SYNTHESIS OF CONDENSED 1,2,4-TRIAZOLO-HETEROCYCLES

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SUMMARY: Dehydrogenative cyclization of hydrazones derived from aromatic aldehydes and 2-hydrazino-1,3-benzothiazole, 2-hydrazinoquinoline, 2-hydrazinolepidine and 2-hydrazinopyridine using different dehydrogenating or oxidizing agents gave the corresponding 3-aryl-1,2,4-triazolo [3,4-b] 1,3-benzothiazoles, 3-aryl-1,2,4-triazolo [4,3-a] quinolines, 3-aryl-1,2,4-triazolo [4,3-a] lepidines and 3-aryl-1,2,4-triazolo [4,3-a] pyridines respectively. 1-Aroyl-2-(1,3-benzothiazol-2-yl)-, 1-aroyl-2-(quinol-2-yl)- and 1-aroyl-2-(lepid-2-yl) hydrazines were also prepared and their dehydrative cyclization using acetyl chloride was attempted. Under the used conditions 1-aroyl-2-(quinol-2-yl) hydrazines directly cyclized to 1,2,4-triazolo [4,3-a] quinolines while 1-aroyl-2-(1,3-benzothiazol-2-yl) hydrazines and 1-aroyl-2- (lepid-2-yl) hydrazines gave 1-acety-2-aroyl-1-1-(1,3-benzothiazol-2-yl) hydrazines and 1-acetyl-2-aroyl-1-(lepid-2-yl) hydrazines respectively. The latter were successfully cyclized through the elimination of an acetic acid molecule to the corresponding 3-aryl-1,2,4-triazolo-heterocycle by heating in boiling phenol.

Key Words: Hydrazines, hydrazones, cyclization.

INTRODUCTION

Many studies (18) have shown that condensed 1,2,4-triazolo-heterocycles possess diverse biological activities such as fungicidal (5, 7, 8, 14, 15) bactericidal (5, 7, 8, 14, 15) analgesic (12), anixolytic (19) and anti-inflammatory (1) activities. This inspired us to synthesize some of these compounds namely: 3-aryl-1,2,4-triazolo [3,4-b] 1,3-benzothiazoles, 3-aryl-1,2,4-triazolo [4,3-a] quinolines, 3-aryl-1,2,4-triazolo [4,3-a] lepidines, and 3-aryl-1,2,4-triazolo [4,3-a] pyridines, which we hope to possess some biological activities.

MATERIALS AND METHODS

General

Melting points were determined with a kofler block and are uncorrected. The infrared spectra (IR) were recorded for potassium bromide discs on a Unicam SP-1025 or Pye Unicam SP-2000 spectrophotometers. Proton magnetic resonance (^{1}H NMR) spectra were carried out at ambient temperature (~25°C) and at 90 MH_2 with a Varian EM-390 spectrometer for solutions in $CDCl_3$ or $(CD_3)_2SO$. Follow up at the reactions and checking the homogeneity of the prepared compounds were made by performing thin-layer chromatography (TLC) on Silica gel G (Merck) pre-coated plates (layer thickness 0.25 mm) used without pre-treatment. All ratios of the solvent systems used were volume-to-volume (v/v); the distance of solvent travel was 5 cm, and the spots were detected by exposure to iodine vapor for a few minutes. All solvent evaporations were performed in a Buchi rotary evaporator under diminished pressure. Elemental microanalyses were performed in the Microanalysis Laboratory, Department of Chemistry, Faculty of Science, Alexandria University using a Perkin-Elmer model PE-240 analyzer and in the Microanalysis Unit Cairo University, Cairo, Egypt.

Hydrazones (1a–1d)

A solution of 2-hydrazino-1,3-benzothiazole (1a), 2-hydrazino-quinoline (1b), 2-hydrazinolepidine (1c), or 2-hydrazinopyridine (1d) (0.004 mole) was treated with the appropriate aromatic

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aldehyde (0.004 mole) and the mixture was heated for 15 mins on a boiling water-bath. The product which separated upon attaining ambient temperature, was filtered, washed and crystallized from methanol (Table 1).

