

## Genetics of Castes and Tribes of India: Taste Sensitivity

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**ABSTRACT** In the present paper an attempt has been made to study the distribution differences in tasting ability in India, which are analysed in relation to ecological, socio-economic and linguistic factors. Among population groups of India, the frequency of the taster allele (*T*) is 0.457 (varies from 0.108 to 0.912). It is present in high frequency among scheduled caste and in low frequency among community. Among the different zones, it is present in high frequency in population groups of Islands followed by North and South India and in low frequency in West and Central India, where it is low in scheduled tribe groups in general. In Himalayan region, its frequency is high (0.533) as compared to non-Himalayan region (0.426). From Eastern Himalayan region the frequency of allele *T* is low (0.538) among populations with Mongoloid affinities as compared to the Mongoloid populations of East Asia and Southeast Asia (0.70) which may be due to high frequency of goiter in this region. High frequency is observed in Austro-Asiatic and Tibeto-Chinese families than in Dravidian and Indo-European families.

### INTRODUCTION

The importance of the ability to taste phenylthiocarbamide (P.T.C.) was realized long back in 1932 by Fox, when he failed to make any taste out of it, while his colleague found it to be bitter. Thereafter, Synder (1932) showed that the inheritance of the ability to taste P.T.C. was dependent on a single autosomal dominant gene. The simple model is, however, complicated by other factors like sex (Blakeslee and Salmon 1931; Falconer 1947; Mohr 1951; Pons 1955), age (Harris and Kalmus 1949a; Mohr 1951; Kalmus 1958; Glanville et al. 1964); the presence or absence of the saliva of the subject (Cohen and Ogden 1949) and also the strength of the test solution (Harris and Kalmus 1949b). These factors invariably modify the phenotypic expression and their genetic relationships to tasting and non-tasting alleles are not yet determined. It has been suggested that there are modifying genes at other loci (Stern 1960; Blumberg 1961) or otherwise, the penetrance of the two alleles may vary (Boyd 1950; Kalmus, 1958). Incomplete dominance and penetrance of the taster was suggested by Das (1958) and he estimated the degree of penetrance of taster gene to be 80 per cent, but it may be less (Das 1966). He further added that as it is most likely that the variation in the expression of the taster allele including its complete suppression could be due to extra-genic factors, the degree of penetrance might be different in different peoples, places, ages etc.

There are various methods to distinguish tasters from non-tasters (Fox 1932; Parr 1934; Blakeslee and Salmon 1935; Boyd and Boyd 1937; Hartman 1939; Harris and Kalmus 1949a) but the sorting technique with serial dilutions of Harris and Kalmus (1949a) is widely used with minor modifications because of its superiority in discerning the threshold of the individual with near perfection.

Today, it has been established beyond doubt that the ability to taste P.T.C. exhibits a strong dimorphism in human populations. The above factors which modify the actual response itself, additional researches have brought to light a number of relationships to this polymorphism, the most prominent being the ties of the thyroid, as well as its activity as a goitrogen (Harris and Kalmus 1949b). A number of studies have shown an excess of non-tasters among individuals having adenomatous goiter (Harris et al. 1949; Kitchin et al. 1959; Azevedo et al. 1965) and in addition to this, it was found that athyreotic cretins were significantly more likely to be non-tasters than normal controls (Shepard and Gartler 1960; Frazer 1961). Non-tasters have also more susceptibility to dental caries (Chung et al. 1964) and diabetes mellitus (Terry and Segall 1947; Terry 1950).

Some more reports are also available regarding the association of non-tasters with diseases (Saldanha 1956; Beiguelman 1964; Brachtel and Walter 1974; Mourao and Salzano 1978); such associations remain merely reports, and detailed work would be needed to advance further comments in this direction. Similarly, no specific relationship exists regarding the association of

the ability to taste P.T.C. with the change of age, sex and social habits, *viz.*, smoking, dietary habits (Blakeslee and Salmon 1935; Hartman 1939; Falconer 1947; Akesson 1959). For critical review on this subject *see* Jørgensen (1969).

