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# Efficient synthesis of imidazole derivatives using multicomponent reactions of activated acetylenic compounds

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**Abstract:** An efficient synthesis of imidazolo thiazines is described. This involves a reaction of isothiocyanate with Pyruvates in the Presence of imidazole.

**Keywords:** Imidazole; Ethyl bromopyruvate; Ethylpyruvate; isothiocyanate

## Introduction

In general, multi-component reactions (MCRs) are economically and environmentally very advantageous because multi-step syntheses produce considerable amounts of waste mainly due to complex isolation procedures often involving expensive, toxic and hazardous solvents after each step. MCRs are perfectly suited for combinatorial library syntheses, thus are finding increasing use in the discovery process for new drugs and agrochemicals [1-7]. In recent years, the research into novel active organic substances and into the design of molecular electronic devices has attracted considerable interest [8,9]. In this respect, several studies involved sulfur-containing compounds because they present good conduction in organic materials [10,11] or are relevant biologically. Also, sulfurcontaining anions have found extensive use as versatile reagents in organic synthesis. Some heterocyclic compounds containing a Imidazole ring in their structures offer important applications in pharmaceutical as well as in agrochemical chemistry [12,13].

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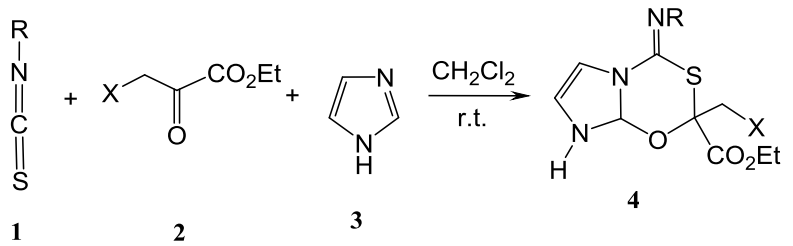
For example, ritonavir, an anti-HIV drug contains the Imidazole moiety. These products, which have N and S atoms, are bridged easily with other molecules [14,15] or can coordinate several metal ions.

For example, they could be used to entrap mercury in the environment [16] and as a new inhibitor for copper [17]. Herein, we describe an efficient procedure for direct synthesis of 7-ethyl 5,6-dialkyl 7*H*-[1,3]imidazolo[2,3-*b*][1,3]thiazine-5,6,7-tricarboxylate. This involves a reaction of activated isothiocyanate with Pyruvates in the Presence of Thiazol in dichloromethane at room temperature (Scheme 1).

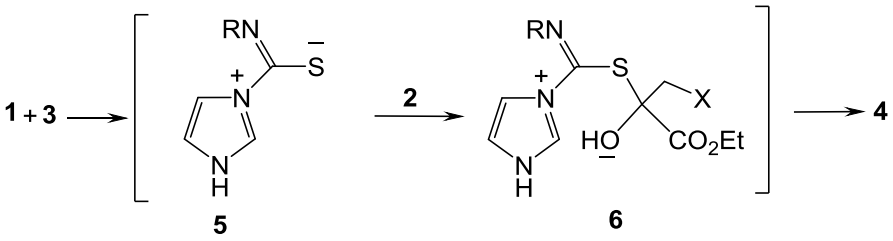
The reaction of **1** with **3** in the presence of pyruvates **2** led to imidazole derivatives **4** in 80-90% yields (Scheme 1). Structures of compounds **4a–d** were assigned by IR, $^{1}$H NMR, $^{13}$C NMR and mass spectral data. For example, the $^{1}$H NMR spectrum of **4a** exhibited one triplet at 1.25 ($^{3}J_{HH}$ = 7.2) for methyl proton and two singlets at 3.68 and 3.89 for methoxy groups. Because of stereogenic center in these products, hydrogens of $CH_2$ and $OCH_2$ groups are diasterotopic, therefore, two doublets were observed at 4.09 ($^{2}J_{HH}$ = 10.9) and 4.17 ($^{2}J_{HH}$ = 10.9) for $CH_2$ group, one multiplet at 4.18-4.25 for $OCH_2$ moiety and one singlet at 6.60 ppm for CH groups. The carbonyl groups resonances in the $^{13}$C NMR spectra of **4a** appear at 162.9, 164.1 and 167.5 ppm. The mass spectrum of **4a** displayed the molecular ion peak at *m*/*z* = 422.




| 1, 2, 4 | R | X | Yield (%) of **4** |
|---|---|---|---|
| **a** | Me | Br | 90 |
| **b** | Et | Br | 85 |
| **c** | Me | H | 85 |
| **d** | Et | H | 80 |

**Scheme 1.** Synthesis of imidazole derivatives

A tentative mechanism for this transformation is proposed in Scheme 2. It is conceivable that, the initial event is the formation of the 1:1 adducts **5** from the Reaction of activated isothiocyanate **1** with thiazol **3** which is subsequently attacked by pyruvates to produce **6**. Intermediate **6** undergoes cyclization reaction to generate **4**.




