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FLAVONOIDS—38†

REACTION OF 2′-HYDROXYCHALCONE DIBROMIDES AND -α-BROMOCHALCONES WITH AZIDE ION‡

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Abstract—The reaction of 2′-hydroxychalcone dibromides **1** or α-bromo-2′-hydroxychalcones **15** with sodium azide resulted in a mixture of α-azido-2′-hydroxychalcones **2**, 3-aryl-5-(2-hydroxyphenyl)isoxazoles **3**, flavones **4**, aurones **5** and 4-aryl-5-(2-hydroxybenzoyl)-1,2,3-triazoles **6**. The product ratio was strongly influenced by the character of the substituent at position C-4. Similar results were obtained with 2′-benzyloxy-4-nitrochalcone dibromide (**10**) and 2′-benzyloxy-α-bromo-4-nitrochalcone (**17**). The mechanism of the transformation of chalcone dibromides into the products via an α-bromochalcone intermediate is discussed.

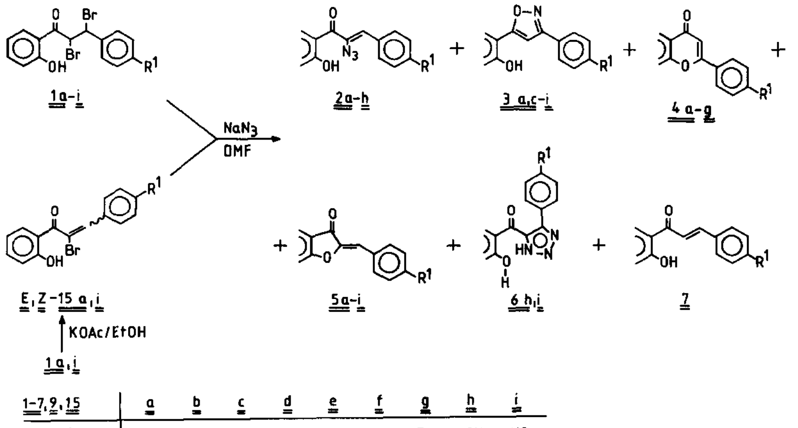
In a previous paper of this series we have reported on the reaction of 2′-OR-chalcone dibromides with azide ion and on the possibilities of the application[1] of the resulting α-azido-2′-OR-chalcones for the synthesis of various flavonoid derivatives. For determining of the scope and limits of usefulness and mechanism of this reaction, studies have been carried out also with 4-substituted 2′-OR-chalcone dibromides.

When 2′ - hydroxy - 4 - R^1 - chalcone dibromides (**1a–i**) were treated with sodium azide in DMF besides (Z) - α - azido - 2′ - hydroxy - 4 - R^1 - chalcones (**2a–h**) additional products, namely 5 - (2 - hydroxyphenyl) - 3 - (4 - R^1 - phenyl) - isoxazoles (**3a, c–i**), 4′-R^1-flavones (**4a–g**), 4′-R^1-aurones (**5a–i**) and 5 - (2-hydroxybenzoyl) - 4 - (4 - R^1 - phenyl) - 1,2,3 - triazoles (**6h, i**) were also produced (Scheme 1) but the formation of the corresponding (*E*)-**2** isomers could not be detected.[2] The ratio of products is summarized in Table 1.

The structure of the isolated azides **2a–h** were supported by chemical evidence, as well; with a catalytic amount of base the corresponding 3-amino-4′-R^1-flavones (**9a–h**) could be obtained via the base-induced nitrogen elimination[1,4] of the initially formed 3-azidoflavanones (**8**). The structure of the hitherto unknown 4′-isopropylflavone (**4d**), 4′-isopropylaurone (**5d**) and 4′-fluoroaurone (**5e**) were proved also by independent syntheses (Scheme 2) applying known procedures.[5,6]

Treatment of 2′ - benzyloxy - 4 - nitrochalcone dibromide (**10**) with sodium azide yielded α - azido - 2′ - benzyloxy - 4 - nitrochalcone (**11**) and 5 - (2 - benzyloxybenzoyl) - 4 - (4 - nitrophenyl) - 1,2,3 - triazole (**13**) besides the major product 5 - (2 - benzyloxyphenyl) - 3 - (4 - nitrophenyl) - isoxazole (**12**) (Scheme 3).