The frequency of the taster allele *T* is about 0.50 among European populations. Among Southwest Asian populations it varies from 0.43 to 0.75. Among Mongoloid populations of East Asia and Southeast Asia the frequency of allele *T* is very high (about 0.70, ranges from 0.55 to 0.95). The frequency among Tibetans varies from 0.62 to 0.67. Among Africans also the frequency is high, albeit less than Mongoloids (Mourant et al. 1976; Roychoudhury and Nei 1988).

### IDENTIFY AND DISTINGUISH THE PEOPLE

For the biogenetical study of the people of India, researchers have generally used the following criteria to identify and distinguish the people: 1. Regional Groups, 2. Ethnic Groups, 3. Linguistic Groups, and 4. Religious Groups.

It should, however, be kept in mind that these are the convenient units of study, although there are significant levels of overlapping between them. For example, an occupational group pursuing traditional job inhabits a region, shares religion with other categories, belongs to one or the other language group and has an aggregation of ethnic properties. But in the human population genetic studies, out of these criteria one is chosen (Bhasin, 1988).

In the present study an attempt has been made to analyse the above mentioned biogenetical traits into 1. Regional Groups, 2. Ethnic Groups, 3. Traditional Occupational Groups and 4. Linguistic Groups (For details see Bhasin et al. 1994; Bhasin and Walter 2001, 2002; Bhasin 2006a, b)

**Mean Weighted Values:** To discern the pattern of regional groups, ethnic groups, traditional occupational groups and linguistic groups using the frequency data, the mean weighted values of the trait has been calculated and estimates for the various groups are presented.

### FREQUENCY OF TASTE SENSITIVITY AMONG INDIANS

The frequency of allele *T* among Indian populations is 0.457 (varies from 0.108 among Munda of Ranchi - Bihar to 0.912 in scheduled

caste of Andhra Pradesh) which is little low as compared to Europeans but similar to that of Southwest Asian populations. The frequency is highest from the Islands zone as compared to rest of the zones of India—North (0.488), South (0.483), Central (0.389) and West (0.369) India. Among the population groups from Himalayan region mostly with Mongoloid affinities, the frequency is highest (0.533) as compared to Non-Himalayan regions (0.426). The frequency of allele *T* is low in scheduled tribes (0.451) as compared to other groups with minor differences. It appears that populations with Mongoloid affinities possess high frequency of taster allele (*T*) and quite high frequencies are observed among the Mongoloids of Asia as compared to Indian tribal groups among whom high frequencies of the non-taster allele (*t*) are found. The frequency of allele *T* is high from Islands natural region (0.547) and also from the Himalayan mountain complex region (0.545), from where the frequency starts decreasing towards peninsular plateau. From the different climatic regions, the frequencies are high in polar, cold, humid and all monsoon type regions and is lowest in tropical savannah type region (0.377) (Bhasin et al. 1994; Bhasin and Walter 2001).

From East India, the frequency of allele *T* is quite low from the states of Bihar (0.298, varies from 0.108 to 0.490) and Orissa (0.324, ranges from 0.268 to 0.571) from where the frequencies are low among scheduled tribes as compared to rest of the ethnic groups, whereas from the states of Nagaland, Tripura, Meghalaya, Sikkim and Darjeeling district of West Bengal among the populations with Mongoloid affinities the frequencies are quite high (0.702, 0.597, 0.580, 0.694 and about 0.600, respectively).

Similar high frequencies are observed from Western Himalayan region among populations with Mongoloid affinities from the states of Jammu and Kashmir (Ladakhis - 0.762), Himachal Pradesh (Gurkhas - 0.615, Lahaulies - 0.643, Spitiens - 0.654, Kinnaura - 0.606, Shipi - 0.662, Bodhs - 0.656, Savangalas - 0.626) and Uttar Pradesh - Central Himalayan region (different groups of Bhotias about 0.600, Gurungs - 0.656 among others). The frequency of allele *T* is also quite high among Newars; Sherpas and Tamangs combined; and Sherpas (0.523, 0.533 and 0.719, respectively) of Nepal and Tibetans (varies from 0.616 to 0.672) (For details see Bhasin et al. 1992).

