NOVEL AND EFFICIENT ACCESS TO THIENO[3,4-c]CINNOLINES

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Abstract – New substituted methyl thieno[3,4-c]cinnoline-3-carboxylate compounds were synthesized from the corresponding methyl 3-aminothiophene-2-carboxylate precursors by a new route using a modified Sandmeyer reaction. Under proper conditions, Sandmeyer reaction led to the formation of thieno[3,4-c]cinnoline compounds by a regioselective intramolecular cyclization, instead of the expected substitution of the amino group by a bromine atom.

INTRODUCTION
The thienocinnoline system is scarcely described in literature, likewise furocinnoline and other similar cinnoline systems. Thomas et al. reported that the cinnoline derivatives of formula I possess antiangiogenic properties and they exhibit effects on VEGF, a property which could be useful in the treatment of a number of diseases including cancer and rheumatoid arthritis. Nakao et al. have synthesized the thienocinnolines II which showed anxiolytic, hypnotic, antiepileptic and nootropic activities, they are potent agonists, partially agonists or inverse agonists of the benzodiazepine receptors (Chart 1).

Chart 1

\[
\text{W = O, NH, S, CH}_2 \\
\text{n = 1 to 5}
\]
Barton described the synthesis of thieno[2,3-c], thieno[3,2-c] and especially thieno[3,4-c]cinnolines from the corresponding 2-aminophenylthiophenes. As depicted in scheme 1, the thieno[2,3-c]cinnoline \( \text{Vb} \) was obtained in 69% yield via intramolecular electrophilic attack of the diazonium cation at the free \( \alpha \)-position of 3-(2-aminophenyl)thiophene \( \text{IIIb} \). Thieno[3,4-c]cinnoline ring system was constructed by the same direct diazotisation procedure through an intramolecular electrophilic attack of the diazonium cation at the less reactive \( \beta \)-position of the thiophene ring. For example, 1,3-dimethylthieno[3,4-c]cinnoline \( \text{Va} \) was obtained from 3-(2-aminophenyl)-2,5-dimethylthiophene \( \text{IIIa} \), in 54% yield.

\[
\text{Scheme 1}
\]

\[
\begin{align*}
\text{IIIa} & \quad \text{R = Me} \\
\text{IIIb} & \quad \text{R = H}
\end{align*}
\]

NaNO\(_2\), H\(_2\)O, 3N HCl, 1N EtCO\(_2\)H, 0.15N H\(_2\)SO\(_4\), 0-3 °C, 1 h; (ii) NaOAc, H\(_2\)O, 0-3 °C, 1 h, then rt, 24 h. \( \text{Va} \) (54%), \( \text{Vb} \) (69%).

The synthesis of thieno[3,2-c]cinnoline \( \text{Vc} \) was also described, using 2-aminophenylthiophene \( \text{IIIc} \) as a starting material, via an azaborine \( \text{VI} \) in analogy with the synthesis of benzo[c]cinnoline described by Dewar and Poesche (Scheme 2).

\[
\text{Scheme 2}
\]

\[
\begin{align*}
\text{IIIc} & \quad \text{NH}_2 \\
\text{IVa-b} & \quad \text{N=N}^+ \\
\text{Vc} & \quad \\
\end{align*}
\]

(i) BCl\(_3\), xylene, reflux ; (ii) H\(_2\)O; (iii) NaNO\(_2\), HCl ; (iv) NaOAc (29-36%).

In this paper, we wish to describe a new efficient methodology for the synthesis of thieno[3,4-c] cinnolines, using an alternative approach based on the reactivity of aminothiophenes.
RESULTS AND DISCUSSION

During the synthesis of new methyl-4-aryl-3-bromothiophene-2-carboxylates 4 from the corresponding aminothiophene esters 1 under the classical Sandmeyer reaction conditions, using the procedure described by Corral et al.,⁸ we have observed that in some cases the yields were rather low and the formed bromothiophenes 4 were accompanied by a non-halogenated by-product. It is worthy to mention that when the aryl group was a simple phenyl or a phenyl group bearing an electron-withdrawing substituent, the reaction was univocal and led to the expected bromo derivatives in good yields (Scheme 3).

Scheme 3

\[
\begin{array}{c}
\text{NH}_2 \\
\text{R} \\
\text{CO}_2\text{Me}
\end{array} \quad \xrightarrow{i} \quad \begin{array}{c}
\text{Br} \\
\text{R} \\
\text{CO}_2\text{Me}
\end{array}
\]

(i) NaNO₂, Cu₂Br₂, HBr 48%, H₂O, 0 °C to 60 °C, 1.5 h.