1-Aroyl-2-(1,3-benzothiazol-2-yl) hydrazines (4a), 1-aroyl-2-(quinol-2-yl) hydrazines (4b), and 1-aroyl-2-(lepid-2-yl) hydrazines (4c)

A mixture of 2-chloro-1,3-benzothiazole (3a), 2-chloroquinoline (3b), or 2-chlorolepidine (3c) (0.004 mole) and the appropriate aroyl-hydrazine (0.004 mole) was heated at 170–180°C for 30 mins and then allowed to attain ambient temperature. The hard mass was triturated with methanol, filtered, and crystallized from methanol-chloroform to give the title compounds (Table 2).

1-Acetyl-2-aroyl-1-(1,3-benzothiazol-2-yl) hydrazines (5a) and 1-acetyl-2-aroyl-1-(lepid-2-yl) hydrazines (5c)

A mixture of 1-aroyl-2-(1,3-benzothiazol-2-yl) hydrazines (4a) or 1-aroyl-2-(lepid-2-yl) hydrazines (4c) (0.002 mole) and acetic acid 15 ml) and acetyl chloride (15 ml) was heated under reflux for 30 mins after complete dissolution has occurred. The mixture was cooled and carefully poured into a cold saturated solution of sodium hydrogen carbonate (200 ml). The product, which separated, was filtered, washed with water, and crystallized from methanol-chloroform to give title compounds (Table 2).

3-Aryl-1,2,4-triazolo [3,4–b] 1,3-benzothiazole (2a), 3-Aryl-1,2,4-triazolo [4,3–a] quinolines (2b), 3-aryl-1,2,4-triazolo [4,3–a] lepidines (3c) and 3-aryl-1,2,4-triazolo [4,3–a] pyridines (3d)

Method (A): To a solution of the particular hydrazone (1a–1d, 0.003 mole) in dry dichloromethane (50 ml), lead tetraacetate (0.006 mole) was added and the mixture was heated under reflux for 3 hours. The mixture was diluted with water (50 ml) and the dark inorganic residue was filtered and washed with dichloromethane (30 ml). The organic layer was washed with a saturated sodium hydragen-carbonate solution (3x25 ml), and water (2x30 ml), and dried (Na_2SO_4). Evaporation of the solvent gave a residue which was crystallized from methanol to give the title compounds (Table 3).

Method (B): A mixture of the particular hydrazone (1a–1d, 0.003 mole) and sodium carbonate (2.4 gm) in chloroform (50 ml) was treated with bromine (0.2 ml) and stirred for 30 mins at ambient temperature. The inorganic residue was filtered and the filtrate and the filtrate was evaporated to dryness. The obtained residue was crystallized from methanol to give the title compounds (Table 3).

Method (C): A solution of the particular hydrazone (1a–1d, 0.003 mole) in ethanol (20 ml) was treated with 10% ethanolic ferric chloride (20 ml) and the mixture was heated under reflux for 3 hours and then evaporated to dryness. The obtained dark residue was dissolved in chloroform (30 ml) and the solution was washed with water (3x10 ml), dried (Na_2SO_4) and evaporated. Crystallization of the obtained residue from methanol gave the title compounds (Table 3).

Method (D): A solution of the particular hydrazone (1b–1d, 0.003 mole) in dioxane (3 ml) was treated with 30% sodium hypochlorite solution (10 ml) and the mixture was heated on a boiling water-bath for 5 mins. The mixture was left to attain ambient temperature and the product which separated, was filtered, washed with water, and crystallized from methanol to give the title compounds (Table 3).

Method (E): A solution of the particular aldehyde (quinol-2-yl) hydrazone (1b, 0.003 mole) or (lepid-2-yl) hydrazone (1c, 0.003 mole) in toluene (20 ml) was heated under reflux for 10 hours with 10% palladium-on-charcoal (0.5 g). The catalyst was filtered on a celite layer and the filtrate was evaporated. The obtained product was crystallized from methanol to give the title compounds (Table 3).

Method (F): A mixture of the particular 1-acetyl-2-aroyl-(1,3-benzothiazol-2-yl) hydrazine (5a, 0.003 mole) or 1-acetyl-2-aroyl-1-(lepid-2-yl) hydrazine (5c, 0.003 mole) and phenol (5 ml) was heated under reflux for 24 hours. The mixture was evaporated under reduced pressure and co-evaporated with water. The resulting residue was crystallized from methanol to give the title compounds (Table 3).

