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DISTRIBUTION AND FREQUENCY OF PHENYLTHIOCARBAMIDE (PTC) TASTER AND NON TASTER ALLELES IN THE NIGERIAN POPULATION

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Abstract

There is limited information on population genetics of the Nigerian population as regards taste perception. This study investigated the distribution and frequency of taster (*T*) and non-taster (*t*) alleles in the Nigerian population using phenylthiocarbamide [(PTC), % composition = 30 mcg/strip] taste strips. Overall, a total of 6167 (3799 males and 2368 females) Nigerians from all the states of the geopolitical zones were used for this study. The frequency of non tasters was 22.60% and the *t* allele frequency was 0.48; while the frequency of tasters was observed to be 77.40% and the *T* allele frequency was 0.52. There were observable but statistically insignificant ($p<0.05$) differences in the PTC taste sensitivity among the geopolitical zones and according to sex. Generally there were more female than male tasters. The ability to taste PTC among Nigerians was found to be bimodal. Data obtained on subjects from Northern Nigeria is new and together with those of other zones in the country differ from previously published estimates for the Nigerian population. Our finding shows that the Nigerian population varies genetically with respect to PTC taste sensitivity, and this could be indicative of possible heterogeneity in the origin of the Nigerians.

Key words: Gene frequency, phenylthiocarbamide, taste sensitivity, geographical zone, Nigerian population, genetic variation.

Introduction

Understanding of genetic variation that exists among individuals is a very crucial tool in classifying and comparing them. Taste perception is one of the traits that have genetic implication in grouping individuals. It is known to influence individuals' qualities of foods and susceptibility to diseases (Prescott *et al*., 2001). The ability to taste phenylthiocarbamide (PTC) is a genetic trait that has also been referred to as "an honorary blood group" (Mc Kusick, 1995). To most people PTC is extremely bitter while to others it is completely tasteless. Numerous investigators have used varieties of sampling techniques to confirm the taster-nontaster dichotomy and concluded that in human populations, the inability to taste PTC is due to the homozygosity for an autosomal recessive allele (Snyder, 1932; Guo and Reed, 2001).

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This indicates that PTC taste sensitivity is bimodal. Family and twins studies have shown that the trait is inherited as Mendelian recessive with two alleles typically represented as *T* (taster allele) and *t* (non taster allele) (Whissel -Buechy, 1990).

The population genetics of PTC has received extensive investigation around the world. The distribution of PTC sensitivity varies strikingly in different populations. These populations varied from out-bred group such as school children to small genetically isolated groups such as the Australian Aborigines. Different frequencies of the non taster gene have been reported for the different races (Simmons *et al*., 1954; Scott-Emuakpor *et al*., 1975; Ly and Drewnoski, 2001). Information is however, limited on PTC taste sensitivity of the Nigerian population. Available reports (Kalmus, 1967; Scott-Emuakpor *et al*., 1975; Odeigah, 1994) are limited in the number of individuals tested, the taste strip used, geographical coverage and lack of information on the mode of inheritance of the sense of taste of the Nigerians.

Nigeria is a multi-ethnic federation divided in 1996 into 36 states and the federal capital territory at Abuja (Figure 1). There are over 350 ethno-linguistic groups with an estimated population growth of 140 million and an annual population growth of 2.8% (Federal Republic of Nigeria Gazette, 2007). As part of an ongoing project on heredity and the sense of taste of the Nigerian population, this study was undertaken to investigate the distribution and frequency of PTC taster and non taster alleles in the Nigerian population. This is expected to generate a database and provide an understanding on the distribution of this genetic trait among Nigerians. It will also extend current knowledge on how variable Nigerians are genetically, in terms of taste perception.

Fig. 1. Map of Nigeria showing the States of the Federation and the Federal Capital Territory (FCT)

Materials and methods

Ethical approval

This study was conducted with the approval of UI/UCH Institutional Review Committee via IRC protocol No: UI/IRC/02/0059 on a project entitled heredity and the sense of taste of the Nigerian population.

Taste strips

Phenylthiocarbamide [(PTC); $C_6H_5NHCSNH_2$; CAS No. 103-85-5; % composition = 30 mcg/strip] taste strips were obtained from Carolina Biological Supply Company®, Burlington, North Carolina, USA and TRI-ESS Sciences, INC®, CA, USA.