However, when the phenyl group of the aminoesters 1a-c bears one or two electron-donating groups, the results obtained were quite different where several by-products including deaminated products, thiophene dimers and poly-halogenated products were formed.

Thus, upon optimizing Sandmeyer reaction conditions by heating the aminoesters 1a-c in hydrobromic acid with sodium nitrite in the presence of copper(I) bromide (protocol A), a mixture of two products, the bromo derivatives 4a-c and the thieno[3,4-c]cinnolines 3a-c were obtained. These two products were easily separated by column chromatography, and their structures were confirmed by elemental and spectral analyses. (Scheme 4)

Nevertheless, under the classical Sandmeyer reaction conditions, the above reaction led to the formation of numerous by-products including deaminated products, thiophene dimers and poly-halogenated products.

Unfortunately, this protocol A did not lead to a selective synthesis of either compound 3 or 4. So, consequently, we tried an other protocol (B) previously described by Doyle who recommended to use tert-butyl nitrite and copper(II)bromide to prepare bromo derivatives from the corresponding amino
compounds.\textsuperscript{9,10} Following this new protocol, treatment of 1a and 1b gave only the thieno[3,4-c]cinnolines 3a and 3b respectively with very high yield (≥ 90\%) without any trace of a bromo derivatives. Surprisingly, treatment of 1c gave exclusively the bromo derivative 4c in high yield (95\%) (Scheme 5).

**Scheme 4.** Sandmeyer reaction with optimised conditions – Protocol A

NaNO\textsubscript{2} (1.0 eq.), HBr 48\% / H\textsubscript{2}O (2:1), 0 °C, 30 min., then Cu\textsubscript{2}Br\textsubscript{2} (1.0 eq.), HBr 48\%, 50°C, 1h. 3a/4a (40/60), 3a (30\%); 3b/4b (40/60), 3b (30\%); 3c/4c (20/80), 3c (15\%).

**Scheme 5.** Sandmeyer reaction with modified conditions – Protocol B

(i) t-BuONO (1.5 eq.), CuBr\textsubscript{2} (1.2 eq.), MeCN, 60-70 °C, 4 h, then H\textsubscript{2}O/HCl 20\%, 0 °C-rt. 3a 97\%; 3b 90\%; 4c 95\%.

In order to verify that the cupric salt had no influence on the intramolecular cyclization, we repeated this protocol B in the absence of cupric bromide. For 1a and 1b, the results were the same as those obtained in the presence of copper bromide and the thieno[3,4-c]cinnolines 3a-b were isolated in a similar yield. However in the case of compound 1c the diazonium salt did not cyclize and the sole reaction product was found to be the deaminothiophene 5c\textsuperscript{7} (Scheme 6).
Scheme 6. Modified Sandmeyer reaction

\[ \text{R}^1 \text{R}^2 \text{N}^+ \text{CO}_2\text{Me} \]

(i) \( t\)-BuONO (1.5 eq.), MeCN, 60-70 °C, 4 h, then H\(_2\)O/HCl 20%, 0 °C-rt.

3a 92%; 3b 90%; 5c 95%.

Finally in order to isolate the intermediate diazonium salts we tried another route using tetrafluoroboric acid and sodium nitrite following the procedure described in the literature.\(^{10a,11,12}\) This protocol allowed us to isolate the two tetrafluoroborate diazonium salts 6a and 6c as very stable solids. However, the diazonium salt 6b could not be isolated even at very low temperature and also we could not check its stability since the thieno[3,4-c]cinnoline 3b was directly formed. When the tetrafluoroborate 6a was dissolved in MeCN at rt, it led to the formation of the thieno[3,4-c]cinnoline 3a, while 6c did not cyclize even upon heating at reflux temperature of MeCN, and it gave only the deamino thiophene 5c\(^7\) (Scheme 7).

In conclusion we have described an efficient method for the synthesis of new thieno[3,4-c]cinnolines bearing an ester functionality which could be used to design new compounds of therapeutic importance.