4-Aryl-5-benzoyltriazoles (such as **6h, i** and **13**)



1-7,9,15	a	b	c	d	e	f	g	h	i
R^1	H	MeO	Me	i-Pr	F	Cl	Br	CN	NO$_2$

Scheme 1.

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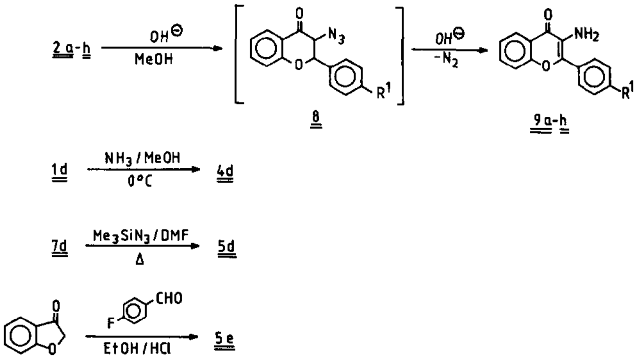
†Part 37; see Ref. 6.

‡A part of this work was presented at the Conference of the Hungarian Chemical Society, Szeged, 21–24 July 1981.

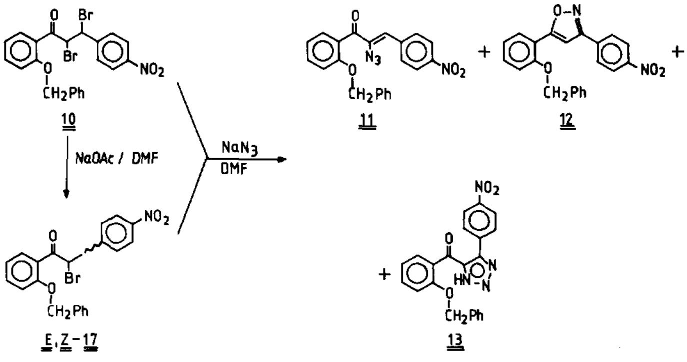
Table 1. Products (%) of the reaction between 2′-hydroxy-4-R^1-chalcone dibromides (**1a–h**) and azide ion

	R^1	**2**	**3**	**4**	**5**	**6**
a	H	82.9	4.9	2.3	1.0	-
b*	MeO	71.1	-	8.9	1.8	-
c	Me	79.7	4.4	2.5	1.1	-
d	i-Pr	80.8	4.1	2.9	1.3	-
e	F	77.5	5.3	3.6	1.5	-
f	Cl	66.5	11.4	3.0	1.0	-
g	Br	69.8	11.7	1.8	2.2	-
h	CN	15.3	66.8	-	6.9	4.4
i	NO_2	-	43.0	-	40.9	7.9

*Besides the indicated products 6.3 % of 2′-hydroxy-4-methoxychalcone /**7b**/ was also isolated. The debromination of chalcone dibromides by nucleophiles is a known reaction[3] but no such elimination process, induced by azide ion, has been reported previously.



Scheme 2.



