

Microwave-assisted preparation of substituted carbazole-9-acetic/propionic acid and their absorption and fluorescence spectroscopic characteristics

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Abstract- A one-pot synthesis method of substituted carbazole-9-acetic/propionic acid with microwave-assisted was described. The approach was carried out using DMF as solvent without any catalysts by the N-alkylation reaction and hydrolysis reaction. The absorption and fluorescence spectroscopic characteristics of the titled compounds are also discussed.

Introduction

Numerous carbazole derivatives exhibit a significant biological activities, such as anticonvulsant,¹ antimicrobial,² antiviral,³ antiinflammatory,⁴ and analgesic.⁵ Some copolymers containing carbazole chromophores express high excitation energy transport efficiency; and their photophysical processes have been the subject of many investigations⁶. Among these carbazole derivatives, carbazole-9-carboxylic acids were important intermediates. Synthetic efforts directed at this class of compounds has been limited. These conventional heating reactions are multi-steps, time-consuming and with low ultimate yields. Due to limitations in synthetic methods for these compounds, coupled with our interests in the microwave-assisted reactions , an alternate approach to these compounds was needed.

Microwave-assisted treatment of liquid and solid samples has been a very helpful method for organic and inorganic synthesis and its application in rapid synthetic organic chemistry has received much attention in recent years ⁹. In this communication, we describes a methodology for preparation some substituted carbazole-9-acetic/propionic acid assisted by microwave irradiation.

Results and discussion

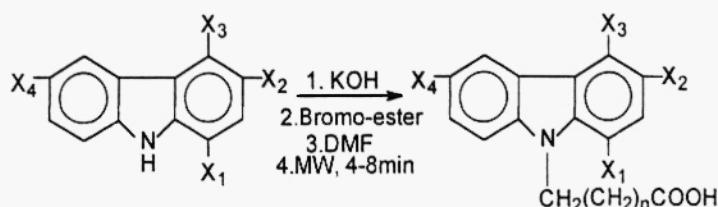
Synthesis of substituted carbazole-9- acetic/propionic acid.

The starting material, 1,4-dimethyl-carbazole, was prepared according to the reported methods. and obtained in

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satisfactory yields ¹⁰. A mixture of 1,4-dimethyl-carbazole with bromo-esters and potassium hydroxide in N,N-dimethylformamide (DMF) was irradiated in an open vessel in a domestic microwave oven for 6 minute, and treated with water and hydrochloric acid to afford 1,4-dimethyl-carbazole-9-acetic/propionic acid in 85%/83% yield. The helegended-carbazoles were synthetized according to the literature ¹¹. Similarly, their reaction with bromo-ester was carried out, and the results are summarized in table 1 (Scheme 1)

Scheme 1



1a X _{1,3} =CH ₃ X _{2,4} =H	2a X _{1,3} =CH ₃ X _{2,4} =H n=0
1b X ₂ =I X _{1,3,4} =H	2b X _{1,3} =CH ₃ X _{2,4} =H n=1
1c X _{2,4} =Cl X _{1,3} =H	2c X ₂ =I X _{1,3,4} =H n=0
1d X _{2,4} =Br X _{1,3} =H	2d X _{2,4} =Cl X _{1,3} =H n=0
1f X _{1,2,4} =Br X ₃ =H	2f X _{2,4} =Br X _{1,3} =H n=0
	2e X _{1,2,4} =Br X ₃ =H n=1

Table 1 The microwave-assisted reaction
of the substituted carbazole with bromo-ester

product	Bromo-ester	Microwave power(w)	Irradiation time (min)	Yield (%)	mp/°C ^a
2a	BrCH ₂ COOC ₂ H ₅	375	6	67	165-166
2b	BrCH ₂ CH ₂ COOC ₂ H ₅	375	6	65	175-177
2c	BrCH ₂ COOC ₂ H ₅	375	4	85	162-164
2d	BrCH ₂ COOC ₂ H ₅	375	5	81	224-225
2e	BrCH ₂ COOC ₂ H ₅	375	5	78	245-246
2f	BrCH ₂ CH ₂ COOC ₂ H ₅	375	8	45	185-186