Scheme 7. Synthesis of diazonium tetrafluoroborate salts

(i) HBF\(_4\)\(\cdot\)H\(_2\)O (50%), H\(_2\)O, 50 °C, 1 h, then NaNO\(_2\) (1.1 eq.), H\(_2\)O, –15 °C, 1.5 h, (90%) ; (ii) MeCN, rt to reflux, 1 h. 6a 93%; 6c 98%; 3a 80%; 5c 85%.
EXPERIMENTAL

Melting points were determined on a Köfler melting point apparatus and are uncorrected. IR spectra were taken with a Perkin Elmer BX FT-IR. HRMS (EI) determinations were made using a spectrometer JEOL JMS GCMate. ESI-MS was performed using a spectrometer LC-MS Waters alliance 2695 (ESI+). 1H-NMR (400 MHz) and 13C-NMR (100 MHz) were recorded on a JEOL Lambda 400 Spectrometer. Chemical shifts are expressed in parts per million downfield from tetramethylsilane as an internal standard. Thin layer chromatography (TLC) was performed on silica gel 60F-264 (Merck). Elemental analyses were performed at the ‘Institut de Recherche en Chimie Organique Fine’ (Rouen).

Classical procedure of the Sandmeyer reaction (Protocol A)

Methyl 7-methoxythieno[3,4-c]cinnoline-3-carboxylate (3c)

To a stirred solution, cooled to 0 °C, of sodium nitrite (0.20 g, 2.99 mmol) in H2O (4 mL), a solution of methyl 3-amino-4-(4-methoxyphenyl)thiophene-2-carboxylate 1c (0.80 g, 2.99 mmol) in HBr (48%, 8 mL) was dropwise added. Stirring was continued for 30 min at the same temperature then a solution of Cu2Br2 (0.50 g, 2.99 mmol) in HBr was added, followed by heating the reaction mixture at 70 °C till the evolution of nitrogen gas ceased, and the completion of the reaction was checked by TLC. After cooling, the reaction mixture was poured onto cold water and the solid precipitate was filtered, washed with water and air dried. Compounds 3c and 4c were separated by silica gel column chromatography using AcOEt as an eluent (Rf 3c = 0.5, Rf 4c = 0.9). Compound 3c was crystallized from EtOH to give an orange powder (0.12 g, 15% yield), mp 228 °C. IR (KBr): 3426, 2925, 2248, 1704, 1607-1415, 1274, 1118 cm^-1. 1H NMR (DMSO-d6) δ 8.04 (s, 1H, H1); 7.64 (s, 1H, H6); 7.44 (d, 3JH8H9 = 8.2 Hz, 1H, H8); 7.20 (d, 3JH9H8 = 8.2 Hz, 1H, H9); 3.88 (s, 3H, OMe); 3.84 (s, 3H, CO2OMe). 13C NMR (DMSO-d6) δ 163.1 (s, 1C, CO); 159.1 (s, 1C, C7); 155.6 (s, 1C, CIV); 153.2 (s, 1C, CIV); 147.5 (s, 1C, C3); 145.6 (s, 1C, C6H); 142.9 (s, 1C, C8H); 140.6 (s, 1C, C9H); 130.1 (s, 1C, C1H); 117.3 (s, 1C, CIV); 115.7 (s, 1C, CIV); 55.1 (s, 1C, Meester); 54.0 (s, 1C, OMe). MS m/z (%): 275 (21) [M+]; 244 (100) [M+-(OMe)]; 216 (42) [M+(CO2Me)]; 157 (16). Anal. Calcd for C13H10N2O3S: C, 56.92; H, 3.67; N, 10.21. Found: C, 56.85; H, 3.48; N, 10.25.

Compound 4c is identical to that obtained following the modified procedure described below.

Methyl 3-bromo-4-(3,4-dimethoxyphenyl)thiophene-2-carboxylate (4a)