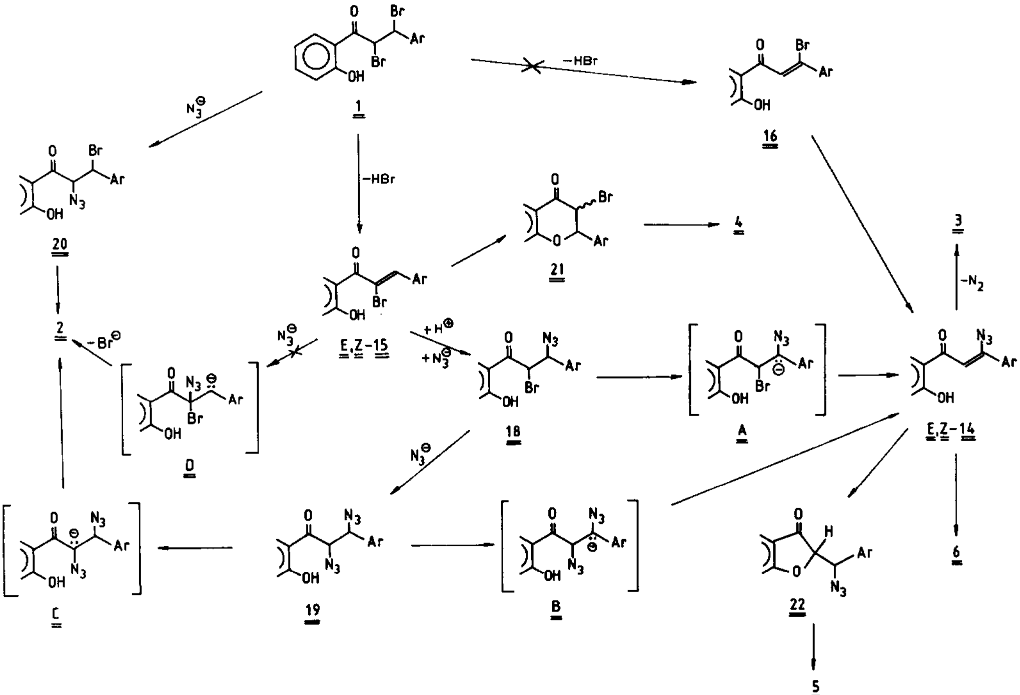
Scheme 3.

have been supposed[7] to be the intermediates of the transformation of β-azido-chalcones into isoxazoles. Our results preclude this assumption, since **6h**, **i** and **13** are stable derivatives and can be recovered unchanged even after treatment with sodium azide in refluxing DMF for several hours. Besides the characteristic ^{1}H-NMR and mass spectra their structure is supported by the positive reaction with alcoholic silver nitrate.[8]

On the basis of the product-distribution data (Table 1) it was established that the increasing electron-withdrawing character of R^1 substituent results in simultaneous decrease of the formation of **2** and preferred production of isoxazole **3**, aurone **5** and triazole **6**, with a drastic change in the case of strong electron-withdrawing substituents (e.g. CN, NO_2). This change is much more distinct than in the case of 2′-unsubstituted chalcone dibromides, which give exclusively α-azides[9] whereas the presence of a C-4 nitro group results in the formation of 55% α-azide and 20% of isoxazole.[10]

The above product ratios suggest that **3**, **5** and **6** are produced from the same intermediate, β-azido-2′-hydroxychalcones (**14**). The formation of isoxazoles from β-azido-enones is a well-known reaction[7,11] and several authors[12] have reported that the vinylazides having electron-withdrawing substituent at β-position give triazoles. As the preparation of the latter vinylazides from compounds having good leaving group have been well-documented[11,14] it was necessary to investigate whether **14** (and also products **3**, **5** and **6** originating from **14**) formed from α-bromo-2′-hydroxychalcone (**15**) (produced from **1** in the first step of the reaction[9,11b,15]) or from an alternative β-bromo-2′-hydroxychalcone (**16**).

By treatment of dibromides **1a**, **i** with potassium acetate in absolute ethanol[16] the (*E*)- and (*Z*)-α-bromo-2′-hydroxychalcones **15a**, **i** were prepared. The difference in the m.p. of (*Z*)-**15i** from the reported value and the restricted assignment of a single, poorly informative ^{1}H-NMR spectrum[16] necessitated the investigation of the structure in detail. The UV and IR spectral data and, above all, the ^{13}C-NMR shifts unequivocally proved the constitution and configuration of these derivatives. Reaction of **10** with sodium acetate in DMF gave (*E*)- and (*Z*)-2′-benzyloxy-α-bromo-4-nitrochalcones (**17**). Treatment of the resulting (*E*)- and (*Z*)-**15a** with



Scheme 4.