a: 2a, lit¹⁰ 164-166°C. 2c, lit¹⁴ 162-163°C. 2e, lit¹⁵ 243-247

When the vicinal positions of the N-H bond have substituted group, like compound 1a and 1e, the irradiated time was resulted in longer under microwave power at 375W so as to give the good yields. To increase the irradiating time under this microwave power gave more tar as well as lower yield. In case of microwave power at 225W, the desired yield would not been obtained owing to more substrate no reacted. Whereas higher microwave power above 525W leaded to give more tar. The amount of KOH to the yield was also important. The range of mole ratio

of KOH and substituted carbazole within 3-5 was suitable for the reaction. In contrast to the 'wet' reaction, we tried to perform the reaction in absent of solvent, so-called 'dry' condition, but only little product was obtained. Thus, it is worthy to note that the reactivity of the compounds (1a-1e) toward microwave-induced reaction, to a large extent, on the sort of reaction media, the strength of microwave power, the time of irradiation, the position of the substituted group on the mother ring of the carbazole, and the ratio of the starting material.

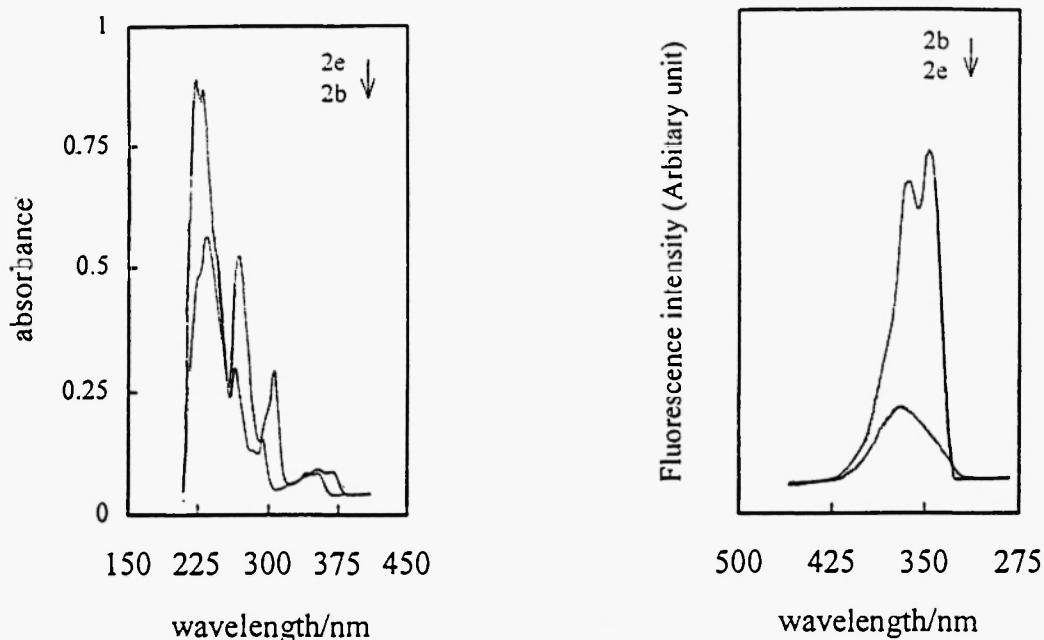


Figure 1. Absorption spectra of 1.4-dimethylcarbazole-9-propionic acid (2b) and 3.6-dibromo-carbazole-9-acetic acid (2e) in MeCN. Concentration: 1×10^{-5} M.

Figure 2. Fluorescence spectra of 1.4-dimethylcarbazole-9-propionic acid (2b), and 3.6-dibromo-carbazole-9-acetic acid (2e) in MeCN. Excitation wavelength: (2b) 287nm, slit=1, (2e) 299nm, slit=5.

Absorption and Fluorescence Spectra of substituted carbazole-9-acetic/propionic acid-

The absorption spectra and fluorescence Spectra of 1.4-dimethyl-carbazole-9-propionic acid and 3.6-dibromo-carbazole-9-acetic acid in MeCN are shown in figure 1 and 2, as representative examples. The figure 1 showed 1.4-dimethyl-carbazole-9-propionic acid had five adsorption bands at 342nm, 325nm, 287nm, 262nm and 242nm, whereas 352nm, 337nm, 299nm, 266nm, 239nm, 231nm for 3.6-dibromo-carbazole-9-acetic acid. Owing to having bromine atoms as autochrome, the absorption bands of 3.6-dibromo-carbazole-9-acetic acid are red shift in contrast to the 1.4-dimethyl-carbazole-9-propionic acid, and maximum molar absorptivity of the former are also larger than the latter. In the fluorescence spectra, 1.4-dimethyl-carbazole-9-propionic acid showed two emission bands at 353nm and 368nm with the maximum excitation band at 287nm, while 3.6-dibromo-carbazole-9-acetic acid showed one emission bands at 368nm with the maximum excitation band at 299nm in MeCN. The intensity of fluorescence of 3.6-dibromo-carbazole-9-acetic acid was weaker than 1.4-dimethyl-carbazole-9-propionic acid