This compound was obtained following the same procedure described above for 3c, using methyl 3-amino-4-(3,4-dimethoxyphenyl)thiophene-2-carboxylate 1a. Compounds 3a and 4a were separated by silica gel column chromatography using AcOEt as eluent (Rf 3a = 0.5, Rf 4a = 0.9). Compound 4a was
crystallized from EtOH as colorless crystals (2.30 g, 38% yield), mp 138 °C. IR (KBr): 2958, 1726, 1610-1421, 1251, 1231, 1074, 785 cm⁻¹. ¹H NMR (DMSO-d₆) δ 8.45 (s, 1H, H₅); 7.97 (s, 1H, HAr); 7.78 (d, ³JHH = 8.0 Hz, 1H, HAr); 6.96 (d, ³JHH = 8.0 Hz, 1H, HAr); 3.85 (s, 3H, OMe); 3.83 (s, 3H, OMe); 3.76 (s, 3H, CO₂Me). ¹³C NMR (DMSO-d₆) δ 163.8 (s, 1C, CO); 159.9 (s, 1C, C Ar); 159.7 (s, 1C, CIV); 149.8 (s, 1C, C₃); 147.7 (s, 1C, C₂); 126.9 (s, 1C, CHAr); 126.6 (s, 1C, CHAr); 125.4 (s, 1C, Cs); 114.9 (s, 1C, C₃H); 114.5 (s, 1C, CHAr); 95.8 (s, 1C, CHAr); 55.2 (s, 1C, OMe); 55.1 (s, 1C, OMe); 50.7 (s, 1C, Me). MS m/z (%): 356-358 (29) [M +.]; 325-327 (100) [M +-(OMe)]; 297-299 (35) [M +-(CO₂Me)]; 218 (30) [M +-(Br, CO₂Me)]; 204 (17). Anal. Calcd for C₁₄H₁₃BrO₄S: C, 47.07; H, 3.67. Found: C, 46.85; H, 3.48.

Compound 3a is identical to that obtained following the modified procedure described below.

Methyl 4-[3-(benzyloxy)-4-methoxyphenyl]-3-bromothiophene-2-carboxylate (4b)
This compound was obtained following the same procedure described above for 3c, using methyl 3-amino-4-(3-benzyloxy-4-methoxyphenyl)thiophene-2-carboxylate 1b. Compounds 3b and 4b were separated by silica gel column chromatography using AcOEt as eluent (Rf 3b = 0.5, Rf 4b = 0.9). Compound 4b was crystallized from EtOH as beige crystals (0.72 g, 36% yield), mp 148 °C. IR (KBr): 3014, 1731, 1603-1420, 1246, 1229, 1074, 765 cm⁻¹. ¹H NMR (DMSO-d₆) δ 8.25 (s, 1H, H₅); 8.04 (s, 1H, HAr); 7.78 (d, ³JHH = 8.0 Hz, 1H, HAr); 7.55 (d, ³JHoHm = 7.0 Hz, 2H, Hm); 7.50 (d, ³JHH = 8.0 Hz, 1H, HAr); 7.41 (dd, ³JHmHo = 7.0 Hz, ³JHmHp = 7.6 Hz, 2H, Hm); 7.37 (t, ³JHpHm = 7.6 Hz, 1H, Hp); 5.39 (s, 2H, OCH₂); 4.01 (s, 3H, OMe); 3.89 (s, 3H, CO₂Me). ¹³C NMR (DMSO-d₆) δ 162.8 (s, 1C, CO); 159.9 (s, 1C, C Ar); 159.7 (s, 1C, C Ar); 149.8 (s, 1C, C₂); 149.7 (s, 1C, C₃); 147.7 (s, 1C, C₂); 126.9 (s, 1C, CHAr); 126.6 (s, 1C, CHAr); 125.4 (s, 1C, Cs); 114.9 (s, 1C, C₃H); 114.5 (s, 1C, CHAr); 95.8 (s, 1C, CHAr); 55.9 (s, 1C, CH₂); 55.1 (s, 1C, OMe); 50.7 (s, 1C, Me). MS m/z (%): 432-434 (10) [M⁺]; 401-403 (100) [M⁺-(OMe)]; 373-375 (47) [M⁺-(CO₂Me)]; 294 (23) [M⁺-(Br, CO₂Me)]; 266 (9). Anal. Calcd for C₂₀H₁₇BrO₄S: C, 55.44; H, 3.95. Found: C, 55.75; H, 3.68.

Compound 3b is identical to that obtained following the modified procedure described below.

Modified procedure of the Sandmeyer reaction (Protocol B)