The frequency of allele *T* is low among

scheduled tribes from Central India and it is almost similar among all the tribals except Dhurwa in which it is quite low (0.180). The frequency is quite high among different ethnic groups reported from South India (0.483, varies from 0.184 to 0.912) and it is highest among scheduled caste groups (0.662). The frequency of allele *T* is highest among the population groups with Mongoloid affinities from the Himalayan region followed by South Indians.

From West India the frequency of allele *T* is observed lowest (0.369, varies from 0.249 to 0.536) as compared to other zones and the frequencies are almost similar in both the states of Gujarat (0.368) and Maharashtra (0.371). Among the scheduled castes and scheduled tribes of West India (0.302 and 0.331, respectively) the frequencies are lowest as compared to rest of the groups.

Among the Nicobarese with Mongoloid affinities the frequency of *T* allele is high (0.595)

and from Andaman Islands, among Onges the frequency is 0.436 as compared to Bhandas, who had migrated from Uttar Pradesh (0.335).

In general, the frequency of taster allele *T* is high among the population groups with Mongoloid affinities from the Himalayan region but lower than the Mongoloid populations from Far East and Southeast Asia and lowest among the scheduled tribes. The frequency of allele *T* is low in West India and from there the frequency starts increasing in all the directions (Table 1, Fig. 1).

The allele frequency *T* correlations with various climatic factors and altitude by different ethnic groups though showing significant differences are not high (Table 2).

Among the different occupational groups, the frequency of allele *T* is almost similar among higher—priesthood (0.453), trade and commerce (0.459) and others—agriculture (0.481) and menial workers (0.474) groups, which indicates gene flow

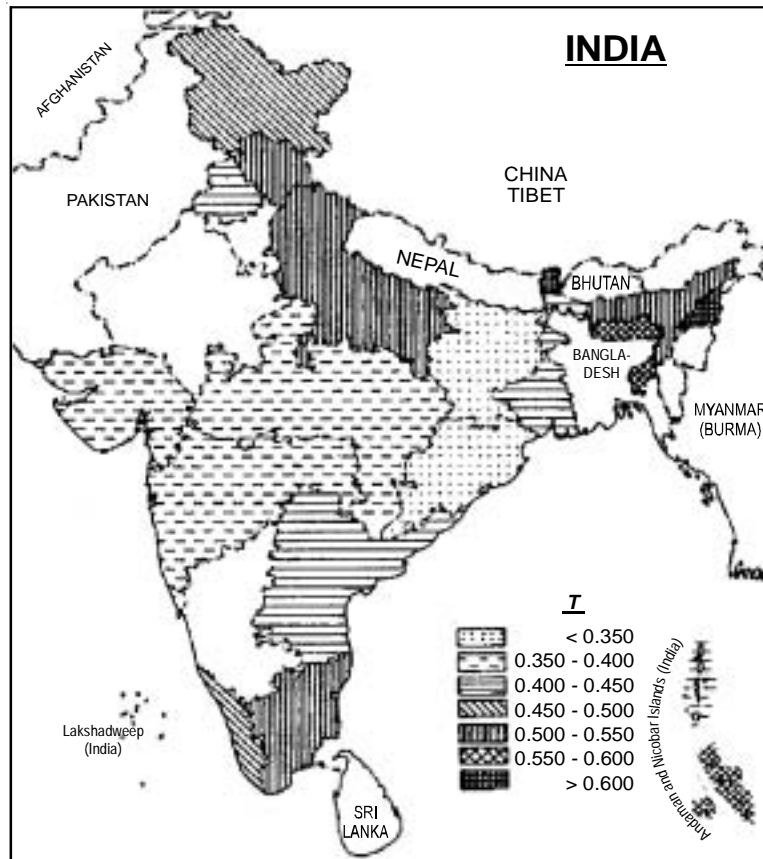


Fig. 1. Allele *T* of taste sensitivity in different regions of India

Table 1: Taste sensitivity (Allele frequencies)