Human subjects and administration of PTC taste strips

The subjects consisted of individuals (age ≥ 15 years) from the 6 geographical regions of Nigeria (Fig. 1, Table 1). This consisted of students from 10 institutions of higher learning and individuals from towns and cities in these zones. All the subjects participated voluntarily. Each participant was given a PTC taste strip and filter paper (as control), and was asked to put each at a time on their tongue and allow to be soaked in their saliva before describing their taste perception to each strip. The subjects rinsed their mouths with potable water between each strip. Taste description of each subject along side their age, state of origin, sex and tribe were recorded.

Data analysis

Data obtained were organized according to the state and zone of origin, age and sex of each subject. They were grouped as tasters and non tasters based on their taste sensitivity and 2 × 2 contingency Chi- square was used to analyze the data (at 0.05 level of significance) using the SPSS 14.0® statistical package. The allelic frequencies were computed based on Hardy-Weinberg assumptions (The Open University, 1983; Russell, 1998).

Results

A total of 6167 individuals (3799 males and 2368 females) of age range 15 to 30 years participated in this study. Table 1 shows the division of the participants according to the geographical regions, state of origin and sex. Overall, there were 4773 (77.40%) tasters and 1394 (22.60%) non tasters. Tasters described their tastes as bitter, sour or sweet. The allelic frequencies for tasters (*T*) and non tasters (*t*) of PTC were 0.52 and 0.48 respectively. 23.37% of the males (gene frequency = 0.48) and 21.37% of the females (gene frequency = 0.46) were non tasters (Table 2). There were more female (78.63%) than male (76.63%) tasters but this is statistically insignificant (χ^2 = 3.356, $p>0.05$, df=1). In each of the geographical regions except the South South (χ^2 = 7.899, $p<0.05$, df=1) and South West (χ^2 = 4.556, $p<0.05$, df=1) regions, there was no significant association ($p>0.05$) between gender and taster and non taster ability of the subjects (Table 2). The allele frequencies of non tasters of PTC in the six geographical regions ranged from 0.40 in the Southeast to 0.51 in the Southwest. We did not observe any taste variation in the subjects according to age.

Table 1. Geopolitical zones, states and the number of participants in the study on phenylthiocarbamide taste sensitivity in Nigeria.

Geopolitical zone	Name of states in each zone	Participants		
		Male	Female	Total
South West	Oyo, Ogun, Ondo, Osun, Lagos, and Ekiti	1034	872	1906
South East	Abia, Anambra, Ebonyi, Enugu, and Imo	169	218	387
South South	Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers	223	256	479
North Central	Kogi, Niger, Benue, Plateau, Nassarawa, Kwara, Abuja*	1139	622	1761
North East	Adamawa, Taraba, Borno, Yobe, Gombe, Bauchi	710	175	885
North West	Kano, Kaduna, Sokoto, Katsina, Jigawa, Zamfara, Kebbi	524	225	749

* Federal Capital Territory (FCT)

Table 2. Distribution and allele frequency of phenylthiocarbamide tasters and non tasters in Nigeria

Zone/sex	Number		Percentages		Allele frequency	
	Tasters	Non-Tasters	Tasters	Non-Tasters	*T*	*t*
North – West						
Male	398	126	75.95	24.05	0.51	0.49
Female	183	42	81.33	18.67	0.57	0.43
South – South						
Male	180	43	80.72	19.28	0.56	0.44
Female	178	78	69.53	30.47	0.45	0.55
South – West						
Male	749	285	72.44	27.56	0.48	0.53
Female	669	203	76.72	23.28	0.52	0.48
South – East						
Male	137	32	81.07	18.93	0.56	0.44
Female	188	30	86.24	13.76	0.63	0.37
North – East						
Male	563	147	79.30	20.70	0.55	0.46
Female	148	47	84.57	15.43	0.61	0.39
North – Central						
Male	884	255	77.61	22.39	0.53	0.47
Female	496	126	79.74	20.26	0.55	0.45
Total Males (n=3799)	2911	888	76.63	23.37	0.52	0.48
Total Females (n=2368)	1862	506	78.63	21.37	0.54	0.46
Overall Total (n=6167)	4773	1394	77.40	22.60	0.53	0.47

