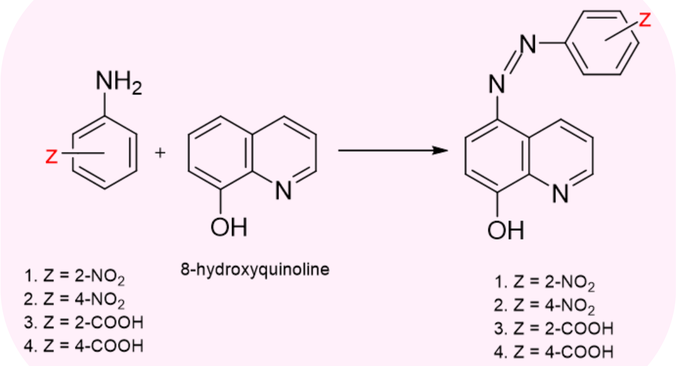
Synthesis and optical propertiesof Azo Dye–Based Chemosensors Derived from 8- Hydroxyquinoline

Bunthika Kittrakul[1] , **Professor Dr. Mookda Pattarawarapan**[1]

[1]*Department of Chemistry Faculty of Science Chiang Mai University Thailand*

Abstract

Azo dyes derived from 8-hydroxyquinoline were synthesized via azo coupling with four diazonium precursors : 2-nitroaniline, 4-nitroaniline, 4-aminobenzoic acid, and anthranilic acid to investigate the effects of electron-withdrawing substituents on their physicochemical and spectroscopic properties. The products contain an azo linkage (-N=N-) connecting two aromatic rings, forming an extended conjugated system responsible for visible light absorption. Nitro ($-NO_2$) and carboxyl (-COOH) substituents enable comparison of their effects on electron delocalization within the azo–quinoline framework. UV–Visible spectroscopy revealed characteristic absorption bands of the conjugated system, while FTIR spectroscopy confirmed the presence of -N=N-, -OH, -COOH, and $-NO_2$ groups consistent with the proposed structures. The purity of the compounds was verified by thin-layer chromatography (TLC). These results suggest that substituent variation influences electronic distribution and optical absorption, indicating potential applications in azo-based optical sensors for ion detection.



Introduction

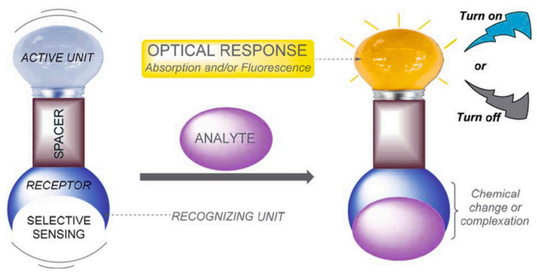
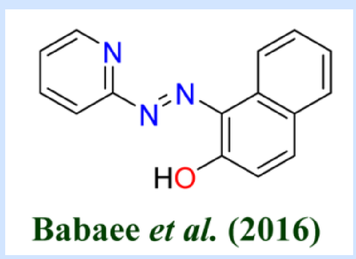


Fig.1 Schematic representation of a colorimetric/fluorescent chemosensor.[1]



8-hydroxyquinoline-based chemosensor for detecting Al^{3+}, Fe^{2+}, and Fe^{3+} ions through fluorescence and colorimetric responses.

Fig.2 Structure of previous reserch[2]

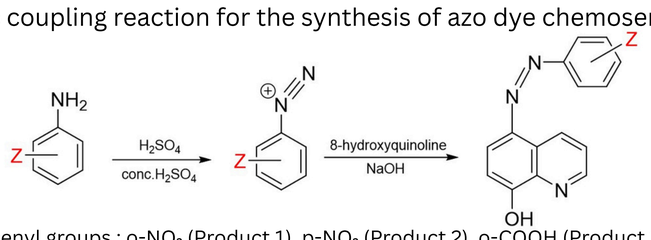
In recent decades, chemosensors have emerged as a significant area in supramolecular and analytical chemistry due to their ability to convert chemical stimuli into measurable optical or electronic signals, enabling simple and sensitive detection even in complex systems. Among various platforms, optical chemosensors are particularly attractive for their simplicity, high sensitivity, and rapid response. Azo dye–based systems are widely used as colorimetric sensors because of their strong absorption, structural tunability, and facile synthesis. Incorporation of 8-hydroxyquinoline further enhances sensing performance through its strong metal-chelating ability. Thus, azo dye–derived 8-hydroxyquinoline frameworks offer a promising approach for developing selective and efficient metal ion chemosensors.