Particulars	Subjects studied	No. of studies	Frequency T		
			Mean	Min	Max
<b>I. NATURAL REGION</b>					
Himalayan Mountain Complex	6550	46	<b>0.545</b>	0.285	0.762
Indus-Ganga-Brahmaputra Plains	20610	86	<b>0.469</b>	0.248	0.664
Peninsular Plateau	23737	136	<b>0.419</b>	0.108	0.912
Islands	878	8	<b>0.547</b>	0.335	0.678
<b>2. CLIMATIC REGION</b>					
Monsoon Type with Short Dry Season	1397	13	<b>0.519</b>	0.268	0.678
Monsoon Type with Dry Season	3627	18	<b>0.518</b>	0.184	0.729
Tropical Savannah Type	16525	93	<b>0.377</b>	0.108	0.912
Semi Arid Steppe Type	1442	7	<b>0.448</b>	0.257	0.577
Hot Desert Type	-	0	-	-	-
Monsoon Type with Dry Winters	28021	141	<b>0.489</b>	0.248	0.755
Cold Humid Winters with Short Summers	271	1	<b>0.631</b>	0.631	0.631
Polar Type	492	3	<b>0.659</b>	0.643	0.762
<b>3. POLITICAL DIVISION OF INDIA</b>					
<b>I. NORTH INDIA</b>					
<i>A. Western Himalaya (S. No. 1, 2)</i>					
1. Jammu and Kashmir	243	3	<b>0.460</b>	0.370	0.762
2. Himachal Pradesh	2395	18	<b>0.508</b>	0.285	0.654
3. Punjab	1608	10	<b>0.410</b>	0.248	0.586
4. Chandigarh UT	2288	7	<b>0.519</b>	0.426	0.655
5. Haryana	-	0	-	-	-
6. Delhi UT	1462	9	<b>0.421</b>	0.288	0.532
<i>B. Central Himalaya (S. No. 7, Eight Districts of Uttar Pradesh)</i>					
7. Uttar Pradesh	4530	37	<b>0.513</b>	0.307	0.532
8. Rajasthan	-	0	-	-	-
<b>II. WEST INDIA</b>					
9. Gujarat	3533	19	<b>0.368</b>	0.249	0.473
10. Maharashtra	2974	14	<b>0.371</b>	0.268	0.536
11. Goa, Daman and Diu UT	-	0	-	-	-
12. Dadra and Nagar Haveli UT	-	0	-	-	-
<b>III. EAST INDIA</b>					
<i>C. Eastern Himalaya (S. No. 13 to 20 and Darjeeling District of West Bengal)</i>					
13. Arunachal Pradesh	-	0	-	-	-
14. Assam	7324	23	<b>0.515</b>	0.348	0.664
15. Nagaland	273	3	<b>0.702</b>	0.635	0.755
16. Manipur	-	0	-	-	-
17. Mizoram	-	0	-	-	-
18. Tripura	401	1	<b>0.597</b>	0.597	0.597
19. Meghalaya	1624	13	<b>0.580</b>	0.502	0.676
20. Sikkim	261	2	<b>0.694</b>	0.638	0.733
21. West Bengal	6024	17	<b>0.433</b>	0.272	0.528
