste strips (30 mcg/strip) were obtained from Carolina Biological Supply Company, North Carolina, USA. Each participant was given a PTC taste strip and a filter paper (as control) and was asked to put each on their tongue and allow to be soaked in their saliva before describing their perception to each strip. Taste description of each participant was recorded. Questionnaires were administered to obtain data such as age, sex, number of bouts of malaria per year. Laboratory investigations were carried out in the Parasitology Laboratory, Department of Biomedical Sciences, College of Health Sciences, Ladoke Akintola University of Technology, Mercyland, Osun State, Nigeria.

### 2.4 Statistical Analysis

The statistical package for social sciences (SPSS version 14.0) statistical package was used for statistical analysis. Differences between percentages and proportions were tested by chi-square test. Sample means were compared by student's t test. A p-value of <0.05 was considered to be significant. The allelic frequencies were determined using Hardy-Weinberg method [9].

## 3. RESULTS AND DISCUSSION

Of the 567 subjects who participated in this study, 276 (48.7%) were males and 291 (51.3%) were females. The distribution of PTC tasters and non-tasters by sex is given in Table 1. Overall, 441 (76.9%) and 126 (23.1%) of the study population were tasters and non-tasters of PTC respectively. Of the 441 tasters, 209 (75.7%) of the 276 male subjects and 232 (79.7%) of the 291 female subjects were tasters. Although more females than males were observed to be tasters, the difference was not statistically significant ( $\chi^2=3.04$ ,  $df=1$ ,  $p=0.08$ ). The mean ages of tasters ( $30.6\pm 11.8$  years) and non-tasters ( $29.9\pm 12.3$  years) were not significantly different. The allelic frequencies for tasters (T) and non-tasters (t) of PTC were 0.53 and 0.47 respectively. Sixty-seven (24.3%) of the males (allelic frequency=0.49) and 59 (20.3%) of the females (allelic frequency=0.45) were non-tasters. Taste sensitivity to PTC was not dependent on age ( $\chi^2=5.6$ ,  $df=3$ ,  $p=0.13$ ).

The distributions of tasters and non-tasters among the malaria infected subjects and control subjects are given in Table 2. The mean ages of malaria subjects ( $30.1\pm 12.0$  years) and control subjects ( $31.4\pm 11.5$  years) were not significantly different. Malaria infection was dependent on age ( $\chi^2=19.12$ ,  $df=1$ ,  $p=0.002$ ). Of the 242 subjects with symptomatic malaria, 198 (81.8%) were tasters and 44 (18.2%) were non-tasters; 121(80.1%) and 30 (19.9%) of the 151 subjects with asymptomatic malaria were tasters and non-tasters respectively while 122(70.1%) and 52 (29.9%) of the 174 control subjects were tasters and non-tasters respectively. There was a significant association between malaria infection and ability to taste PTC ( $\chi^2=8.53$ ,  $df=1$ ,  $p=0.003$ ). There was a significant association between

symptomatic malaria infection and ability to taste PTC ( $\chi^2=7.81$ ,  $df=1$ ,  $p=0.005$ ). Also, there was a significant association between asymptomatic malaria infection and ability to taste PTC ( $\chi^2=4.30$ ,  $df=1$ ,  $p=0.038$ ). However, the ability to taste PTC was not dependent on whether malaria infection was symptomatic or asymptomatic ( $\chi^2=0.17$ ,  $df=1$ ,  $p=0.678$ ). Our data showed that the annual mean bout of malaria for tasters ( $2.891\pm 0.889$ ) was significantly higher than that of malaria for non-tasters ( $2.429\pm 0.903$ ) ( $t=5.08$ ,  $p=0.0001$ ). Trophozoites of *Plasmodium falciparum* from the study population are shown in Plate 1.

**Table 1. Distribution of phenylthiocarbamide tasters and Non-tasters by sex**

Subjects	Allelic frequency			T	t
	Tasters	Non-tasters	Total		
Male (%)	209 (75.7)	67 (24.3)	276(48.7)	0.51	0.49
Female (%)	232 (79.7)	59 (20.3)	291(51.3)	0.55	0.45
Total	441 (77.8)	126 (22.2)	567(100.0)	0.53	0.47

**Table 2. Distribution of Phenylthiocarbamide Tasters and Non-tasters by Malaria Infection**

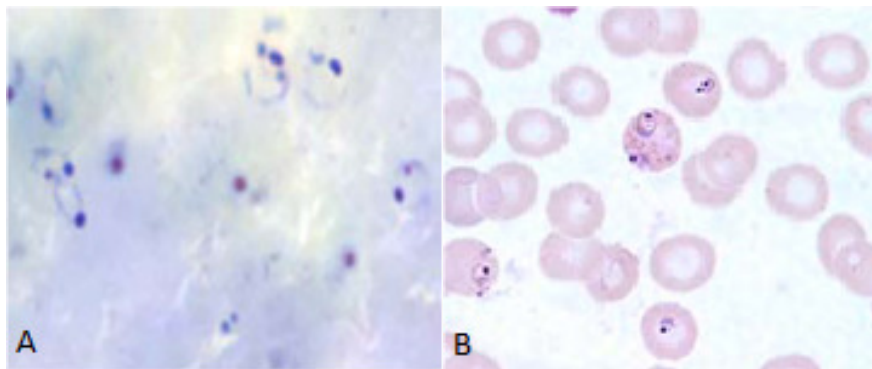
Subjects	Tasters (%)	Non-tasters (%)	Total (%)
Symptomatic malaria	198 (81.8)	44 (18.2)	242 (42.7)
Asymptomatic malaria	121 (80.1)	30 (19.9)	151 (26.6)
Non-malaria	122 (70.1)	52 (29.9)	174 (30.7)
Total	441 (77.8)	126 (22.2)	567 (100.0)

Our data showed that 76.9% and 23.1% of the study population were tasters and non-tasters of PTC respectively. The high incidence of tasters among this study population is in line with recent reports of other studies in Southwestern Nigeria [10,11]. Bakare et al. [10] reported 77.4% tasters and Alimba et al. [11] reported 70.6% tasters. Also, the frequency of tasters observed in this study is similar to those reported in other African countries. Boyd [12] reported 76% tasters among Assiut and 78% tasters among Egyptians. Globally, studies have reported that approximately 70% of the world populations are tasters [13,14].