**Scheme 2.** Proposed mechanism for synthesis of imidazole derivatives

## Conclusion

In conclusion, the reaction of isoyhiocyanates with pyruvates in the presence of imidazole or benzothiazol led imidazolo thiazines in excellent yields. The present procedure has the advantage that the reaction is performed under neutral conditions, and the starting material can be used without any activation or modification.

## Experimental

All compounds in these reactions were obtained from Fluka and were used without further purification. M.p.: Electrothermal-9100 apparatus; uncorrected. IR Spectra: Shimadzu IR-460 spectrometer. $^{1}$H and $^{13}$C NMR spectra: Bruker DRX-500 AVANCE instrument; in $CDCl_3$ at 500.1 and 125.7 MHz, respectively; $\delta$ in ppm, *J* in Hz. EI-MS (70 eV): Finnigan-MAT-8430 mass spectrometer, in *m/z*. Elemental analyses (C, H, N) were performed with a Heraeus CHN-O-Rapid analyzer.

## General Procedure for the Preparation of Compounds 4a-d

Imidazole (2 mmol) were added to a mixture of pyruvates (2 mmol) and activated acetylenic ester (2 mmol) at room temperature. The reaction mixture was then stirred for 12 h to afford the pure compounds **4a-d**.

### *7-ethyl 5,6-diethyl 7-bromo-7H-[1,3]imidazolo[2,3-b][1,3]thiazine-5,6,7-tricarboxylate (4a):*

Yellow oil, yield: 0.76 g (90%). IR (KBr): 1725, 1591, 1549, 1473, 1368, and 1015. $^{1}$H NMR: 1.25 (3 H, *t*, $^{3}J_{HH}$ = 7.2, Me), 3.68 (3 H, s, OMe), 3.89 (3 H, s, OMe), 4.09 (1 H, *d*, $^{2}J_{HH}$ = 10.9, CH), 4.17 (1 H, *d*, $^{2}J_{HH}$ = 10.9, CH), 4.18-4.25 (2 H, *m*, $OCH_2$), 5.69 (1 H, *d*, $^{3}J_{HH}$ = 4.5, CH), 6.19 (1H, *d*, $^{3}J_{HH}$ = 4.5, CH), 6.60 (1 H,

*s*, CH). $^{13}$C NMR: 13.9 (Me), 31.8 ($CH_2Br$), 51.9 (OMe), 52.1 (OMe), 62.9 ($OCH_2$), 79.6 (C), 91.0 (CH), 102.7 (CH), 109.3 (C), 128.8 (CH), 141.7 (C), 162.9 (C=O), 164.1 (C=O), 167.5 (C=O). EI-MS: 422 ($M^+$, 10); 350 (20), 348 (20), 167 (25), 149 (60), 84 (100), 57 (62). Anal. Calcd for $C_{14}H_{16}BrNO_7S$ (422.24): C, 39.82; H, 3.82; N, 3.32; found: C, 39.80; H, 3.80; N, 3.31%.

***7-ethyl 5,6-diethyl 7-bromomethyl-7H-[1,3]imidazolo[2,3-b][1,3]thiazine-5,6,7-tricarboxylate (4b):***

Yellow Oil, yield: 0.76 g (85%). IR (KBr): 1732, 1685, 1583, 1504, 1453 and 1384. $^1$H NMR: 1.22 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.28 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.35 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 4.12 (1 H, *d*, $^2J_{HH}$ = 10.5, CH), 4.18 (1 H, *d*, $^2J_{HH}$ = 10.5, CH), 4.19-4.23 (4 H, *m*, 2 $OCH_2$), 4.29-4.37 (2 H, *m*, $OCH_2$), 5.71 (1H, *d*, $^3J_{HH}$ = 4.6, CH), 6.20 (1H, *d*, $^3J_{HH}$ = 4.6, CH), 6.62 (1 H, *s*, CH). $^{13}$C NMR: 13.8 (Me), 13.9 (Me), 14.0 (Me), 35.7 ($CH_2Br$), 61.0 ($OCH_2$), 62.4 ($OCH_2$), 62.7 ($OCH_2$), 78.4 (C), 90.9 (CH), 102.5 (CH), 113.4 (C), 121.4 (CH), 142.0 (C), 162.4 (C=O), 163.6 (C=O), 167.6 (C=O). EI-MS: 450 ($M^+$, 5); 377 (24), 375 (24), 370 (68), 231 (45), 229 (45), 84 (100), 73 (60). Anal. Calcd for $C_{16}H_{20}BrNO_7S$ (450.30): C, 42.68; H, 4.48; N, 3.11; found: C, 42.70; H, 4.50; N, 3.10%.

