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hTAS2R38 RECEPTOR GENOTYPES PREDICT SENSITIVITY TO BITTERNESS OF THIOUREA COMPOUNDS IN SOLUTION AND IN SELECTED VEGETABLES

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Abstract

With twenty-five G-protein-coupled TAS2R receptors bitterness is the most complex taste sensation in terms of signal transduction. The objective of this sensory study was to investigate the effect of hTAS2R38 bitter receptor gene genotypes on intensity of bitterness of different N-C=S containing compounds. In addition, we studied the bitterness of vegetables that produce glucosinolates, which also contain thiourea groups. People homozygous for the PAV form of the hTAS2R38 gene were significantly more sensitive to N-C=S containing compounds than those homozygous for the AVI haplotype. However, PAV subjects were not more sensitive than AVI subjects for structurally unrelated bitter tasting compounds. In addition, PAV/PAV subjects rated the glucosinolate generating vegetables as 60% more bitter on average than did the AVI/AVI subjects. This shows that genetic variation in taste perception predictably determines the taste of vegetables.

Introduction

Flavour has a great impact on food choice and acceptability. Taste and Aroma are the foundation of flavour. Bitterness is known to be the most complex taste sensation with twenty-five taste receptors being members of G-protein-coupled TAS2R receptor family. Bitterness may be a principal reason for food rejection. Human’s ability to taste bitter compounds that contain a thiourea (-N-C=S) structure, such as phenylthiocarbamide (PTC) and its chemical relative propylthiouracil (PROP), depends on their TAS2R38 bitter receptor genotype (1,2). Similarly, genetic approaches may be employed to determine sources of variability in the perception of complex chemical matrices such as in foods. Many nutritionally important compounds may contribute to unpleasant bitter taste. But individual differences in bitterness perception of these compounds might be significant. Yet, a receptive field for this receptor and its parallel in human bitterness sensitivity have not been mapped. Understanding of these genetic differences in humans is necessary for the study of food and specific food preferences.

The objective of this study was to investigate the effect of hTAS2R38 bitter receptor gene genotypes on intensity of bitterness of different N-C=S containing compounds. In addition, we studied the bitterness of vegetables that produce glucosinolates, which also contain thiourea groups (3). We hypothesised that people who possess one or two PAV alleles of hTAS2R38 would find these stimuli and vegetables bitterer than those who carried only the insensitivity alleles (AVI/AVI).

Experimental
All participating subjects (19-64 years) were genotyped for their hTAS2R38 genotypes and pre-screened for being homozygous sensitive (PAV) or homozygous insensitive (AVI) using allele-specific probes and primers (1). Subjects were recruited according to a protocol approved by the Office of Regulatory Affairs at University of Pennsylvania.

Thiourea compounds such as PTC, PROP, dimethylthiourea, diethylthiourea, diphenylthiourea, acetylthiourea, 2-mercapto benzimidazole, sodium thiocyanate and methimazole were high quality (>99% purity) and commercially available. As control stimuli we used pure uracil, urea and QHCl.

The taste profiles of different N-C=S containing compounds were examined with a trained sensory panel (n=24) at the sensory evaluation laboratory at Monell Chemical Senses Center. The subjects rated the intensity of bitterness on computer controlled gLMS scales. All the compounds were tasted in ½-log step solution series in three different sessions. In addition to N-C=S-compounds, the subjects evaluated also selected vegetables (3).

Results

_Bitterness of N-C=S compounds._ The mean ratings of PAV/PAV (n=13) and AVI/AVI (n=11) genotypes for N-C=S containing compounds are shown in Figure 1. Results show that people possessing the PAV form of the hTAS2R38 gene were significantly more sensitive to N-C=S containing compounds than were those possessing the AVI haplotype. Plots for PTC and PROP were similar to other N-C=S compounds and also previous studies (1). However, in case of control compounds (QHCl, uracil and urea) without N-C=S the sensitive people (PAV/PAV) were not more sensitive than insensitive people (AVI/AVI). This result shows the power of N-C=S moiety on individual differences.

Bitterness of vegetables. To find out the effect of N-C=S also in vegetables the subjects tasted both glucosinolate generating and control vegetables (3). The vegetables that produce glucosinolates were perceived bitterer by people who possess sensitive PAV allele of hTAS2R38 gene. Overall, PAV/PAV subjects rated glucosinolate generating vegetables as 60% more bitter than AVI/AVI. However, these two genotype groups found the nonglucosinolate-generating vegetables equally bitter. This shows that, general bitterness of non-glucosinolate generating vegetables could not be explained by hTAS2R38 receptor genotype.

Conclusions

People homozygous for the PAV form of the hTAS2R38 gene were significantly more sensitive to N-C=S containing compounds than those homozygous for the AVI haplotype. However, PAV subjects were not more sensitive than AVI subjects for bitter tasting compounds structurally unrelated to N-C=S. In addition, PAV/PAV subjects rated the glucosinolate generating vegetables more bitter than did the AVI/AVI subjects. This shows that genetic variation in taste perception predictably determines the taste of vegetables. Moreover, this may also mediate preference and consumption of vegetables, which remains to be determined. The taste of foods has a large impact on food choice. Furthermore, the relationship between perception and the physical food properties is central to new food product development. There is a need to increase the knowledge on the taste and sensory quality of vegetables but also other healthful foods overall to improve their intake.
Figure 1. Mean intensities of bitterness of thiourea compounds and control stimuli. Panel consisted of 13 PAV/PAV (←→) and 11 AVI/AVI (→←) subjects.

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References