Methyl 7,8-dimethoxythieno[3,4-c]cinnoline-3-carboxylate (3a)
To a hot (70°C) stirred solution of anhydrous CuBr₂ (0.9 g, 4.09 mmol) and tert-butylnitrite (0.7 mL, 5.11 mmol, 90%) in MeCN (20 mL) was added slowly methyl 3-amino-4-(3,4-dimethoxyphenyl) thiophene-2-carboxylate 1a (1.0 g, 3.41 mmol). The reaction was stirred at this temperature till completion of the reaction (TLC). After cooling to rt the reaction mixture was poured into an aqueous solution of HCl. The
residue obtained after the usual work-up was purified by silica gel column chromatography using AcOEt /MeOH (9:1) as an eluent to give compound 3a as a bright yellow crystals (1.16 g, 97% yield), mp 236 °C. IR (KBr): 3438, 3180, 1717, 1636-1424, 1315, 1268, 1246, 1072, 1069 cm\(^{-1}\). \(^1\)H NMR (DMSO-\(d_6\)) \(\delta\) 9.16 (s, 1H, H1); 8.06 (s, 1H, H6); 8.04 (s, 1H, H9); 4.06 (s, 3H, OMe); 4.02 (s, 3H, OMe); 3.99 (s, 3H, CO\(_2\)Me). \(^{13}\)C NMR (DMSO-\(d_6\)) \(\delta\) 163.5; 159.9; 159.2; 155.4; 155.3; 147.5; 145.7; 143.5; 130.0; 126.8; 117.3; 55.2; 54.1; 53.5. LC-MS: tr = 2.88 min. 305 [M\(^+\)]. Anal. Calcd for C\(_{14}\)H\(_{12}\)N\(_2\)O\(_3\)S: C, 55.26; H, 3.97; N, 9.21. Found: C, 54.99; H, 3.72; N, 9.44.

Methyl 8-benzyloxy-7-methoxythieno[3,4-c]cinnoline-3-carboxylate (3b)

This compound was obtained following the same procedure described for 3a using methyl 3-amino-4-(3-benzyloxy-4-methoxyphenyl)thiophene-2-carboxylate 1b. Bright orange powder (0.93 g, 90% yield), mp 236 °C. IR (KBr): 3090, 2925, 2237, 1704, 1607-1415, 1274, 1259, 1247, 1199, 1190, 1118 cm\(^{-1}\). \(^1\)H NMR (DMSO-\(d_6\)) \(\delta\) 9.11 (s, 1H, H1); 8.20 (s, 1H, H6); 8.05 (s, 1H, H9); 7.57 (d, \(3J_{HH}= 5.9\) Hz, 2H, H\(_m\)); 7.44 (dd, \(3J_{HH}= 5.9\) Hz, 2H, H\(_m\)); 7.73 (t, \(3J_{HH}= 5.9\) Hz, 1H, H\(_p\)); 5.37 (s, 2H, OCH\(_2\)); 4.02 (s, 3H, OMe); 3.99 (s, 3H, CO\(_2\)Me). \(^{13}\)C NMR (DMSO-\(d_6\)) \(\delta\) 160.8 (s, 1C, CO); 159.7 (s, 1C, C\(_{IV}\)); 158.7 (s, 1C, C\(_{IV}\)); 155.4 (s, 1C, C\(_{IV}\)); 154.3 (s, 1C, C\(_{IV}\)); 147.4 (s, 1C, C\(_{IV}\)); 145.7 (s, 1C, CH); 144.9 (s, 1C, CH); 129.9 (s, 1C, C\(_1\)); 116.6 (s, 1C, C\(_{IV}\)); 114.6 (s, 1C, C\(_{IV}\)); 110.3 (s, 2C, CH\(_l\)); 110.1 (s, 2C, CH\(_m\)); 109.7 (s, 1C, CH\(_p\)); 55.6 (s, 1C, CH\(_2\)); 55.1 (s, 1C, Me\(_{ester\})\); 54.4 (s, 1C, OMe). LC-MS: tr = 10.02 min.; 381 [M\(^+\)]. Anal. Calcd for C\(_{20}\)H\(_{16}\)N\(_2\)O\(_4\)S: C, 63.15; H, 4.24; N, 7.36. Found: C, 62.85; H, 4.48; N, 7.25.

Methyl 3-bromo-4-(4-methoxyphenyl)thiophene-2-carboxylate (4c)