***7-ethyl 5,6-dimethyl 7-methyl-7H-[1,3]imidazolo[2,3-b][1,3]thiazine-5,6,7-tricarboxylate (4c):***

Yellow Oil, yield: 0.58 g (85%). IR (KBr): 1716, 1687, 1429, 1364, 1199 and 1103. $^1$H NMR: 1.17 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.75 (3 H, s, Me), 3.65 (3 H, *s*, $OCH_3$), 3.82 (3 H, *s*, $OCH_3$), 4.12-4.17 (2 H, *m*, $OCH_2$), 5.61 (1 H, *d*, $^3J_{HH}$ = 4.6, CH), 6.11 (1 H, *d*, $^3J_{HH}$ = 4.6, CH), 6.52 (1 H, *s*, CH). $^{13}$C NMR: 13.6 (Me), 23.6 (Me), 51.7 ($OCH_3$), 53.0 ($OCH_3$), 61.9 ($OCH_2$), 89.9 (C), 90.7 (CH), 101.3 (CH), 112.7 (C), 121.4 (CH), 138.4 (C), 163.1 (C=O), 164.5 (C=O), 169.8 (C=O). EI-MS: 343 ($M^+$, 10); 270 (85); 306 (66); 292(64), 284 (60);275 (85), 84 (100); 59 (67). Anal. Calcd for $C_{14}H_{17}NO_7S$ (343.35): C, 48.97; H, 4.99; N, 4.08; found: C, 48.95; H, 4.92; N, 4.02%.

***7-ethyl 5,6-diethyl 7-methyl-7H-[1,3]imidazolo[2,3-b][1,3]thiazine-5,6,7-tricarboxylate (4d):***

Yellow Oil, yield: 0.59 g (80%). IR (KBr): 1716, 1686, 1461, 1360, 1312 and 1025. $^1$H NMR: 1.16 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.19 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.27 (3 H, *t*, $^3J_{HH}$ = 7.2, Me), 1.71 (3 H, s, Me), 4.00-4.18 (4 H, *m*, 2 $OCH_2$), 4.20-4.32 (2 H, *m*, $OCH_2$), 5.58 (1 H, *d*, $^3J_{HH}$ = 4.6, CH), 6.07 (1 H, *d*, $^3J_{HH}$ = 4.6, CH), 6.52 (1 H, *s*, CH). $^{13}$C NMR: 13.8 (Me), 13.9 (Me), 14.0 (Me), 23.8 (Me), 60.8 ($OCH_2$), 61.7 ($OCH_2$), 62.5 ($OCH_2$), 78.2 (C), 90.7 (CH), 101.3 (CH), 112.5 (C), 121.6 (CH), 138.8 (C), 162.8 (C=O), 163.9 (C=O), 170.0 (C=O). EI-MS: 371 ($M^+$, 15); 298 (85); 225 (66); 292(64), 275 (85), 84 (100); 45 (84). Anal. Calcd for $C_{16}H_{21}NO_7S$ (371.41): C, 51.74; H, 5.70; N, 3.77; found: C, 51.70; H, 5.68; N, 3.71%.

## References


[1] Ugi, I.; Domling, A. *Endeavour* **1994**, *18*, 115.
[2] Heck, S.; Domling, A. *Synlett* **2000**, 424.
[3] Kraus, G. A.; Nagy, J. O. *Tetrahedron* **1985**, *41*, 3537.
[4] Posner, G. H. *Chem. Rev*. **1986**, *86*, 831.
[5] Uji, I. *J. Prakt. Chem*. **1997**, *339*, 499.
[6] Bienayme', H.; Bouzid, K. *Tetrahedron Lett*. **1998**, *39*, 2735.
[7] Ziegler, T.; Kaiser, H.-J.; Schlomer, R.; Koch, C. *Tetrahedron* **1999**, *55*, 8397.
[8] Lehn, J. M. *Supramolecular Chemistry–Concepts and Perspectives*, VCH, Weinheim, 1995 (Chapter 8).
[9] Petty, M. C.; Bryce, M. R.; Bloor, D. (Eds.), *Introduction to Molecular Electronics*, Edward Arnold, London, **1995**.
[10] Bryce, M. R. *Chem. Soc. Rev*. **1991**, *20*, 355, and references therein.
[11] Jorgensen, T.; Hansen, T. K.; Becer, J. *Chem. Soc. Rev*. **1994**, *23*, 41.
[12] Schulze, K.; Rihter, F.; Seisheit, R.; Krause, R.; Muhlstadt, M. *J. Prakt. Chemie*. **1980**, *322*, 629.
[13] Layman, D. L.; Scovill, J. P.; Bartosevich, J. F.; Bruce, J. *J. Med. Chem*. **1983**, *26*, 35.
[14] Trabanelli, G. *Corrosion* **1991**, *47*, 410.
[15] Shaban, A.; Kalman, E.; Telegdi, J.; Dora, Gy. *J. Appl. Phys*. A **1998**, *66*, 545.
[16] Costa, J.; Delgado, R.; Drew, M. G. B.; Flix, V. *J. Chem. Soc. Dalton Trans.* **1999**, 4331.
[17] Vastag, G.; Szocs, E.; Shaban, A.; Kalman, E. *Pure Appl. Chem*. **2001**, *73*, 1861.