<b>Particulars</b>					
<b>Subjects studied</b>					
<b>No. of studies</b>					
<b>Mean</b>					
<b>Min</b>					
<b>Max</b>					
22. Bihar	1894	13	<b>0.298</b>	0.108	0.496
23. Orissa	3354	14	<b>0.324</b>	0.268	0.571
<b>IV. CENTRAL INDIA</b>					
24. Madhya Pradesh	867	9	<b>0.389</b>	0.180	0.483
<b>V. SOUTH INDIA</b>					
25. Karnataka	-	0	-	-	-
26. Andhra Pradesh	4346	28	<b>0.447</b>	0.184	0.912
27. Tamil Nadu	3274	15	<b>0.550</b>	0.342	0.729
28. Kerala	1211	9	<b>0.496</b>	0.257	0.638
29. Pondicherry UT	1011	4	<b>0.406</b>	0.363	0.422
<b>VI. ISLANDS</b>					
30. Lakshadweep UT	-	0	-	-	-
31. Andaman Islands and Nicobar Islands UT	188	2	<b>0.370</b>	0.335	0.436
	690	6	<b>0.595</b>	0.402	0.678
<b>3A. ZONES OF INDIA</b>					
<b>I. North India</b>					
	12526	84	<b>0.488</b>	0.248	0.762
<b>II. West India</b>					
	6507	33	<b>0.369</b>	0.249	0.536
<b>III. East India</b>					
	21155	86	<b>0.453</b>	0.108	0.755
<b>IV. Central India</b>					
	867	9	<b>0.389</b>	0.180	0.483
<b>V. South India</b>					
	9842	56	<b>0.483</b>	0.184	0.912
<b>VI. Islands</b>					
	878	8	<b>0.547</b>	0.335	0.678
<b>INDIA (TOTAL)</b>					
	51775	276	<b>0.457</b>	0.108	0.912
<b>3B. REGIONS OF HIMALAYA</b>					
<b>A. Western Himalaya</b>					
	2638	21	<b>0.504</b>	0.285	0.762
<b>B. Central Himalaya</b>					
	2361	17	<b>0.540</b>	0.368	0.702
<b>C. Eastern Himalaya</b>					
	10228	43	<b>0.538</b>	0.348	0.755
<b>HIMALAYA (TOTAL)</b>					
	15227	81	<b>0.533</b>	0.285	0.762
<b>NON-HIMALAYAN REGIONS</b>					
	36548	195	<b>0.426</b>	0.108	0.912
<b>4. ETHNIC GROUP</b>					
<b>A. ZONES OF INDIA</b>					
<b>I. NORTH INDIA</b>					
Caste					
	5974	44	<b>0.489</b>	0.285	0.702
Scheduled Caste					
	336	3	<b>0.478</b>	0.458	0.489
Scheduled Tribe					
	1489	9	<b>0.601</b>	0.486	0.762
Community					
	4727	28	<b>0.452</b>	0.248	0.656
<b>II. WEST INDIA</b>					
Caste					
	1665	8	<b>0.410</b>	0.318	0.485
Scheduled Caste					
	828	3	<b>0.302</b>	0.268	0.344
Scheduled Tribe					
	1476	9	<b>0.331</b>	0.249	0.473