Table 2. Products (%) of the reaction of dibromides **1a**, **i**, **10** and α-bromochalcones **15a**, **i**, **17** with azide ion

Chalcone		Products /%/				
		α-azide /2,11/	isoxazole /3,12/	flavone /4/	aurone /5/	triazole /6,13/
2′-OH-	1a	82.9	4.9	2.3	1.0	0.0
	Z-15a	37.1	20.2	22.7	6.8	0.0
	E-15a	34.9	16.7	14.7	6.6	0.0
2′-OH- -4-NO_2	1i	0.0	13.0	0.0	40.9	7.9
	Z-15i	0.0	17.3	0.0	48.3	15.2
	E-15i	0.0	14.5	0.0	60.2	15.3
2′-$PhCH_2$-O- -4-NO_2	10	9.8	72.9	-	-	9.2
	Z-17	traces	49.5	-	-	30.2
	E-17	traces	46.7	-	-	40.5

sodium azide under the condition used in the case of **1a**, compounds **2a, 3a, 4a** and **5a** were produced whereas the analogous reaction of (*E*)- and (*Z*)-**15i** gave **3i, 5i** and **6i**. In the similar reaction of (*E*)- and (*Z*)-**17** compounds **11, 12** and **13** were obtained (Schemes 1, 3). The products were identical, in each case, with those obtained from the corresponding dibromides **1a, i, 10** and this fact unequivocally supports the route **1**→**15**→**14** and excludes **16**.

At the same time, the product distributions specifically change and these changes are independent of the character of the substituent. Starting with α-bromochalcones **15, 17** the amount of the formed α-azidochalcones **2, 11** decreased (Table 2). This result may be explained if only a part of the α-azide is produced by the generally accepted AdS_NE reaction[9,11d,17] of the α-bromochalcone (**15**→**18**→**19**→**2**, Scheme 4) whereas the remaining part forms directly by S_NE reaction (**1**→**20**→**2**). The contribution of this latter path was estimated[9] less than 10% in the case of 2′-unsubstituted chalcone dibromides.

The suggested mechanism is indicated in Scheme 4. Flavones **4** form from **15** via 3-bromo-flavanones **21**.[18] The further transformation of intermediates **18** and **19** is of decisive role in the product-distribution. The elimination reaction of such compounds is considered to proceed via an ElcB-type mechanism.[11d,19] The electron-withdrawing substituents effectively stabilize transition states **A** and **B** and thus make the formation of **14** more preferred than that of **2**.

The obtained data for product distribution completely preclude the third reaction-path **15**→**D**→**2** suggested by Hassner *et al.*[9,11d] as the stabilization effect of the substituent R^1 on the intermediate **D** would lead to an opposite product distribution.

The further transformation of the β-azide **14** (the ratio of **3**, **5** and **6**) is influenced by several factors (e.g. the electron-density at the α- and β-carbons, the (*E*)-(*Z*) ratio, the acid concentration of the medium etc.). The evaluation of these effects requires further investigations.

EXPERIMENTAL

M.ps are uncorrected. UV spectra were registrated in $CHCl_3$ solution on a UNICAM SP 800 instrument, IR spectra were recorded with a Perkin-Elmer 263 instrument, in KBr discs unless otherwise stated. NMR spectra were run on a Bruker WP 200 SY spectrometer ($CDCl_3$, internal standard TMS, $\delta = 0$ ppm). Coupling constants are given in Hz. Mass spectra were obtained with a VG-7035 GC-MS system (EI, 70 eV, 200°).

Kieselgel 40 (Merck) were used for column chromatography, eluant: petroleum ether–EtOAc (4:1) unless otherwise specified.

