

A Note on Polymorphism: The Ability to Smell Urinary Metabolites of Asparagus

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SUMMARY

It has been recognised for many years that an odorous substance is excreted in the urine after eating asparagus. Lison et al (1980) demonstrated that urinary excretion of this substance is universal and that the variable is the ability to detect the related odour — this ability being related to a dominant autosomal gene. The present study demonstrates the frequency of this gene in the Johannesburg Chinese population (0,131).

INTRODUCTION

It has been recognised for many years that some individuals excrete an odorous substance in their urine after eating asparagus. This odorous substance was regarded as being either

- (a) the result of an inborn error of metabolism, or
- (b) an inherited trait.

However, Lison et al (1980) suggested that the urinary excretion of this odorous substance is in fact universal, and that the variable is the ability to detect the related odour. It is possible that this odour sensitivity is a genetic hypersensitivity or general hyperosmia rather than an inborn error of metabolism. Furthermore, it is thought to be controlled by a single autosomal dominant gene.

It is known (Amoore, 1971) that in human populations there is a great variation with respect to olfactory acuity. Even amongst individuals with no obvious abnormality, the range in sensitivity may be several thousand-fold between the least and most sensitive observers. Thus it has been anticipated that some individuals in a population possess a specific sensitivity for a particular substance which the majority of the population cannot detect, and that this sensitivity is genetic in origin.

The present investigation seeks to determine if a specific hyperosmia is present in the Chinese population of Johannesburg. The experiment to be repeated is very similar to that conducted by Lison et al (1980) on a group of Israeli Jews of Ashkenazic, Yemenite and Moroccan origin, and a small group of mixed origin. The ages of these groups ranged from 17 to 69 years.

MATERIALS AND METHODS

Materials

The present investigation was carried out on a sample of 98 Johannesburg Chinese schoolchildren whose ages ranged from 6-11 years.

In order to eliminate any sex bias, the number of males and females is almost equal, that is, 46 males and 52 females.

Individuals with upper respiratory tract infections were not included in the test sample.

The majority of the individuals tested were not first degree relatives.

Methods

There was some doubt as to whether or not individuals who could detect an odour in their own urine after eating asparagus, could also detect the same odour in the urine of another individual — thus posing the question whether or not every subject involved in the experiment should be required to eat asparagus and then urinate, or if a single sample could be used for all tests. Following Lison et al (1980) a pilot experiment was conducted using the urine of adult males who had previously eaten asparagus.

The samples of urine were then presented to three volunteers who were aware of their ability to detect the urinary products of asparagus, and it was found that the characteristic odour could be detected by each of the volunteers — it was therefore concluded that urine from any one individual could be used for the present investigation.

Smell-test solutions

On the morning of the experiment, 270g of canned asparagus was eaten and the bladder emptied between one and two hours later. Immediately thereafter an undiluted sample of urine (solution 1) was decanted and a further twelve serial double dilutions of the urine were prepared with tap water.

Test Procedure

Each subject was initially presented with a test tube containing 40 ml tap water — representing 'no odour' — to act as a blank and the question was asked: "Is this water?" The serially diluted samples were then sniffed in order of increasing concentration until a transition point was reached at which a solution was first identified as giving off an odour. Retests were then made at and

around the transition point and a water sample was presented at random intervals. The smell threshold was defined as the lowest concentration of test substance that was differentiated from water in two successive tests. At no stage were the contents of any of the tubes revealed, and no subject was aware of what odour to expect.

RESULTS

Table I: DISTRIBUTION OF SMELL THRESHOLDS FOR THE ODOUR OF URINARY METABOLITES OF ASPARAGUS IN JOHANNESBURG CHINESE SCHOOLCHILDREN

Solution No.	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of males	—	3	2	10	11	5	3	3	3	6	—	—	—
No. of females	2	3	3	12	8	12	—	3	1	5	1	1	1
Total	2	6	5	22	19	17	3	6	4	11	1	1	1

Table II: PERCENTAGE FREQUENCY AND GENE FREQUENCY (P) OF SMELLERS IN JOHANNESBURG CHINESE SCHOOLCHILDREN TESTED

Sample	No. tested	Smellers		Gene frequency (P)
		No.	%	
Males	46	12	26,1	0,140
Females	52	12	23,1	0,123
Total	98	24	24,5	0,131

Two of the subjects were unable to detect a special odour in any of the diluted urine samples. It was found, moreover, that one of these subjects was able to differentiate the odour of the undiluted sample (solution 1) from water while the other could not distinguish between the concentrated sample and water. These observations are suggestive of anosmia, but whether this apparent anosmia is specific for the substance under test or whether it is a general defect in these two subjects was not determined in the present study.

All the other subjects identified the odour only as "a sour smell", but no one could be more specific. Discontinuous distributions were obtained in both the male and female samples and for the total population tested. Table I indicates that the antimode, that is, the threshold between smellers and non-smellers, for the combined sexes is at solution number 7 (1:128 dilution). However, the antimode for the male and female samples was different, that for the male at solution being at number 9, while for the female it was at solution number 7. These differences in the percentage frequency of smellers in the two sexes were tested by the chi-square test, using Yate's correction, and it was found to be not significant at the level of $P < 0,05$.

The gene frequencies were calculated on the assumption that the trait for the specific hyperosmia under consideration is determined by a single autosomal dominant gene — the frequencies for the 'smell' gene in males, females and

total Chinese School population are presented in Table II and it is evident that approximately a quarter of the population carry the 'smell' gene.

DISCUSSION

In a similar study of an Israeli population, Lison et al (1980) observed a 9,8% frequency of 'smellers' (gene frequency of 'smell' gene 0,024) and found no significant difference in the frequency of this gene in his age and sex sub-groups. Comparison with the results obtained in the present study shows that the frequency of 'smellers' is significantly higher in the Johannesburg Chinese schoolchildren — the difference being significant at the level of $P < 0,01$.

A search of the literature indicated that the above two populations are, to date, the only two assessed for frequency of the 'smell' gene, and it may thus possibly be premature to suggest that yet another useful 'gene marker' has been identified.

CONCLUSION

The urinary excretion of a pungent odorous substance after asparagus is eaten appears to be universal. The distribution curve of the smell thresholds for the odour of urinary metabolites of asparagus is bimodal, with the threshold of a small minority constituting the minor peak on the dilute side of the antimode. These results lend support to the view that the ability to detect the odorous substance constitutes a genetic polymorphism. Studies of the thresholds of large kinships would be decisive in determining whether or not there is a genetic factor.

There were no differences in the distribution of 'smellers' and 'non-smellers' for the specific odour in males and females.

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