Novel naphthoquinone-coumarin conjugates

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Introduction

Mannich bases derived from lawson are potential antineoplastic agents. Besides their various biological activities, coumarins often exhibit strong fluorescence. This work aims at the synthesis of novel hybrid compounds containing these two nuclei with fluorescent properties for biological activity studies. The rare examples of naphthoquinone-coumarin hybrids are natural products.

Results and Discussion

Compounds 1 and 2 were obtained as orange solids from the Mannich reaction of lawson with heptylamine and 3-formylcoumarins.


The ^1H NMR spectra of 1 and 2 (DMSO-d_6, 500 MHz) exhibit typical signals of the naphthoquinone and coumarin aromatic hydrogens in the δ 8.2-6.9 range. The H11 signal appears around δ 5.6 and the other aliphatic protons, in the expected regions.

Table 1. UV-Vis data for 1 and 2 (MeCN, 1.64x10^{-5} mol/L).

<table>
<thead>
<tr>
<th></th>
<th>λ_1 (nm)</th>
<th>Log ε_1</th>
<th>λ_2 (nm)</th>
<th>Log ε_2</th>
<th>λ_3 (nm)</th>
<th>Log ε_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>271</td>
<td>4.43</td>
<td>314</td>
<td>3.91</td>
<td>438</td>
<td>3.27</td>
</tr>
<tr>
<td>2</td>
<td>270</td>
<td>4.38</td>
<td>328</td>
<td>4.28</td>
<td>439</td>
<td>3.33</td>
</tr>
</tbody>
</table>

TD-DFT calculations (B3LYP/6-31+G(d,p)/PCM) were carried out to understand the electronic structure of the conjugates. The lowest absorption band in the UV-Vis spectra, around 440 nm (see Fig. 1 and 2) is characterized by two main contributions: CT from the amino group lone electron pair (HOMO) to the naphthoquinone (LUMO), and by the transfer from the coumarin moiety (HOMO-1) to the naphthoquinone (LUMO). The band at ca. 320 nm is assigned to naphthoquinone (π-π*) and the most intense band around 270 nm, to coumarin (π-π*).

Preliminary fluorescence data were obtained (MeCN) by excitation of the three absorption bands (λ_{max}, Table 1) of all compounds. Compounds 1 and 2, when excited at λ_1, have emission maxima around 310 nm. Excitation of λ_2 resulted in emissions at 348 (1) and 430 nm (2), while excitation of the lowest energy band λ_3 resulted in emissions at 582 (1) and 573 nm (2).

Conclusions

Two novel naphthoquinone-coumarin conjugates were synthesized and characterized by ^1H NMR and UV-visible spectroscopy. Their electronic structures were characterized as a donor-acceptor system. Additional fluorescence studies are in progress.

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