2′-*OR*-4-*R*^{1}-*chalcone dibromides* (**1a–i, 10**)

Dibromides **1a–i, 10** were prepared by the reaction of the corresponding 2′-OR-4-R^1-chalcone with pyridinium hydrobromide perbromide in AcOH,[5] and recrystallized from benzene–hexane. **1a** 63.2% yield, m.p. 190–192°, lit[20] 192°; **1b** 71.2% yield, m.p. 138–140°, lit[2] 137–138°; **1c** 71.0% yield, m.p. 148–151°; ^{1}H-NMR 12.08 (s, OH), 5.80 (d, H_α, J 11.9); 5.62 (d, H_β, J 11.9); 2.37 (s, Me); IR 1638 (C=O); 658 (C–Br). Found: C, 48.27; H, 3.41; Br, 39.38. $C_{16}H_{14}Br_2O_2$ requires: C, 48.27; H, 3.54; Br, 40.14%. **1d** 70.7% yield, m.p. 136–139°; ^{1}H-NMR 12.06 (s, OH); 5.91 (d, H_α, J 12.1); 5.63 (d, H_β, J 12.1); 2.94 (m, C$\underline{H}$Me$_2$); 1.27 (d, CHMe$_2$); IR 1640 (C=O), 655 (C–Br). Found: C, 51.08; H, 4.13; Br, 37.97. $C_{18}H_{18}Br_2O_2$ requires: C, 50.73; H, 4.26; Br, 37.50%. **1e** 72.6% yield, m.p. 163–166°; ^{1}H-NMR 12.1 (s, OH); 5.89 (d, H_α, J 11.7); 5.63 (d, H_β, J 11.7); IR 1634 (C=O); 656 (C–Br). Found: F, 4.84; Br, 39.78. $C_{15}H_{11}Br_2FO_2$ requires: F, 4.73; Br, 39.75%. **1f** 64.3% yield, m.p. 181–184°, lit[16] 180–181°. **1g** 72.8% yield, m.p. 180–185° (dec), lit[16] 180–181°. **1h** 53.3% yield, m.p. 196–198°; ^{1}H-NMR (DMSO) 11.85 (s, OH); 6.83 (d, H_α, J 11.7); 6.06 (d, H_β, J 11.7); IR 2229 (CN); 1637 (C=O); 650 (C–Br). Found: N, 3.30; Br, 39.17. $C_{16}H_{11}Br_2NO_2$ requires: N, 3.42; Br, 39.07%. **10** 60.3% yield, m.p. 139–142°, lit[5] 138–140°.

Reaction of 2′-*hydroxy*-4-*R*^{1}-*chalcone dibromides* (**1a–i**) *with sodium azide*

A soln of **1** (5 mmol) and NaN_3 (16.6 mmol) in 20 ml DMF was stirred for 4–5 h (in the case of **1i** for 24 h) at room temperature, then poured onto water and extracted with ether. The dried ($MgSO_4$) extract was evaporated and separated by column chromatography. In the case of **1i** the precipitated product was filtered off, washed with water and the crude product was chromatographed using benzene for the elution. The separation of **2b** and **7b**, formed from **1b** and eluted together, was accomplished by repeated chromatography using CH_2Cl_2–petroleum ether–Me_2CO (50:50:3) mixture. Compounds were crystallized from abs. ethanol unless otherwise stated (see footnotes of Table 4). The product distributions are indicated in Table 1, the physical and spectroscopic data of the isolated **2** and **3** are summarized in Tables 3 and 4.

Flavones **4a–g**, aurones **5a–i** and chalcone **7b** were identified by TLC (Kieselgel 60 F_{254}; Merck; toluene–EtOAc (4:1)), m.p. and mixed m.p. and/or by IR data.

4 - (4 - *Cyanophenyl*) - 5 - (2 - *hydroxybenzoyl*) - 1,2,3 - *triazole* (**6h**); m.p. 172–175° (PhH); ^{1}H-NMR (DMSO) 11.0 (broad, OH, NH); 7.94 (s, H-2′, H-3′, H-5′, H-6′); 7.81 (d, H-6″), 7.51 (dd, H-4″), 6.95 (m, H-3″, H-5″); IR 3420 (OH); 3173 (NH); 2234 (CN); 1627 (C=O); 1259, 1151, 1116, 988, 917 (triazole skeleton); MS *m/e* 290 ($M^{+\cdot}$, 59.8%); 273 (6.6); 272 (2.5); 262 (5.2), 261 (11.0); 197 (7.6); 121 (64.9); 120 (100). Found: N, 19.11. $C_{16}H_{10}N_4O_2$ requires: N, 19.30%.