Discussion

There is variation among human populations in their ability or inability to taste PTC. PTC taste sensitivity, a classical inherited trait has a genetic, epidemiologic and evolutionary importance and has been implicated in human health and dietary preferences (Wooding *et al*., 2004; Kim and Drayna, 2005). In this study, we investigated the distribution and frequencies of taster and non taster allele in Nigeria using PTC taste sensitivity. Our data showed that 22.60 % (allele frequency = 0.48) of the studied subjects were found to be non tasters of PTC. This differs from previous reports on this subject in Nigeria. Kalmus (1967) reported a value of 13.7% for the non tasters in an Ibadan population in southwestern Nigeria; Scott-Emuakpor *et al*. (1975) reported 12.50% (t = 0.334) while Odeigah (1994) reported 12.60% (t = 0.335). The differences in these reports and ours may be due to the sample size and sampling techniques utilized. They used sorting techniques while we administered PTC impregnated taste strips (Moberg *et al.*, 2007). In terms of sample size, we have used the largest sample size so far on PTC study in Nigeria. This cuts across the various geographical zones of the country unlike previous reports that were restricted to populations in Ibadan and Lagos State in Southwestern Nigeria respectively. Nigeria has experienced a tremendous increase in population growth and inter-tribal marriages irrespective of the ethnic and religious differences.

In concert with previous studies (Kalmus, 1967; Scott-Emuakpor *et al.,* 1975; Odeigah, 1994), our data shows that the Nigerian population exhibits bimodal distribution with respect to PTC taste sensitivity. Differences in the number and frequencies of tasters and non tasters across the zones might be due to the non-uniform sample size from each zone and is statistically insignificant (χ^2 = 3.356, p>0.05, df =1). Similar differences had been reported by Eriksson *et al*. (1970) between Lapps and Finns in Finland, and among the old regional groups in Nigeria (Scott-Emuakpor *et al*., 1975). This is however, the first major report on PTC taste sensitivity and distribution in northern Nigeria. We are not aware of any other report on this zone except those of Scott-Emuakpor *et al*. (1975) wherein only 17 human subjects of Northern origin was sampled. The frequency (%) of non tasters obtained herein is similar to those of other studies in Africa and other continents. Boyd (1950) reported 24.0% among Assiut and 22.0% among Egyptians in Africa; Zhang *et al*. (1988) reported 23.0% among the Chinese while Eriksson *et al*. (1970) reported 22.1% among Europeans. Most of the tasters described their PTC taste as bitter or sour while a few considered it to be sweet. The ability to taste PTC as sweet might have been a possible mutation of the PTC gene that predisposed them to be sweet tasters (Guo and Reed, 2001).

Assessment of PTC perception has been extensively used in science to demonstrate human diversity. It is at times assumed that PTC tasting ability occurs with equal frequencies in males and females. The present finding shows that the frequency of non taster alleles in the female is less than that of the males. Although this is statistically insignificant, it is in agreement with those of Odeigah (1994) who reported similar findings among a Nigerian subpopulation; and Brown and Corcos (1982) who also reported similar findings among the US populations. Our observations may be useful

in anthropological studies and in human health effects. PTC itself has not been found in nature, but the ability to taste PTC is correlated strongly with the ability to taste other naturally occurring bitter substances, many of which are toxic (Harris and Kalmus, 1949; Barnicot *et al*. 1951; Tepper, 1998). For instance, non tasters of PTC tend to ingest a greater quantity of bitter tasting goitrogenic substances present naturally in edible plants which may exert greater thyroid stress. Such stress during intrauterine or early childhood growth and development might have effect on neurological maturation which in turn may make them more susceptible to epilepsy than tasters (Pal *et al*., 2004). Also inability to taste PTC has been associated with a number of medical and neurological illnesses not typically related to taste (Li *et al*., 1990; Ali *et al*., 1994; Moberg *et al*., 2005; 2007).

This study has shown differences in the sense of taste of the Nigerians using PTC taste strips. There are more Nigerian female than male tasters. There also appeared to be some geographical differences (though statistically insignificant) in PTC taste sensitivity as indicated by our data. This calls for further studies with larger sample size and with the use of other taste strips such as sodium benzoate. In line with previous observations on some other genetic traits in the country (Mosuro, 1996; Bakare *et al*., 2006; Azeez *et al*., 2007; Akinboro *et al*., 2008), the Nigerian population varies genetically with respect to PTC taste sensitivity.

We are currently compiling data on the mode of inheritance of *T* and *t* alleles in some Nigerian families.

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