Objective

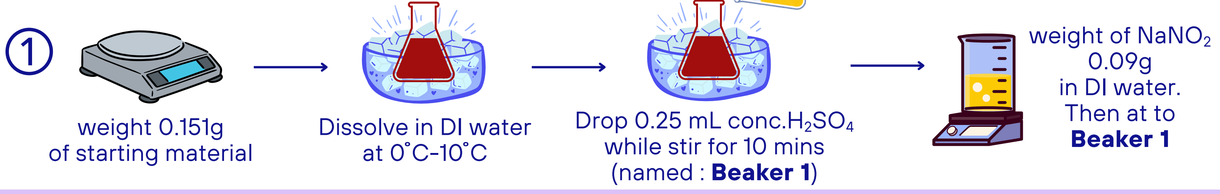
1. To synthesize a series of azo dye–based chemosensors derived from 8-hydroxyquinoline via azo coupling reactions using different diazonium precursors.
2. To investigate and compare the optical properties of the synthesized azo dyes by UV–Vis pectroscopy, including their absorption behavior and maximum absorption wavelengths (λmax).

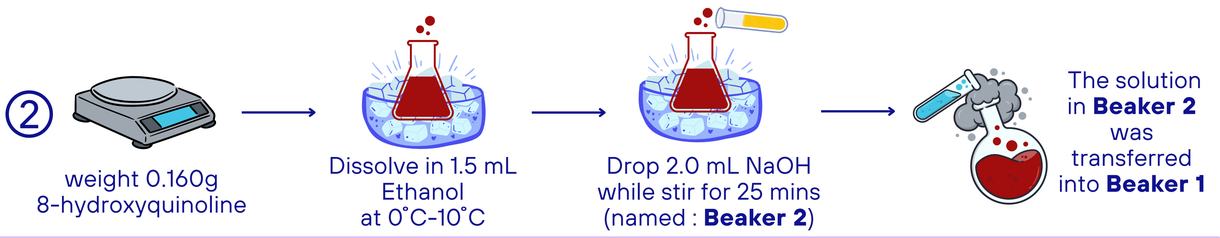
Method

Azo coupling reaction for the synthesis of azo dye chemosensors



(Z represents substituted phenyl groups : o-NO_2 (Product 1), p-NO_2 (Product 2), o-COOH (Product 3), and p-COOH (Product 4).)





Characterization



UV–Vis spectroscopy



FT-IR spectroscopy



Melting point determination



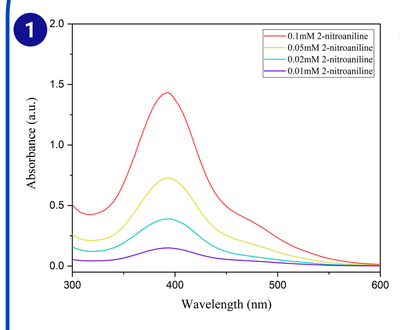
Thin-layer chromatography (TLC)

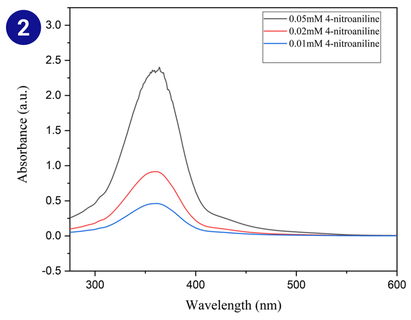
Acknowledgement

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Result & Discussion

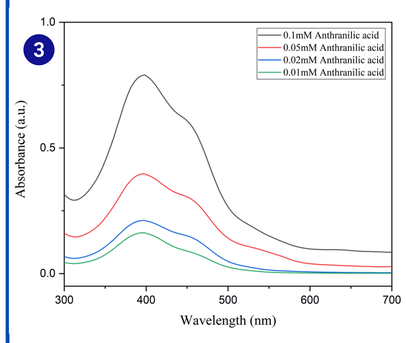
Optical property analysis using UV–Vis spectroscopy

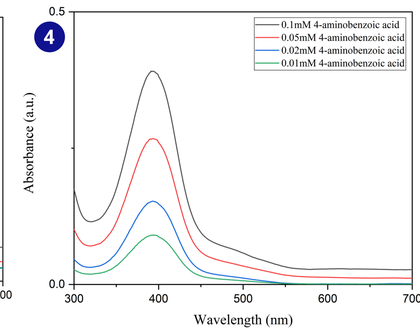




- Product of 2-nitroaniline
λmax at 393 nm, with absorbance values of 1.4329, 0.7284, 0.3896, and 0.1497 a.u. at 0.1, 0.05, 0.02, and 0.01 mM, respectively.

- Product of 4-nitroaniline
λmax at 361 nm, with higher absorbance values of 4.6858, 2.4031, 0.9156, and 0.4626 a.u. at 0.1, 0.05, 0.02, and 0.01 mM, respectively.