This compound was obtained following the same procedure described for 3a using methyl 3-amino-4-(4-methoxyphenyl)thiophene-2-carboxylate 1c. Crystallization from EtOH gave colorless crystals (8.14 g, 95% yield), mp 124 °C. IR (KBr): 3054, 1720, 1602-1418, 1275, 1117 cm\(^{-1}\). \(^1\)H NMR (DMSO-\(d_6\)) \(\delta\) 8.06 (s, 1H, H5); 7.37 (d, \(3J_{HH}= 7.8\) Hz, 2H, H\(_{Ar}\)); 7.01 (d, \(3J_{HH}= 7.8\) Hz, 2H, H\(_{Ar}\)); 3.84 (s, 3H, OMe); 3.79 (s, 3H, CO\(_2\)Me). \(^{13}\)C NMR (DMSO-\(d_6\)) \(\delta\) 160.6 (s, 1C, CO); 159.2 (s, 1C, C\(_2\)); 143.5 (s, 1C, C\(_{Ar}\)); 130.5 (s, 2C, CH\(_{Ar}\)); 130.0 (s, 1C, C\(_1\)); 127.3 (s, 1C, C\(_4\)); 126.7 (s, 1C, C\(_3\)); 117.3 (s, 1C, C\(_{Ar}\)); 113.8 (s, 2C, CH\(_{Ar}\)); 55.2 (s, 1C, Me\(_{ester\})\); 52.5 (s, 1C, OMe). MS \(m/z\) (%): 327-329 (19) [M\(^+\)]; 296-298 (100) [M\(^+\)-OMe]; 268-270 (29) [M\(^+\)-(CO\(_2\)Me)]; 188 (35) [M\(^+\)-(Br, CO\(_2\)Me)]; 173 (10). Anal. Calcd for C\(_{13}\)H\(_{11}\)BrO\(_3\)S: C, 47.72; H, 3.39. Found: C, 47.89; H, 3.51.

**Synthesis of diazonium tetrafluoroborate salts**
4-(3,4-Dimethoxyphenyl)-2-(methoxycarbonyl)thiophene-3-diazonium tetrafluoroborate (6a)

A solution of methyl 3-amino-4-(3,4-dimethoxyphenyl)thiophene-2-carboxylate 1a (1.0 g, 3.41 mmol) in an aqueous solution of tetrafluoroboric acid (5 mL, 50%) was stirred at 50 °C during 30 min. Then, the solution was cooled to –15 °C and a solution of sodium nitrite (0.3 g, 3.75 mmol) in H₂O (3 mL) was slowly added during 20 min and the resulting solution was kept at this temperature for 1 h. The reaction mixture was then treated with ether and the diazonium salt precipitate was filtered, washed with ether and air dried to give red powder. (1.25 g, 93% yield), mp 216 °C. IR (KBr): 3093, 2958, 2269, 1702, 1603-1438, 1300, 1249, 1202, 1065, 727 cm⁻¹. ¹H NMR (DMSO-d₆) δ 8.45 (s, 1H, H₅); 7.97 (s, 1H, HAr); 7.78 (d, 3JHH = 7.8 Hz, 1H, HAr); 7.20 (d, 3JHH = 7.8 Hz, 1H, HAr); 4.01 (s, 3H, OMe); 3.98 (s, 3H, OMe); 3.85 (s, 3H, CO₂Me).

¹³C NMR (DMSO-d₆) δ 160.8 (s, 1C, CO); 158.9 (s, 1C, C₂); 145.7 (s, 1C, CAr); 142.6 (s, 1C, CAr); 130.7 (s, 1C, CHAr); 130.2 (s, 1C, C₅H); 129.5 (s, 1C, C₃); 127.2 (s, 1C, C₄); 117.1 (s, 1C, CAr); 113.9 (s, 2C, CHAr); 55.3 (s, 1C, Meester); 52.3 (s, 1C, OMe); 52.1 (s, 1C, OMe). LC-MS: tr = 7.78 min.; 306 [M⁺].

2-(Methoxycarbonyl)-4-(4-methoxyphenyl)thiophene-3-diazonium tetrafluoroborate (6c)

This compound was obtained following the same procedure described for 6a using methyl 3-amino-4-(4-methoxyphenyl)thiophene-2-carboxylate 1c. Red powder (1.3 g, 98% yield), mp 162 °C. IR (KBr): 3412, 3112, 2966, 2248, 1714, 1609-1470, 1438, 1413, 1271, 1256, 1062, 1023 cm⁻¹. ¹H NMR (DMSO-d₆) δ 8.45 (s, 1H, H₅); 7.78 (d, 3JHH = 7.8 Hz, 2H, HAr); 7.19 (d, 3JHH = 7.8 Hz, 2H, HAr); 4.06 (s, 3H, OMe); 3.85 (s, 3H, CO₂Me). ¹³C NMR (DMSO-d₆) δ 160.8 (s, 1C, CO); 143.5 (s, 1C, CAr); 130.7 (s, 2C, CHAr); 130.2 (s, 1C, C₅H); 129.4 (s, 1C, C₃); 127.3 (s, 1C, C₄); 117.1 (s, 1C, CAr); 114.0 (s, 2C, CHAr); 55.3 (s, 1C, Meester); 52.1 (s, 1C, OMe). LC-MS: tr = 7.73 min.; 276 [M⁺].

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