as expected, due to the heavy-atom effects of the substitution of bromine atoms to carbazole ring. This effect causes drastic enhancement of singlet-triplet intersystem crossing resulting in weak fluorescence and intense phosphorescence ¹². It is well known that polymers containing the pendant carbazolyl chromophores are good electron donors and possess outstanding electrical and photoelectrical properties. Owing to these photophysical property, the synthesis of various carbazole derivatives has attracted the attention of investigators.

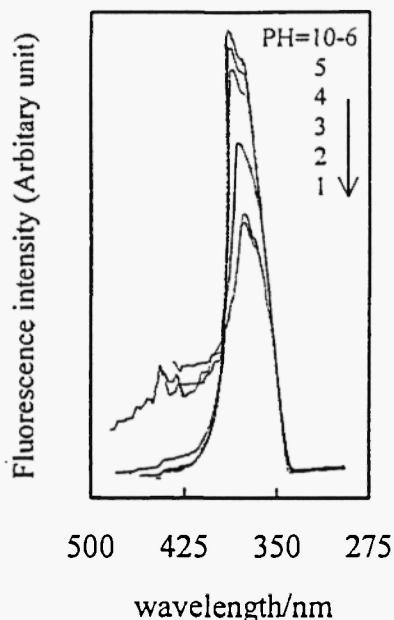


Figure 3. The fluorescence spectra of 1,4-dimethyl-carbazole-9-propionic acid (2b) at pH=1 to 10

As the fluorescence spectra of 1,4-dimethyl-carbazole-9-propionic acid at pH=1 to 10 shown in Figure 3, it could be seen that, to be a weak acid, the change of pH value of the solution intensively influence fluorescence emission. The acid and its conjugate base both emit fluorescence, and the intensity of the latter is larger than former without emission band shift. The similar spectra were obtained in case of other substituted carbazole-9-acetic/propionic acid and the spectra data are summarized in table 2.

Experimental

¹H NMR measurements were performed on FT-100A-NMR spectrometer in CD₃COCD₃. Chemical shifts are reports as parts per million(δ) relative to tetramethylsilane. IR spectra were recorded on a IR-810 spectrometer in KBr discs. Absorption and fluorescence spectra were recorded on a HITACHI 330 and HITACHI 650-10S spectrophotometers, respectively. Melting points were determined on PHMK micro-melting-point apparatus and are uncorrected. Microwave Irradiation were carried out with a domestic microwave oven Galanz

WP750B(2450MHz).

Table 2 Spectra data of substituted carbazole-9-acetic/propionic acid

compound	UV/ λ_{max} nm(ϵ) in MeCN	Fluorescence/ λ_{max} nm in MeCN	IR (cm $^{-1}$)/KBr	^1H NMR δ (ppm)
		Excitation	Emission	
2a	242 (50300)	287	350	3050,2970,1703, 2.74,2.81,5.40, 6.86-8.22
2b	242 (45500)	287	353	3017,2919,1706 2.75-2.95,4.91, 6.88-8.25
2c	239 (44400)	296	347	3044,2929,1709 5.22, 7.38-8.25
2d	230 (74880)	299	365	3041,2925,1712 5.24, 7.50-8.24
2e	231 (64500)	299	368	3075,2933,1712 5.24, 7.58-8.38
2f	231 (46200)	300	336	3045,2927,1710 2.06,4.72, 7.64-8.37

General procedure for substituted carbazole-9-acetic/propionic acid (2a-2f).

A mixture of the substituted carbazole(1a-1e) (0.012mol), sodium hydroxide (0.072mol), and the bromo-ester (0.015mol) in DMF was heated in a domestic microwave oven in an open round-bottomed flask for an appropriate time (see Table 1). Then water was poured into flask. The filtrate was acidified by adding hydrochloric acid until precipitation separated entirely. The precipitation was filtered, washed with water, and dried in vacuum. The crude product was purified by recrystallization from chloroform and alcohol (90:10) to give the desired the product. yield: 45-85 %.

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