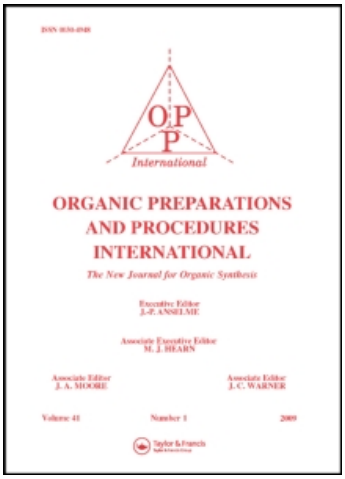

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SYNTHESIS OF 2-ARYL[1,2,4]-TRIAZOLO[5,1-*b*]BENZOTHIAZOLES

Huey-Min Wang[a]; Ling-Ching Chen[a]
[a] Graduate Institute of Pharmaceutical Sciences, Kaohsiung Medical College, Kaohsiung, Taiwan Republic of CHINA

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SYNTHESIS OF 2-ARYL[1,2,4]TRIAZOLO[5,1-*b*]BENZOTHIAZOLES

Submitted by Huey-Min Wang and Ling-Ching Chen*
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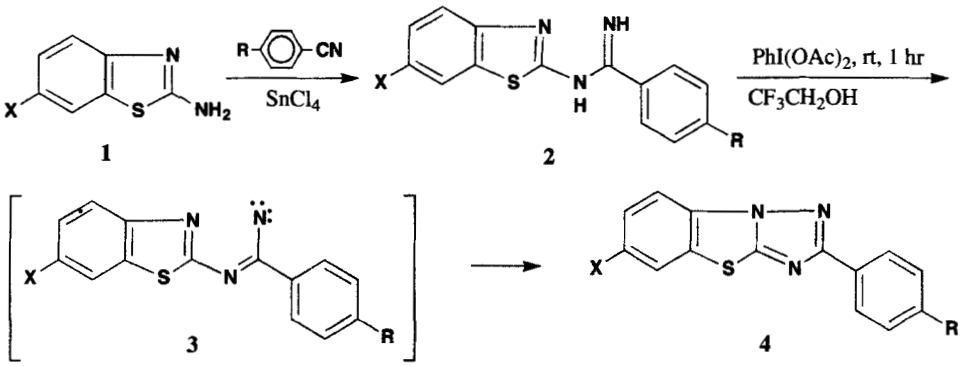
Graduate Institute of Pharmaceutical Sciences
Kaohsiung Medical College
Kaohsiung 807, Taiwan, Republic of CHINA

Oxidative cyclization of *N*-heteroarylamidines[1-9] is a route for the synthesis of new fused heterocyclic systems containing a 1,2,4-triazole moiety. Recently, hypervalent iodine reagents have been extensively used in organic synthesis due to their low toxicity, ready availability, and easy handling.[10] As an oxidant, phenyliodoso (III) diacetate (PIDA) is the most frequently used and easily available reagent in the family of hypervalent iodine compounds. In this work, we report the oxidative cyclization of *N*-(benzothiazol-2-yl)benzamidines (**2**) by PIDA, which affords 2-aryl[1,2,4]triazolo[5,1-*b*]benzothiazoles (**4**)[11] efficiently.



a) X = R = H b) X = H, R = Me c) X = H, R = Cl d) X = Me, R = H e) X = R = Me
f) X = Me, R = Cl g) X = OMe, R = H h) X = OMe, R = Cl i) X = OMe, R = Cl j) X = R = Cl

Reaction of 2-aminobenzothiazole (**1a**) with benzonitrile in the presence of anhydrous stannic chloride at 140° (for 2 hrs gave *N*-(benzothiazol-2-yl)benzamidine (**2a**). Similarly, amidines **2b-j** were prepared by the reaction of 2-amino-6-methyl, 2-amino-6-methoxy and 2-amino-6-chlorobenzothiazoles (**1**) with benzonitrile, *p*-methyl and *p*-chlorobenzonitriles in the presence of anhydrous stannic chloride. Their structures were readily assigned on bases of spectral data and elemental analysis. Oxidative cyclization of *N*-(benzothiazol-2-yl)benzamidines (**2**) with PIDA in 2,2,2-trifluoroethanol (TFE) at room temperature for 1 hr resulted in the formation of 2-aryl[1,2,4]triazolo[5,1-*b*]benzothiazoles (**4**) in 72-85 % yield. The formation of compounds **4** may be rationalized through the electrocyclization of nitrene intermediates **3**, resulting from the oxidation of **2** in the presence of PIDA.