RESULTS AND DISCUSSION

Dehydrogenative and oxidative cyclization of hydrazones derived from aromatic aldehydes and cyclic amidrazones are among the good methods for the preparation of a wide range of condensed 1,2,4-triazoloheterocyclic compounds (10,11,13,18). Sometimes, however, these cyclization reactions did not proceed straightforwardly as expected which led to erroneous structural assignment to the products. Thus, whereas Bower and Doyle (2) and Desphande (6) assigned the product of lead tetraacetate (LTA) oxidation of benzaldehyde 1,3-benzothiazol-2-yl hydrazones (1a, R=H) the structure of 3-phenyl-1,2,4-triazolo [3,4-b] 1,3-benzothiazole (2a, R=H), Butler *et al.* (3) assigned the same product 1 acetyl-2-benzoyl-1-(1,3-benzothiazol-2-yl) hydrazine structure (5a, R=H). In our hands, the LTA oxidation of 1a (R=H) gave two products, the first of which showed two amide absorption bands at 1700 and 1665 cm^{-1} and an NH band at 3400 cm^{-1}. It is elemental analysis agreed with the molecular formula $C_{16}H_{13}N_3O_2S$ and was assigned, therefore, the hydrazido structure 5a (R=H). Compound 5a (R=H) was unequivocally prepared from 2-chloro-1,3-benzothiazole (3a) by fusion with benzoylhydrazine to give the

Table 1: Physical, elemental analysis, and spectral data of hydrazones 1a-1d.

Compd. No.	R	MP (°C)	Yield (%)	Molecular Formula	Analyses (%) Calc/Found			IR(KBr) cm^{-1}		
					C	H	N	NH	C=N	^{1}H NMR (δ) ppm
1a	H	226	78	$C_{14}H_{11}N_3S$	66.40 66.73	4.35 4.55	16.60 16.51	- -	1632	8.03-6.98 (m, 10H, 9 aromatic H+ -CH=N)*
1a	OMe	205	80	$C_{15}H_{13}N_3OS$	63.60 63.32	4.59 4.66	14.84 14.77	- -	1625	7.83-6.77 (m, 9H, 8 aromatic H+ -CH=N)**
1a	Cl	265	80	$C_{14}H_{10}N_3SCl$	58.43 58.87	3.48 3.61	14.61 14.55	- -	1635	12.17 (s, 1H, deuteratable, NH), 8.10-6.97 (m, 9H, 8 aromatic H+ -CH=N)**
1a	Br	285	83	$C_{14}H_{10}N_3SBr$	50.60 50.44	3.01 3.03	12.65 12.46	- -	1635	12.18 (s, 1H deuteratable, NH), 8.08-7.00 (m, 9H, 8 aromatic H+ -CH=N)**
1a	NO_2	290	82	$C_{14}H_{10}N_4O_2S$	56.38 56.78	3.36 3.56	18.79 18.34	- -	1630	12.33 (s, 1H deuteratable, NH), 8.22-6.98 (m, 9H, 8 aromatic H+ -CH=N)**
1b	H	134	77	$C_{16}H_{13}N_3$	78.00 77.73	5.50 5.26	17.00 17.30	- -	1635	
1b	OMe	101	78	$C_{17}H_{15}N_3O$	73.65 73.60	5.42 5.80	14.95 15.20	3300	1610	
1b	Cl	162	68	$C_{16}H_{12}N_3Cl$	68.21 68.30	4.26 4.70	14.92 15.00	- -	1640	
1b	Br	176	80	$C_{16}H_{12}N_3Br$	58.90 58.50	3.68 3.75	12.88 12.80	- -	1638	
1b	NO_2	212	78	$C_{16}H_{12}N_4O_2$	65.75 66.00	4.11 4.10	19.18 19.50	- -	1640	
1c	H	160	67	$C_{17}H_{15}N_3$	78.16 78.15	5.75 5.96	16.09 16.30	3260 -	1625	7.77-7.15 (m, 11H, 10 aromatic H + -CH=N), 2.57 (s, 3H, CH_3)*
1c	OMe	200	71	$C_{15}H_{17}N_3O$	74.23 74.22	5.84 5.94	14.43 14.49	3330	1610	7.75-6.85 (m, 10H, 9 aromatic H + -CH=N), 3.80 and 2.60 (m, 3H, each, 2 CH_3)*
1c	NMe_2	175	71	$C_{19}H_{20}N_4$	75.00 75.28	6.58 6.77	18.42 18.63	3230	1618	7.95-7.13 (m, 10H, 9 aromatic H + -CH=N), 2.93 (s, 6H, $2CH_3$), 2.60 (s,3H, CH_3)**
1c	Cl	178	86	$C_{17}H_{14}N_3Cl$	69.64 69.59	4.74 4.94	14.21 14.14	3500	1620	7.78-7.25 (m, 10H, 9 aromatic H + -CH=N), 2.63 (s, 3H, CH_3)*
1c	Br	194	88	$C_{17}H_{14}N_3Br$	60.00 59.60	4.12 4.10	12.35 12.03	- -	1620	7.67-7.40 (m, 10H, 9 aromatic H + -CH=N), 2.63 (s, 3H, CH_3)*
1c	NO_2	264	88	$C_{17}H_{14}N_4O_2$	66.67 66.29	4.58 4.75	18.30 18.23	3230	1620	11.57 (s 1H, deuteratable, NH), 8.18-7.15 (m, 10H, 9 aromatic H+ -CH=N, 2.62 (s, 3H, CH_3)*
1d	H	146	72	$C_{12}H_{11}N_3$	73.10 73.50	5.58 5.20	21.32 21.00	-	1605	
1d	OMe	165	80	$C_{13}H_{13}N_3O$	68.72 68.70	5.73 5.90	18.56 18.40	3250	1590	
1d	Cl	196	82	$C_{12}H_{10}N_3Cl$	62.20 62.10	4.32 4.40	18.14 18.50	-	1605	
1d	Br	185	77	$C_{12}H_{10}N_3Br$	52.17 52.30	3.62 3.40	15.22 15.40	-	1615	
1d	NO_2	260	82	$C_{12}H_{10}N_4O_2$	59.50 59.40	4.13 3.70	23.14 23.30	-	1630	

