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Complex Taste—Taste of D-amino Acids

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Introduction

The taste of amino acids (AAs) has been investigated by many researchers (e.g. Yoshida and Saito, 1969; Schiffman *et al.*, 1982) and AAs are known to have complex taste. For the comparison of both taste quality and taste intensity of various AAs, we performed human psychophysical experiment regarding the taste of AAs using a category-ratio scale, the labeled magnitude scale (LMS; Green *et al.*, 1993). In this report, we demonstrate the taste of D-AAs in comparison to the taste of L-enantiomers that we previously reported (Hayakawa and Kawai, 2004).

Materials and methods

We prepared three-level concentrations of aqueous solutions for each D-AA so as to remain within the 'linear' region of a psychophysical function. Solutions at room temperature were presented to eight trained subjects in random order. Subjects wearing nose clips sipped, tasted and spat each solution and rated the intensities of total taste (TT), sweetness (Sw), saltiness (Sa), sourness (So), bitterness (Bi), umami (Um) and other qualities of oral sensation, respectively, by checking the appropriate position on a 100 mm LMS. We used the geometric mean distance between a check and the lower end of the LMS as the mean rating. We modified the original rating method with the LMS by presenting a 150 mM NaCl solution as a sample stimulus representing a 'moderate' oral sensation.

Results and discussion

Mean TT ratings were taken for fitting to the equation of Stevens's law in order to calculate slope value (SV). We classified the AAs into seven types according to their physicochemical properties (I—Gly, Ala, Ser, Thr; II—Cys, Met, Val; III—Leu, Ile, Phe, Trp; IV—Glu, Asp; V—Gln, Asn; VI—Lys, Arg, His; VII—Pro). We summarize taste quality, SV and calculated concentration for moderate TT intensity by type in Table 1. Type I: both D- and L-AAs had dominantly Sw and the SV direction was D~L. Type IV: both D- and L-AAs had dominantly So and the SV direction was D~L. Types II/III/VI: D-AAs had Sw and Bi, L -AAs mainly Bi and the SV direction was L > D. Type VII: D-Pro had purely Bi and L-Pro, Bi and Sw and the SV direction was D > L.

Taste quality

Most D-AAs elicited dominantly Sw, as Schiffman *et al.* (1982) reported. Among D-AAs, only D-Pro of type VII had pure Bi. In the cases of L-AAs, not only L-Glu of type IV but many AAs of types I and V, such as L-Ala and L-Ser, also elicited Um at high concentrations. In the cases of D-AAs, no amino acid elicited Um at all. As umami is said to be a nutritional signal for protein, it is reasonable that no D-AA elicits Um, which is different from L-AAs in both structural and nutritional properties.

Taste intensity

The magnitude of SV was related to dominant taste quality in the order of Bi > Sw ≥ So. We found a tendency similar to that seen in the L-AA experiment in which the magnitude of SV was related to dominant taste quality as Bi > Sw ≥ So ~ Um. There was no correlation between the magnitude of SV for D- and L-AAs ($r = 0.12$; $P = 0.66$). We calculated the concentration that had a moderate TT intensity using the equation of Stevens' law. A strong correlation was seen between the concentrations of D- and L-AAs in logarithmic value ($r = 0.95$; $P = 0.00$).

References

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Table 1 Taste properties

Type	Physico-chemical properties[a]	AA	Taste quality[b]	Direction[c] L–D	
				SV	Moderate (mM)
I	Small–medium, hydrophilic, neutral	Gly	Sw (weak Um at high conc.)	0.77 –	6.4E+02 –
		Ala	Sw	0.62 ~	3.4E+02 ~
		Ser	Sw, So	0.69 <	8.2E+02 <
		Thr	Sw, very weak So	0.71 ~	7.3E+02 <
II	Medium, hydrophobic	Cys	–	–	–
		Met	Sw, Bi	0.52 >	1.1E+02 >
		Val	Sw, weak Bi	0.83 >	2.4E+02 <<
III	Large, hydrophobic	Leu	Sw, weak Bi	0.56 >>	8.8E+01 ~
		Ile	–	–	–
		Phe	Sw, weak Bi	0.66 >>	2.6E+01 >>
		Trp	Sw, very weak Bi	0.54 >>	7.3E+00 >>
IV	Acidic	Glu	So	0.54 ~	4.2E+00 ~
		Asp	So	0.42 >	2.3E+00 >
V	Amide	Gln	Sw, very weak So	0.45 >	1.8E+02 >>
		Asn	Sw, very weak So	0.66 <	1.2E+02 >>
VI	Basic	Lys	–	–	–
		His	Sw, very weak Bi	0.53 >	4.2E+01 >>
		Arg	Bi, Sw	0.37 >	4.9E+01 ~
VII	Imino acid	Pro	Bi	0.95 <	3.2E+02 >

Key: *a*—size, hydropathy, charge or chemical structure of sidechains of AA; *b*—see text for abbreviations; *c*—signs represent the ratio of the values for L- and D-AA. '>>' and '<<' indicate that the ratio exceeds 2. '>' and '<' indicate that the ratio is between 1.5 and 2. '–' is used for no data and '~' for nearly equal. For example, '<<' means the value of D-AA is greater than that of L-AA by ratio of 2.