4 - (4 - *Nitrophenyl*) - 5 - (2 - *hydroxybenzoyl*) - 1,2,3 - *triazole* (**6i**); m.p. 206–209° (PhH); ^{1}H-NMR (DMSO) 16.0 (broad, NH); 10.9 (broad, OH); 8.32 (d, H-3′, H-5′); 8.03 (d, H-2′, H-6′); 7.83 (d, H-6″); 7.52 (dd, H-4″); 6.96 (m, H-3″, H-5″); IR 3445 (OH); 3205 (NH); 1630 (C=O); 1523, 1346 (NO_2); 1256, 1154, 990, 921 (triazole skeleton); MS *m/e* 310 ($M^{+\cdot}$, 96%); 293 (5.7); 292 (3.6); 282 (6.0); 281 (7.5); 267 (4.2); 217 (3.0); 121 (86.6); 120 (100). Found: N, 18.10; $C_{15}H_{10}N_4O_4$ requires: N, 18.06%.

Reaction of 2′-*benzyloxy*-4-*nitrochalcone dibromide* (**10**) *with sodium azide*

A mixture of **10** (2.1 g, 4 mmol) and NaN_3 (0.85 g, 13.1 mmol) in 20 ml DMF was stirred at room temperature for 18 h. The precipitate was filtered off, washed with DMF and then water to obtain 918 mg (61%) of 5 - (2 - benzyloxyphenyl) - 3 - (4 - nitrophenyl)isoxazole (**12**). The filtrate was evaporated and chromatographed to yield 179 mg (11.9%) of **12**, 158 mg (9.8%) of α-azido-2′-benzyloxy-4-nitrochalcone (**11**) and 149 mg (9.2%) of 5 - (2-benzyloxybenzoyl) - 4 - (4 - nitrophenyl) - 1,2,3 - triazole (**13**): m.p. 159–161° (benzene); ^{1}H-NMR (DMSO): 15.9 (broad, NH); 8.27 (d, H-3′, H-5′); 7.94 (d, H-2′, H-6′); 7.58–7.00 (m, $PhCH_2$ + Ar″–H); 4.96 (s, Ph$\underline{CH_2}$); IR 3166 (NH); 1639 ($\overline{C=O}$); 1518, 1347 (NO_2); 1239 ($\overline{C–O–C}$); 1268, 1109, 995, 984, 912 (triazole skeleton); MS *m/e* 400 ($M^{+\cdot}$, 5.6%); 383 (1.0); 382 (2.1); 121 (6.1); 120 (2.7); 92 (15.2); 91 (100). Physical and spectroscopic data of **11** and **12** are shown in Tables 3 and 4.

(E),(Z)-α-*Bromo*-2′-*hydroxychalcone* (**15a**)

A mixture of **1a** (1.5 g, 3.9 mmol) and anhyd KOAc

Table 3. α-Azido-2′-OR-chalcones (**2a–h**, **11**)