*:$CDCl_3$

**: $(CD_3)_2SO$

Table 2: Physical, elemental analysis, and spectral data of (1-aroyl-2-heterocyle) Hydrazines (4a-4c) and (1-acetyl-2-aroyl-heterocycle) hydrazines (5a-5d).

Compd. No.	R	MP (°C)	Yield (%)	Molecular Formula	Analyses (%) Calc/Found			IR(KBr) cm^{-1}			
					C	H	N	NH	CON	C=N	^{1}H NMR (δ) ppm
4a	H	196	63	$C_{14}H_{11}N_3OS$	62.45 62.40	4.09 3.70	15.61 15.40	3270	1650	1620	10.37 (s, 1H, deuteratable, NH), 8.05-7.28 (m, 9H, aromatic H)*
4a	Cl	240	74	$C_{14}H_{10}N_3OSCl$	55.35 55.60	3.29 3.20	13.84 14.20	- -	1680	1645	
4a	Br	244	66	$C_{14}H_{10}N_3OSBr$	48.28 48.50	2.81 3.00	12.07 12.40	3470	1652	1589	8.08-7.28 (m, 8H, aromatic H)**
4a	NO_2	280	62	$C_{14}H_{10}N_4O_3S$	53.50 53.20	3.18 3.00	17.83 17.50	3480	1690	1605	
4b	Cl	250	78	$C_{16}H_{12}N_3OCl$	64.50 64.30	4.03 4.50	14.12 14.20	3500	1650	1602	
4b	Br	235	70	$C_{16}H_{12}N_3OBr$	56.14 56.30	3.51 3.60	12.28 12.00	3430	1678	1635	
4b	NO_2	205	78	$C_{16}H_{12}N_4O_3$	62.34 62.10	3.90 3.50	18.81 18.50	3270	1640	1620	
4c	Cl	268	67	$C_{17}H_{14}N_3OCl$	65.49 65.60	4.49 4.80	13.48 13.60	3430	1655	1590	8.05-7.10 (m, 9H, aromatic H), 2.68 (s, 3H, CH_3)*
4c	Br	280	64	$C_{17}H_{14}N_3OBr$	57.30 57.70	3.93 4.10	11.80 11.70	3440	1668	1600	
4c	NO_2	245	65	$C_{17}H_{14}N_4O_4$	60.36 60.10	4.14 4.20	16.57 16.90	3470	1680	1610	
5a	H	229	83	$C_{16}H_{13}N_3O_2S$	61.74 61.50	4.18 4.40	13.50 13.80	3400	1700 1690	1580	
5a	Cl	225	83	$C_{16}H_{12}N_3O_2SCl$	55.57 55.60	3.47 3.70	12.17 12.00	3470	1702	1590 1685	
5a	Br	242	83	$C_{16}H_{12}N_3O_2SBr$	49.23 49.20	3.08 3.00	10.77 10.30	3390	1710 1690	1598	
5a	NO_2	260	63	$C_{16}H_{12}N_4O_4S$	53.93 53.70	3.37 3.30	15.73 15.50	3330	1710 1690	1630	
5c	Cl	251	75	$C_{19}H_{16}N_3O_2Cl$	64.50 64.20	4.53 4.30	11.88 12.10	3420	1780 1685	1620	8.13-7.52 (m, 9H, aromatic H), 2.60 (s, 6H, $2CH_3$)**
5c	Br	200	63	$C_{19}H_{16}N_3O_2Br$	57.29 57.30	4.02 4.30	10.55 10.40	3320	1725 1690	1612	
5c	NO_2	241	63	$C_{19}H_{16}N_4O_4$	62.64 62.50	4.40 4.70	15.83 15.50	3335	1695 1670	1632	