In conclusion, the oxidative cyclization of *N*-(benzothiazol-2-yl)benzamidines (**2**) using PIDA is noteworthy for its mild conditions, easy handling, low toxicity, and good yields, and thus appears to be an efficient method for the synthesis of 2-aryl[1,2,4]triazolo[5,1-*b*]benzothiazoles (**4**).

TABLE 1. Yields, mps, Elemental Analyses and Spectral Data **2**

Compd	Yield (%)	mp. (°C)	IR (cm^{-1})	^1H NMR (δ)	Elemental Analyses (Found) C	H	N
2a	78	157-158	3300 1615	6.42 (br s, 1H), 7.26-7.52 (m, 5H), 7.74-7.80 (m, 2H), 7.94-7.98 (m, 2H), 10.60 (br s, 1H)	66.38 (66.40)	4.38 (4.49)	16.59 (16.60)
2b	73	172-173	3300 1630	2.43 (s, 3H), 6.37 (br s, 1H), 7.15-7.45 (m, 4H), 7.74-7.78 (m, 2H), 7.85-7.89 (m, 2H), 10.58 (br s, 1H)	67.39 (67.34)	4.90 (4.93)	15.72 (15.70)
2c	71	183-184	3300 1610	6.35 (br s, 1H), 7.20-7.50 (m, 4H), 7.75-7.81 (m, 2H), 7.90-7.94 (m, 2H), 10.63 (br s, 1H)	58.43 (58.52)	3.50 (3.52)	14.60 (14.61)
2d	75	179-180	3400 1610	2.46 (s, 3H), 6.35 (br s, 1H), 7.10-7.68 (m, 6H), 7.93-7.98 (m, 2H), 10.58 (br s, 1H)	67.39 (67.31)	4.90 (4.90)	15.72 (15.73)
2e	72	198	3400 1615	2.43 (s, 3H), 2.46 (s, 3H), 6.32 (br s, 1H), 7.15-7.67 (m, 5H), 7.83-7.87 (m, 2H, q, 2H, J = 8.3 Hz), 10.50 (br s, 1H)	68.30 (68.26)	5.37 (5.45)	14.93 (14.92)
2f	74	217-218	3300 1620	2.46 (s, 3H), 6.29 (br s, 1H), 7.18-7.68 (m, 5H), 7.89-7.93 (m, 2H), 10.68 (br s, 1H)	59.70 (59.61)	4.01 (3.99)	13.92 (13.98)
2g	71	166	3370 1615	3.87 (s, 3H), 6.32 (br s, 1H), 7.00 (dd, 1H, J = 2.6 and 8.9 Hz), 7.27 (d, 1H, J = 2.6 Hz), 7.35-7.60 (m, 3H), 7.67 (d, 1H, J = 8.9 Hz), 7.97-7.98 (m, 2H), 10.47 (br s, 1H)	63.58 (63.52)	4.62 (4.59)	14.83 (14.82)
2h	70	190-191	3450 1600	2.43 (s, 3H), 3.87 (s, 3H), 6.30 (br s, 1H), 7.00 (dd, 1H, J = 2.6 and 8.8 Hz), 7.15-7.34 (m, 3H), 7.66 (d, 1H, J = 8.8 Hz), 7.85 (d, 2H, J = 8.2 Hz)	64.62 (64.49)	5.08 (5.11)	14.13 (14.12)
2i	76	205	3330 1610	3.87 (s, 3H), 7.00 (dd, 1H, J = 2.6 and 8.8 Hz), 7.26 (d, 1H, J = 2.6 Hz), 7.46 (d, 2H, J = 8.5 Hz), 7.67 (d, 1H, J = 8.8 Hz), 7.90 (d, 2H, J = 8.5 Hz), 10.47 (br s, 1H)	56.69 (56.59)	3.81 (3.77)	13.22 (13.18)
2j	72	215	3330 1620	6.37 (br s, 1H), 7.35 (dd, 1H, J = 2.1 and 8.6 Hz), 7.47 (d, 1H, J = 8.9 Hz), 7.68 (d, 1H, J = 8.6 Hz), 7.73 (d, 1H, J = 2.1 Hz), 7.91 (d, 2H, J = 8.8 Hz), 10.48 (br s, 1H)	52.18 (52.00)	2.82 (2.81)	13.04 (13.00)

EXPERIMENTAL SECTION

All melting points are uncorrcted. The IR absorption spectra were recorded on a Shimadzu IR-27G spectrophotometer, and ^{1}H NMR spectra on a Varian Gemini-200 spectrometer. Chemical shifts were measured in ppm (δ) with respect to TMS. The microelemental analyses were carried out on Heraeus CHN-O Rapid instrument.