Table 1: Contd.....

Particulars	Subjects studied	No. of studies	Frequency T			Particulars	Subjects studied	No. of studies	Frequency T		
			Mean	Min	Max				Mean	Min	Max
Community	2538	13	<b>0.387</b>	0.282	0.536	Community	2538	13	<b>0.387</b>	0.282	0.536
<b>III. EAST INDIA</b>						Warfare	2265	15	<b>0.499</b>	0.325	0.702
Caste	4803	16	<b>0.439</b>	0.296	0.571	Trade and Commerce	1972	13	<b>0.459</b>	0.257	0.587
Scheduled Caste	3452	12	<b>0.486</b>	0.313	0.664	Agriculture	4255	22	<b>0.481</b>	0.184	0.671
Scheduled Tribe	8530	44	<b>0.446</b>	0.108	0.755	Animal Husbandry	538	4	<b>0.295</b>	0.248	0.348
Community	4370	14	<b>0.454</b>	0.272	0.578	Artisans	501	5	<b>0.581</b>	0.458	0.876
<b>IV. CENTRAL INDIA</b>						Mental Workers	3673	16	<b>0.474</b>	0.268	0.912
Caste	-	0	-	-	-	No Information	30156	164	<b>0.450</b>	0.108	0.762
Scheduled Caste	71	1	<b>0.483</b>	0.483	0.483	<b>6. LANGUAGE GROUP</b>					
Scheduled Tribe	717	7	<b>0.377</b>	0.180	0.474	<b>I. AUSTRALO-ASIATIC FAMILY</b>					
Community	79	1	<b>0.405</b>	0.405	0.405	Mon Khmer Group	1958	14	<b>0.579</b>	0.394	0.678
<b>V. SOUTH INDIA</b>						Munda Group	3888	13	<b>0.272</b>	0.108	0.366
Caste	1636	8	<b>0.504</b>	0.257	0.729	<b>II. TIBETO-CHINESE FAMILY</b>					
Scheduled Caste	1537	10	<b>0.662</b>	0.555	0.912	(i) Siamese-Chinese Sub-Family	-	0	-	-	-
Scheduled Tribe	4665	29	<b>0.443</b>	0.198	0.718	Tai Group	-	-	-	-	-
Community	2004	9	<b>0.422</b>	0.184	0.597	(ii) Tibeto-Burman Sub-Family	-	-	-	-	-
<b>VI. ISLANDS</b>						Bhotia Group	492	3	<b>0.659</b>	0.643	0.762
Caste	-	0	-	-	-	Himalayan Group	699	6	<b>0.599</b>	0.458	0.733
Scheduled Caste	-	0	-	-	-	North East Frontier Group	923	6	<b>0.536</b>	0.452	0.618
Scheduled Tribe	878	8	<b>0.547</b>	0.335	0.678	Bodo Group	1924	8	<b>0.576</b>	0.477	0.662
Community	-	0	-	-	-	Naga Group	544	4	<b>0.667</b>	0.631	0.755
<b>INDIA</b>						Kachin Group	-	0	-	-	-
Caste	14078	76	<b>0.464</b>	0.257	0.729	Kuki Chin Group	-	0	-	-	-
Scheduled Caste	6224	29	<b>0.505</b>	0.268	0.912	<b>III. DRAVIDIAN FAMILY</b>					
Scheduled Tribe	17755	106	<b>0.451</b>	0.108	0.762	South Dravidian Group	7390	40	<b>0.489</b>	0.184	0.876
Community	13718	65	<b>0.436</b>	0.184	0.656	Central Dravidian Group	2571	17	<b>0.425</b>	0.180	0.686
<b>B. REGIONS OF HIMALAYA</b>						North Dravidian Group	395	5	<b>0.407</b>	0.275	0.496
<b>A. Western Himalaya</b>						<b>IV. INDO-EUROPEAN FAMILY</b>					
Caste	1535	13	<b>0.456</b>	0.285	0.606	Dard Group	-	0	-	-	-
Scheduled Caste	17	1	<b>0.458</b>	0.458	0.458	North Western Group	-	0	-	-	-
Scheduled Tribe	492	3	<b>0.659</b>	0.643	0.762	Southern Group	3184	16	<b>0.365</b>	0.268	0.500
Community	594	4	<b>0.499</b>	0.348	0.621	Eastern Group	1391	12	<b>0.492</b>	0.390	0.912
<b>B. Central Himalaya</b>						Bihari	10383	28	<b>0.462</b>	0.272	0.664
Caste	-	0	-	-	-	Central Group	13255	82	<b>0.447</b>	0.248	0.702
Scheduled Caste	1642	12	<b>0.512</b>	0.368	0.702	Pahari Group	1810	14	<b>0.476</b>	0.285	0.621
Scheduled Tribe	660	4	<b>0.600</b>	0.575	0.615	Unspecified	638	4	<b>0.552</b>	0.486	0.614
Community	59	1	<b>0.656</b>	0.656	0.656	Other Languages	330	4	<b>0.378</b>	0.329	0.436
<b>C. Eastern Himalaya</b>						No Information	-	0	-	-	-
Caste	1070	3	<b>0.439</b>	0.375	0.484	<b>6A. LANGUAGE FAMILY</b>					
Scheduled Caste	1947	4	<b>0.544</b>	0.402	0.664	I. Austro Asiatic Family	5846	27	<b>0.375</b>	0.108	0.678
Scheduled Tribe	4638	27	<b>0.589</b>	0.394	0.755	II. Tibeto Chinese Family	4582	27	<b>0.591</b>	0.452	0.762
Community	2573	9	<b>0.484</b>	0.348	0.578	III. Dravidian Family	10356	62	<b>0.470</b>	0.180	0.876
<b>5. TRADITIONAL OCCUPATION</b>						IV. Indo European Family	30661	156	<b>0.449</b>	0.248	0.912
Priesthood	8415	37	<b>0.453</b>	0.285	0.729	Other Languages	330	4	<b>0.378</b>	0.329	0.436
						No Information	-	0	-	-	-

