

Simple Colorimetric Detection of Aromatic Amino Acids via Charge-Transfer Complex Formation Within Cucurbit[8]uril Cavities

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Aromatic amino acids phenylalanine (Phe), tryptophan (Trp), and tyrosine (Tyr) show increased plasma concentrations in cases of phenylketonuria, tryptophanemia, and tyrosinemia type I that occur when their metabolism is abnormal. Because delayed treatment causes neurodevelopmental delay and organ damage, a rapid and simple analytical method for plasma aromatic amino acid concentration is required. In this study, a colorimetric sensor was developed using the coloration through formation of a charge-transfer complex between methyl viologen (MV^{2+}) and aromatic amino acids inside the cavity of CB[8]. After formation of the charge-transfer complex, Trp and Tyr changed from colorless to orange-red and pale yellow, respectively ($\lambda_{max} = 442\text{ nm}$, 412 nm), and Phe showed an absorbance change in the ultraviolet region. Under the condition of CB[8] $\cdot$ MV^{2+} 1 mM, absorbance according to Phe, Trp, and Tyr concentration increased linearly in the ranges of 0-0.40 mM, 0-0.40 mM, and 0-0.35 mM, respectively, and this was visually confirmed for Trp and Tyr. Finally, using a computational chemistry program, it was confirmed that electron transfer from the π orbital of Tyr to the π^* orbital of MV^{2+} inside the charge-transfer complex produces color. The CB[8]-based colorimetric sensor reduces pretreatment processes and instrument dependency, allowing results to be easily and rapidly confirmed with the naked eye.

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