***N*-(Benzothiazol-2-yl)benzamidines (2). General Procedure**.- A mixture of 2-aminobenzothiazole (10 mmol), benzonitrile (10 mmol), and anhydrous stannic chloride (12.8 mmol) was heated at 140° (for 2 hrs). The mixture was cooled to room temperature and poured into 20% sodium hydroxide solution (200 mL). The precipitated solid was collected, washed with cold water, dried and extracted with diethyl ether (3x50 mL). The ethereal extracts were dried and evaporated and the residue was subjected to chromatography over a column of silica gel and eluted with chloroform to afford the pure amidines **2** (Table 1).

TABLE 2. Yields, mps, Spectral Data and Literature Comparison of **4**

Compd	Yield (%)	mp. (C)	Lit. mp. (C)	IR (cm^{-1})	^{1}H NMR (δ)
4a	72	183	185[11]	1600	7.21-7.26 (m, 5H), 7.78-17.82 (m, 1H), 8.02-8.08 (m, 1H), 8.23-8.27 (m, 1H)
4b	74	188	189[11]	1600	2.43 (s, 3H), 7.20-7.60 (m, 4H), 7.76-7.81 (m, 1H), 8.00-8.05 (m, 1H), 8.13 (d, 2H, J = 8.1 Hz)
4c	85	226-227	a	1600	7.40-7.65 (m, 4H), 7.78-7.83 (m, 1H), 8.00-8.05 (m, 1H), 8.17-8.21 (m, 2H)
4d	75	173	175[11]	1610	2.51 (s, 3H), 7.32-7.58 (m, 4H), 7.91 (d, 1H, J = 8.2 Hz), 8.21-8.26 (m, 2H)
4e	73	181	182[11]	1610	2.42 (s, 3H), 2.51 (s, 3H), 7.15-7.57 (m, 4H), 7.90 (d, 1H, J = 8.2 Hz), 8.12 (d, 2H, J = 8.2 Hz)
4f	82	195	195[11]	1600	2.51 (s, 3H), 7.31-7.59 (m, 4H), 7.89 (d, 1H, J = 8.3 Hz), 8.17 (d, 2H, J = 8.8 Hz)
4g	76	150	152[11]	1600	3.89 (s, 3H), 7.12 (dd, 1H, J = 2.4 and 8.8 Hz), 7.27 (d, 1H, J = 2.4 Hz), 7.40-7.60 (m, 2H), 7.91 (d, 2H, J = 8.8 Hz),8.21-8.25 (m, 2H)
4h	74	168	167[11]	1600	2.39 (s, 3H), 3.87 (s, 3H), 7.00 (dd, 1H, J = 2.6 and 8.8 Hz), 7.25-7.32 (m, 3H), 7.66 (d, 1H, J = 8.8 Hz), 7.87 (d, 2H, J = 8.2 Hz)
4i	81	192	194[11]	1610	3.90 (s, 3H), 7.13 (dd, 1H, J = 2.4 and 8.9 Hz), 7.27 (d, 1H, J = 2.4 Hz), 7.43-7.48 (m, 2H), 7.90 (d, 1H, J = 8.9 Hz), 8.13-8.18 (m, 2H)
4j	80	243-244	b	1600	7.47 (dd, 1H, J = 2.0 and 8.7 Hz), 7.52-7.58 (m, 2H), 7.79 (d, 1H, J = 2.0 Hz), 7.94 (d, 1H, J = 8.7 Hz), 8.16 (d, 2H, J = 8.9 Hz)

a) *Anal.* Calcd for $C_{14}H_8ClN_3S$: C, 58.84; H, 2.82; N, 14.71. Found: C, 58.76; H, 2.90; N, 14.67.
b) *Anal.* Calcd for $C_{14}H_7Cl_2N_3S$: C, 52.51; H, 2.20; N, 13.12. Found: C, 52.33; H, 2.26; N, 13.13.

2-Aryl[1,2,4]triazolo[5,1-*b*]benzothiazoles (4). General Procedure. - Phenyliodoso (III) diacetate (10 mmol) was added slowly to a stirred solution of the amidine (5 mmol) in 2,2,2-trifluoroethanol (15 mL). After stirring for 1 hr at room temperature, the solvent was evaporated and the residue was subjected to chromatography over a column of silica gel and eluted with hexane-ethyl acetate (5:1) to give the pure 2-aryl[1,2,4]triazolo[5,1-*b*]benzothiazoles (**4**) (Table 2).

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