Cmpd.	M.p. /°C/	Formula	Analysis		IR /CCl_4/			^{1}H-NMR		
			Calcd.	Found	N_3	C=O	Others	OH	H_β	Others
2a	oil	$C_{15}H_{11}N_3O_2$	N:15.84	N:15.42	2200,2119	1623	-	11.37	6.28	-
2b	81-84	$C_{16}H_{13}N_3O_3$	C:65.08 H: 4.44 N:14.23	C:65.05 H: 4.51 N:14.02	2200,2119	1624	2840/OMe/ 1255/C-O-C/	11.30	6.30	3.79/OMe/
2c	71-74	$C_{16}H_{13}N_3O_2$	C:68.81 H: 4.69 N:15.05	C:68.75 H: 4.82 N:14.70	2204,2119	1626	2924 /Me/	11.32	6.25	2.30 /Me/
2d	82-85	$C_{18}H_{17}N_3O_2$	C:70.34 H: 5.57 N:13.67	C:70.82 H: 5.56 N:13.26	2200,2120	1627	2965 /Me/	11.35	6.37	2.92m/$CHMe_2$/ 1.24d/$CHMe_2$/
2e	82-87 /dec/	$C_{15}H_{10}FN_3O_2$	N:14.83 F: 6.71	N:15.16 F: 6.92	2117	1628	-	11.38	6.34	-
2f	91-93	$C_{15}H_{10}ClN_3O_2$	N:14.02 Cl:11.83	N:14.04 Cl:11.58	2193,2119	1624	1096/Ar-Cl/	11.36	6.25	-
2g	101-103	$C_{15}H_{10}BrN_3O_2$	N:12.21 Br:23.22	N:12.01 Br:23.22	2197,2118	1626	1076/Ar-Br/	11.38	6.21	-
2h	117-119 /dec/	$C_{16}H_{10}N_4O_2$	N:19.30	N:19.13	2121	1627	2231/CN/	11.36	6.26	-
11	95-100 /dec/	$C_{22}H_{16}N_4O_4$	N:13.99	N:13.46	2184,2112	1672	1524,1343/NO_2/ 1254/C-O-C/	-	6.54*	5.21*/CH_2Ph/

*Recorded in DMSO-d_6

Table 4. 3-(4-R^1-phenyl)-5-(2-OR-phenyl)isoxazoles (**3a**, **c-i**, **12**)

Cmpd.	M.p. /°C/	Lit.m.p. /°C/	Formula	Analysis		IR				
				Calcd. N%	Found N%	OH^x	C=N	Isoxazole skeleton	/=N-O/	Others
3a	229-232	231-233 [1]	-	-	-	3070	1613	1456,1436,1385	970,952	-
3c	219-221	223-224 [22]	-	-	-	3130	1616	1449,1429,1380	967,951	-
3d	194.5-195.5$^+$	-	$C_{18}H_{17}NO_2$	5.01	4.81	3135	1616	1451,1432,1381	960,951	1393,1365 /$CHMe_2$/
3e	244-245$^+$	-	$C_{15}H_{10}FNO_2$	5.49	5.23	3080	1618	1452,1434,1390	971,959 953	1161 /Ar-F/
3f	237-240	237-239 [23]	-	-	-	3130	1612	1444,1423,1378	963sh,950	1092 /Ar-Cl/
3g	244-246	-	$C_{15}H_{10}BrNO_2$	4.49	4.34	3125	1619	1450,1438,1380	966,951	1076 /Ar-Br/
3h	250-252	-	$C_{16}H_{10}N_2O_2$	10.68	10.19	3140	1615	1450,1432,1390	970,959,951	2234 /CN/
12	199-199.5$^{\bullet}$	-	$C_{22}H_{16}N_2O_4$	7.52	7.44	-	1615	1453,1448,1386	951	1525,1347 /NO_2/ 1253 /C-O-C/

$^+$Crystallized from benzene

$^{\bullet}$Crystallized from methyl ethyl ketone

^{x}Broad /associated OH/. See ref. 22,23.

(0.39 g, 3.97 mmol) in 90 ml abs ethanol was stirred at room temperature for 26 h and then poured onto water and extracted with CH_2Cl_2. The dried and evaporated extract was chromatographed using PhH–$CHCl_3$ (7:3) as eluant. Products was in order of elution *E*-**15a**[18] (390 mg, 32.9%), (*Z*)-**15a**[18] (134 mg, 11.3%), a mixture of *cis*- and *trans*-3-bromoflavanone (**21a**)[25] (278 mg, 23.5%) and **4a** (251 mg, 28.9%).