*:$CDCl_3$, **: $(CD_3)_2SO$

hydrazide 4a (R=H) followed by acetylation to 5a (R=H) which was found to be identical with that obtained from the LTA oxidation of 1a (R=H). The second product only showed infrared C=N absorption at 1575 cm^{-1} and its combustion analysis agreed with the molecular formula $C_{14}H_9N_3S$ of the 3-phenyl-1,2,4-triazolo [3,4–a] 1,3-benzothiazole structure 2a (R=H). The latter compound was also obtained form 5a (R=H) through the loss of an acetic acid molecule by thermal cyclization in boiling phenol. LTA oxidation of p-chlorobenzaldehyde 1,3-benzothiazol-2-ylhydrazone (1a, R=C) gave 5a (R=Cl) which was identical to that indirectly obtained from 3a and p-chlorobenzoylhydrazine followed by acetylation. Cyclization 5a (R=Cl) by heating in boiling phenol gave 2a (R=Cl). Surprisingly, LTA oxidation of p-bromobenzaldehyde and p-nitrobenzaldehyde 1,3-benzothiazol-2-ylhydrazones (1a, R=Br and NO_2) directly gave the corresponding 3-aryl-1,2,4-triazolo [3,4–b] 1,3-benzothiazoles (2a, R=Br, and NO_2). The

