Novel naphthoquinone-coumarin conjugates

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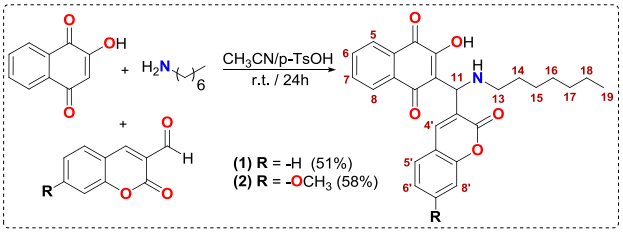
Introduction

Mannich bases derived from lawsone are potential antineoplastic agents.[1] Besides their various biological activities,[2] coumarins often exhibit strong fluorescence.[3] 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.[4]

Results and Discussion

Compounds **1** and **2** were obtained as orange solids from the *Mannich* reaction[5] of lawsone with heptylamine and 3-formylcoumarins[6].



Scheme 1. Synthesis of new *Mannich* bases.

The ^{1}H 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).

	λ_1 (nm)	Log ε_1	λ_2 (nm)	Log ε_2	λ_3 (nm)	Log ε_3
1	271	4.43	314	3.91	438	3.27
2	270	4.38	328	4.28	439	3.33

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*).

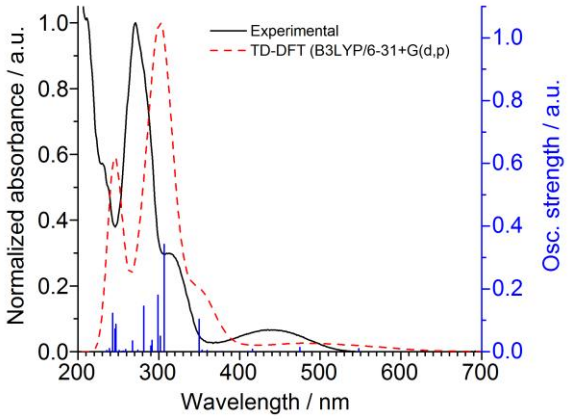


Figure 1. Experimental and theoretical UV-Vis absorption spectra for **1** in MeCN.

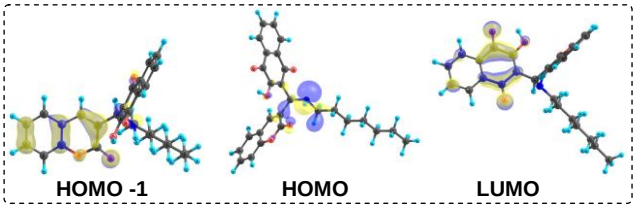


Figure 2. Molecular orbitals involved in the electronic charge transfer.

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 ^{1}H NMR and UV-visible spectroscopy. Their electronic structures were characterized as a donor-acceptor system. Additional fluorescence studies are in progress.

Acknowledgements

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