Our study found no significant association between PTC taste perception and sex. Although more females than males were tasters in this study, the difference was not statistically significant. Similar observations were reported in previous studies carried out among Nigerians [10,11,15]. According to Guo and Reed [13] many studies had reported that women were more likely to be tasters and could taste PTC at lower concentration than could men. There appears to be hormonal mediation of the tasting ability, however, because women are more often taste-sensitive in this regard than are men [13].

Our results showed that there was a significantly higher incidence of PTC tasters among malaria subjects than controls. On the other hand, there was no significant difference between symptomatic and asymptomatic malaria subjects. Thus the taster status is significantly associated with malaria suggesting that the PTC gene, TAS2R38 may directly or indirectly participate in conferring susceptibility. We do not know the mechanism behind this. All the same, one explanation we can give stems from the fact that it is known that the ability to taste PTC has been strongly linked with the ability to taste other naturally occurring bitter substances [1] and non-tasters tend to ingest a greater quantity of bitter tasting substances present naturally in edible plants. In this study area, inhabitants generally take local herbs as

prophylaxis against infections. However, the main local antimalarial herbs are bitter [16] and since tasters dislike taking bitter things, the tendency is for them to avoid or abuse such herbs. Non-tasters on the other hand do not discriminate against such herbs and therefore stand better chance of being protected against malaria infection. This might possibly be one factor responsible for tasters being more infected with malaria than non-tasters. From the responses to the questionnaires administered we found that tasters had more frequent bouts of malaria compared to non-tasters. Further researches are needed in this regard to confirm this relationship and determine the possible mechanism involved.



**Plate 1. Shows trophozoites of *Plasmodium falciparum* in a thick film (A) and a thin film (B)**

#### **4. CONCLUSION**

We observed a significant association between ability to taste PTC and falciparum malaria infection reiterating the fact that individuals' responses to infection have a strong genetic basis. Understanding the genetics of a population can enhance better management and prevention of diseases.

#### **CONSENT**

Written informed consent was obtained from each of the participants recruited for this study.

#### **ETHICAL APPROVAL**

Ethical approval for this study was obtained from the Ethical Committee of Ladoké Akintola University of Technology Teaching Hospital, Osogbo, Nigeria. Therefore, all procedures were performed in accordance with the ethical standards laid down in the 1964 declaration of Helsinki.

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## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

## **REFERENCES**

1. Tepper BJ. 6-n-propylthiouracil: A genetic marker for taste, with implications for food preference and dietary habits. *Am J Hum Genet.* 1998;63:1271-1276.
2. Pal SK, Sharma K, Pathak A, Sawhney IMS, Prabhakar S. Possible relationship between phenylthiocarbamide taste sensitivity and epilepsy. *Neurol India.* 2004;52:206-209.
3. Facchini F, Abbati A, Campagnoni S. Possible relations between sensitivity to phenylthiocarbamide and goiter. *Hum Biol.* 1990;62:545-552.
4. Fraser GB. Cretinism and taste sensitivity to phenylthiocarbamide. *Lancet.* 1961;280:964-965.
5. 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.* 2006;6:63-68.
6. Terry MC. Taste blindness and diabetes in the coloured population of Jamaica. *J Hered.* 1950;41:306-307.
7. Saldanha PH. Apparent pleiotropic effect of genes determining taste thresholds for phenylthiourea. *Lancet.* 1956;271:74.
8. Manlapas FC, Stein AA, Pagliara AS, Apicelli AA, Porter IH, Patterson PR. Phenylthiocarbamide taste sensitivity in cystic fibrosis. *J Pediatr.* 1965;66:8-11.
9. Russell PJ. Population genetics In: *Genetics* 5<sup>th</sup> ed. USA. The Benjamin/Cummings publishing company Inc. 1998:714-71.
10. Bakare AA, Agbolade JO, Iyiola OA, Latunji CA, Alimba CG. Distribution and frequency of PTC taster and non-tasters alleles in the Nigeria population. *The Zoologist.* 2009;7:176-183.
11. Alimba CG, Adekoya KO, Oboh BO. Prevalence and gene frequencies of phenylthiocarbamide (PTC) taste sensitivity, ABO and Rhesus factor (Rh) blood groups and haemoglobin variants among a Nigerian population. *The Egyptian Journal of Medical Human Genetics.* 2010;11:153-158.
12. Boyd WC. *Genetics and Races of man, an introduction to modern physical Anthropology.* Boston: Little, Brown and Company. 1950;453.
13. Guo SM, Reed DR. The genetics of phenylthiocarbamide perception. *Ann Hum Biol.* 2001;28:111-142.
14. Drayna D. Human taste genetics. *Ann Rev Genomics Human Genet.* 2005;6:217-235.
15. Odeigah PG. Smell acuity for acetone and its relationship to taste ability to phenylthiocarbamide in a Nigerian population. *East Afr Med J.* 1994;71:462-466.

16. Sha'a KK, Oguce S, Watila IM, Ikpa TF. *In-vitro* antimalarial activity of the extracts of Vernonia amygdalina commonly used in traditional medicine in Nigeria. Sci World J. 2011;6: 5-9.

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