**Table 2: Correlations with climatic factors and ethnic groups**

<i>Ethnic groups</i>	<i>Taste sensitivity T</i>
<b>Mean Annual Temperature</b>	
Caste	-0.222
Scheduled Caste	0.413 <sup>1</sup>
Scheduled Tribe	-0.570 <sup>3</sup>
Community	-0.349 <sup>2</sup>
Total	-0.326 <sup>3</sup>
<b>Mean Annual Rainfall</b>	
Caste	-0.039
Scheduled Caste	-0.477 <sup>2</sup>
Scheduled Tribe	0.460 <sup>3</sup>
Community	0.221
Total	0.189 <sup>2</sup>
<b>Mean Annual Humidity</b>	
Caste	-0.239 <sup>1</sup>
Scheduled Caste	0.498 <sup>2</sup>
Scheduled Tribe	0.400 <sup>3</sup>
Community	0.061
Total	0.206 <sup>3</sup>
<b>Mean Altitude</b>	
Caste	0.276 <sup>1</sup>
Scheduled Caste	-0.249
Scheduled Tribe	0.351 <sup>3</sup>
Community	0.276 <sup>1</sup>
Total	0.203 <sup>3</sup>

1. Significant at P < 0.05
2. Significant at P < 0.01
3. Significant at P < 0.001

among them, as also observed for other genetic markers (Bhasin et al. 1994; Bhasin and Walter 2001).

Among the populations of Himalayan region with Mongoloid affinities, the frequency of allele *T* is high in Mon Khmer group (0.579) of Austro-Asiatic; in Bhotia group (0.659), Himalayan group (0.599), Bodo group (0.576), Naga group (0.667) of Tibeto-Chinese languages as compared to the speakers of Dravidian followed by Indo-Europeans and Munda group of Austro-Asiatic languages among whom the frequencies are low (0.470, 0.449 and 0.272, respectively) (Bhasin et al. 1994; Bhasin and Walter 2001).

Among population groups of India, the frequency of taster allele *T* is 0.457 (varies between 0.108 and 0.912). From the different zones, it is present in high frequency among population groups of Islands followed by North and South India and is low in West and Central India, as well as among scheduled tribe groups in general. In Himalayan region, it frequency is high (0.533) as compared to Non-Himalayan region (0.426).

From Eastern Himalayan region, the frequency of allele *T* is low (0.538) among populations with Mongoloid affinities as compared to the Mongoloid populations of East Asia and Southeast Asia (0.700) which may be due to high incidence of goiter in the former region (Bhasin et al. 1994). Among the speakers of various languages, the frequency is high in Austro-Asiatic (Mon Khmer) and Tibeto-Chinese speakers with Mongoloid affinities from Himalayan region and Nicobar Islands than in the speakers of Dravidian and Indo-European languages.

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