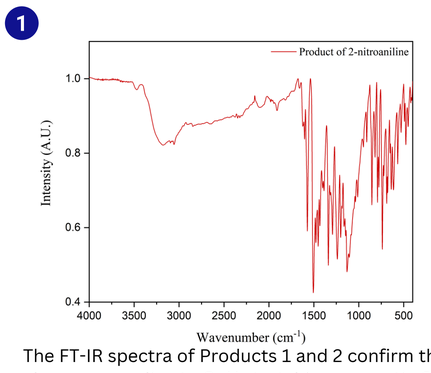


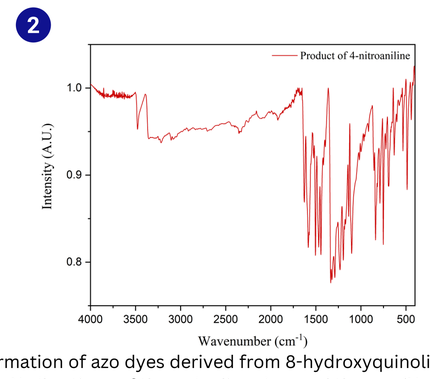


- Product of anthranilic acid
λmax at 398 nm, with absorbance values of 0.7903, 0.3978, 0.2118, and 0.1629 a.u. at 0.1, 0.05, 0.02, and 0.01 mM, respectively.

- Product of 4-aminobenzoic acid
λmax at 393 nm, with absorbance values of 0.3913, 0.2677, 0.1528, and 0.0908 a.u. at 0.1, 0.05, 0.02, and 0.01 mM, respectively.

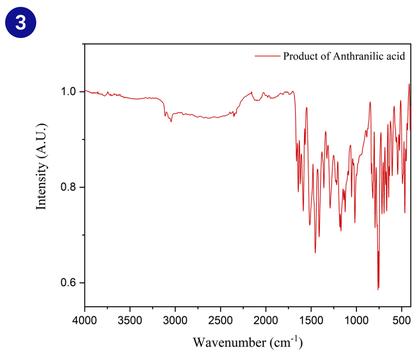
Structural characterization by FT-IR spectroscopy

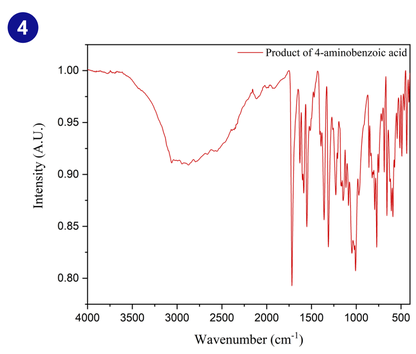




Bond	Wavenumber (cm-1)
O-H	3200-3400
C=N	1600
N=N (azo stetch)	1500
C=C	1600-1450
NO	1340-1350

The FT-IR spectra of Products 1 and 2 confirm the formation of azo dyes derived from 8-hydroxyquinoline. The spectra show characteristic bands corresponding to O–H stretching, aromatic C=C/C=N vibrations of the quinoline ring, and the azo (N=N) linkage. In addition, the presence of strong NO_2 stretching bands further supports the successful incorporation of nitro-substituted aromatic groups.





Bond	Wavenumber (cm-1)
O-H	3250
C-H strtch	3050
COOH	1720
C=C aromatic stetch	1600
N=N (azo stetch)	1500

The FT-IR spectra of Products 3 and 4 also verify the formation of azo dye structures. Characteristic absorptions corresponding to O–H stretching, aromatic ring vibrations, and the azo (N=N) group are observed. The spectra additionally display bands associated with C–O stretching, indicating the presence of the carboxylic acid functional group in these derivatives.

Conclusion

- A series of azo dye–based chemosensors derived from 8-hydroxyquinoline were successfully synthesized via azo coupling and confirmed by FT-IR spectroscopy.
- UV–Vis analysis showed that nitro-substituted dyes (Products 1 and 2) exhibited stronger light absorption than carboxylic acid derivatives (Products 3 and 4).
- Product 2 showed higher absorbance than Product 1, while Product 1 displayed a red-shifted absorption band.

References

1. Gao, X.; Zhang, Y.; Li, J.; Wang, L. Synthesis and Properties of Azo Dye Chemosensors Derived from 8-Hydroxyquinoline. RSC Adv. 2020, 10, 19693–19712.
2. Zhou, X.; Lee, S.; Xu, Z.; Yoon, J. Recent Progress on the Development of Chemosensors for Gases. Chem. Rev. 2015, 115 (15), 7944–8000.