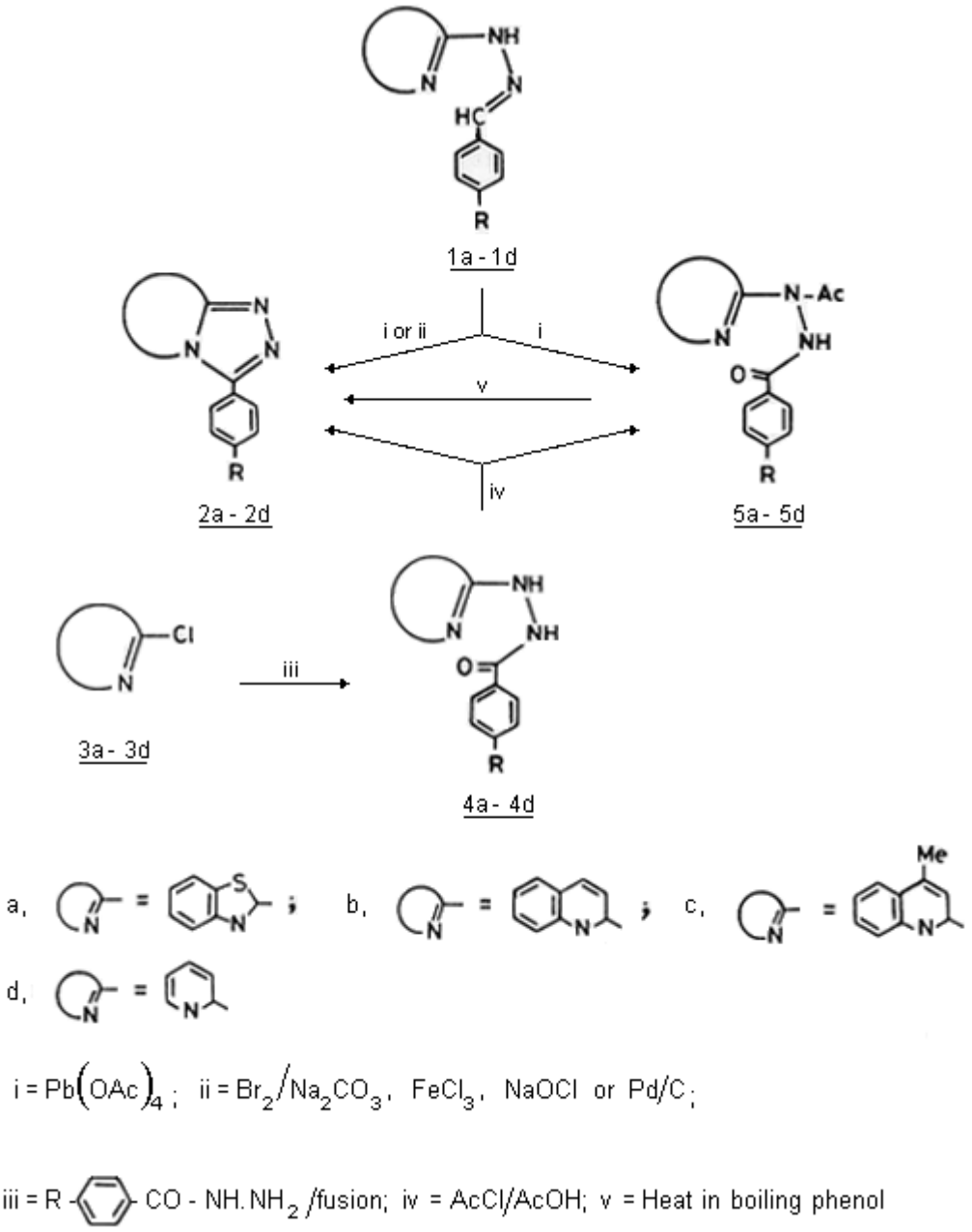
Table 3: Physical, elemental analysis, and spectral data of condensed 1,2,4-Triazolo-heterocycles (2a-2d).

Compd. No.	R	MP (°C)	Method of Cyclization	Molecular Formula	Analyses (%) Calc/Found			IR(KBr) cm^{-1}	
					C	H	N	C=N	^{1}H NMR (δ) ppm
2a	H	158	A,B,F	$C_{14}H_9N_3S$	66.93 66.60	3.59 3.80	16.73 16.70	1575	
2a	OMe	161	C	$C_{15}H_{11}N_3OS$	64.06 64.40	3.91 3.60	14.95 14.70	1615	
2a	Cl	204	A-C,F	$C_{14}H_8N_3SCl$	58.84 58.94	2.80 2.90	14.71 14.71	1600	
2a	Br	215	A-C,F	$C_{14}H_8N_3SBr$	50.91 50.60	2.42 2.80	12.73 12.40	1588	
2a	NO_2	310	A-C,F	$C_{14}H_8N_4O_2S$	56.76 56.36	2.70 2.66	18.92 18.36	1595	
2b	H*	94	A-C	$C_{16}H_{11}N_3$	78.37 78.10	4.49 4.10	17.14 17.50	1620	
2b	OMe	110	A-C	$C_{17}H_{13}N_3O$	74.18 74.11	4.73 4.87	15.28 14.93	1618	
2b	Cl	200	A-E	$C_{16}H_{10}N_3Cl$	68.69 63.30	3.58 3.70	15.03 15.00	1628	7.73-7.27** (m, 10H, aromatic H)
2b	Br	198	A-E	$C_{16}H_{10}N_3Br$	59.26 58.90	3.09 3.10	12.96 12.80	1625	7.93-7.25** (m, 10H, aromatic H)
2b	NO_2	265	A-E	$C_{16}H_{10}N_4O_2$	66.20 66.60	3.50 4.10	19.31 19.20	1635	
2c	H	155	C	$C_{17}H_{13}N_3$	78.76 78.55	5.02 5.16	16.22 16.34	1610	
2c	OMe	175	B,C	$C_{18}H_{15}N_3O$	74.74 74.72	5.19 5.02	14.53 14.65	1642	
2c	NMe_2	285	B,C	$C_{19}H_{18}N_4$	75.50 75.20	5.96 6.01	18.54 18.08	1615	
2c	Cl	205	A-F	$C_{17}H_{12}N_3Cl$	69.51 69.10	4.09 4.40	14.31 14.40	1648	7.93-7.28** (m, 9H, aromatic H), 2.66 (s, 3H, CH_3)
2c	NO_2	298	A-F	$C_{17}H_{12}N_3O_2$	67.11 67.23	3.95 3.95	18.42 18.36	1625	8.47-7.38*** (m, 9H, aromatic H), 2.57 (s, 3H, CH_3)
2d	H	174	A-C	$C_{12}H_9N_3$	73.85 73.50	4.62 4.30	21.53 21.70	1630	
2d	OMe	125	A-C	$C_{13}H_{11}N_3O$	69.33 64.00	4.89 5.40	18.67 18.50	1632	
2d	Cl	198	A-D	$C_{12}H_8N_3Cl$	62.75 62.80	3.49 3.50	18.30 18.32	1632	
2d	Br	200	A-D	$C_{12}H_8N_3Br$	52.55 52.20	2.92 2.62	15.33 15.70	1645	
2d	NO_2	300	A-D	$C_{12}H_8N_4O_2$	60.00 59.63	3.33 3.20	23.33 23.23	1615	

*: Crystallized from benzene-petroleum,

**: $CDCl_3$,

***: $(CD_3)_2SO$



latter compounds were also obtained when 5a (R=Br and NO_2) were cyclized by heating in boiling phenol. Hydrazones 2b, 2c, and 2d derived from 2-hydrazinoquinoline, 2-hydrazinolepidine and 2-hydrazinopyridine respectively, underwent LTA oxidative cyclization to the corresponding 3-aryl-1,2,4-triazolo [4,3–a] azines (2b–2d); the corresponding acetyl hydrazine derivatives 5b–5d have not been isolated. Indirect preparation of the latter compounds was only successful in the case of 1-acetyl-2-aroyl-1-(lepid-2-yl) hydrazines (5c) when 2-chlorolepidine (3c) was fused with aroylhydrazines to give 4c followed by acetylation. Heating of 5c in boiling phenol gave the 3-aryl-1,2,4-triazolo [4,3–a] lepidines (2c) which were identical to those prepared by the LTA oxidation of the hydrazones 1c. In contrast to 1-aroyl-2-(lepid-2-yl) hydrazines (4c), it was interesting to find out that boiling 1-aroyl-2-(quinol-2-yl) hydrazines (ab) with acetic acid-acetyl chloride mixture directly gave the 3-aryl-1,2,4-triazolo [4,3–a] quinolines 2b and not the 1-acetyl-2-aroyl-1-(quinol-2-yl) hydrazines 5b. All attempts to prepare 1-aroyl-2-(pyrid-2-yl) hydrazines

(4d) by reacting 2-chloropyridine (3d) with aroylhydrazines in aprotic solvents or by fusion were unsuccessful.

Oxidation of hydrazones derived from cyclic amidrazones with bromine has also been used for achieving the cyclization to the corresponding tiazolo-heterocycles (4, 9). Subjecting hydrazones 1a–1d to oxidation with bromine in the presence of sodium carbonate at ambient temperature gave the corresponding 3-aryl-1,2,4-triazolo-heterocycyles 2a–2d in good yields. Smooth oxidative cyclization of hydrazones 1b–1d has also been accomplished by heating with ethanolic ferric chloride solution as well as by oxidation with sodium hypochlorite in dioxane at ambient temperature.

Attempted catalytic dehydrogenative cyclization of the hydrazones 1a–1d using 10% palladium-on-charcoal according to the method used in this laboratory (16,17) was only effective in the case of aldehyde (quinol-2-yl) hydrazones (1b) and lepid-2-yl) hydrazones (1c) but failed with the other hydrazones.

Judging the smoothness of the reaction, as well as the state of purity and yield of the products as criteria for evaluating the most suitable cyclizing method, we came to the conclusion that bromine and sodium hypochlorite are the most effective cyclizing reagents.

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