(E),(Z) - α - *Bromo - 2′ - hydroxy* - 4 - *nitrochalcone* (**15i**)

The crude product obtained from **1i** (2.0 g, 4.66 mmol) using the method described for **15a** was chromatographed (eluant: benzene–petroleum ether (1:1)) to give in order of elution 296 mg of unreacted **1a**, 210 mg (12.9%) of (*E*)-**15i**, m.p. 128–130° (benzene–hexane), lit[16] 128–129°; ^{1}H-NMR ($CDCl_3$–DMSO) 11.36 (s, OH); 8.09 (d, H-3, H-5); 7.65–6.80 (m, H_β, H-2, H-6, Ar′–H); ^{13}C-NMR ($CDCl_3$–DMSO) 195.07 (CO); 162.80 (C-2′); 139.63 (C-1); 137.57 (C-4′); 133.06 (C_β); 131.36 (C-6′); 128.35 (C-2, C-6); 123.35 (C-3, C-5); 119.26 (C-5′); 118.36 (C-1′); 118.09 (C-3′); 116.09 (C_α); IR 1629 (C=O); 1608 w (C=C); UV 273 (log $\epsilon = 4.58$); 305 (4.54); 350 sh; 425 mg (26.6%) of (*Z*)-**15i**, m.p. 102–103.5° (benzene–hexane); 101–102° (EtOH), lit[16] 114–115°; ^{1}H-NMR ($CDCl_3$–DMSO) 11.03 (s, OH); 8.30 (d, H-3, H-5); 7.99 (d, H-2, H-6); 7.75–6.90 (m, H_β, Ar′–H); ^{13}C-NMR ($CDCl_3$–DMSO) 193.59 (CO); 161.27 (C-2′); 147.34 (C-4); 139.32 (C-1); 136.13 (C-4′) and 135.17 (C_β) (these values could be interchanged); 131.45 (C-6′); 129.85 (C-2, C-6); 122.95 (C-3, C-5); 121.65 (C-1′); 118.73 (C-5′); 117.78 (C_α); 117.70 (C-3′); IR 1633 (C=O); 1611 (C=C); UV 273.5 (4.43); 312 (4.55); 350 sh; and 212 mg (17%) of **5i**.

(E),(Z) - 2′ - *Benzyloxy* - α - *bromo* - 4 - *nitrochalcone* (**17**)

A mixture of **10** (2.08 g, 4.0 mmol) and anhyd NaOAc (0.45 g, 5.36 mmol) in 20 ml DMF was stirred at room temperature for 20 h, and then poured onto water. Fractional crystallization of the precipitate from benzene–hexane gave 334 mg (19%) of (*E*)-**17** as prisms, m.p. 122–124°, ^{1}H-NMR (DMSO) 8.05 (d, H-3, H-5), 7.70–7.00 (m, $PhCH_2$, Ar–H, H-2, H-6, H_β); 5.20 (s, $PhCH_2$); IR 1648 (C=O); 1620 w (C=C); UV 270 (4.24); 318 (4.41), and 898 mg (51.2%) of (*Z*)-**17** as needles, m.p. 136.5–138°; ^{1}H-NMR (DMSO) 8.28 (d, H-3, H-5); 7.92 (d, H-2, H-6); 7.75–7.05 (m, $PhCH_2$, Ar′–H, H_β); 5.16 (s, $PhCH_2$); IR 1666 (C=O); 1607 sh (C=C); UV 316.5 (4.57).

Reaction of (E)- *and* (Z)-*α-bromo-2′-OR-4-R*^{1}*-chalcones with sodium azide*

(a) A mixture of (*E*)-**15a** (390 mg, 1.29 mmol) and NaN_3 (250 mg, 3.85 mmol) in 8 ml DMF was stirred at room temp, then poured onto water and extracted with dichloromethane. The dried and concentrated extract was chromatographed to afford 119 mg (34.9%) of **2a**, 19 mg (6.6%) of **5a**, 51 mg (16.7%) of **3a** and 42 mg (14.7%) of **4a**.

(b) Starting with *E*-**15a** (120 mg, 0.4 mmol) and applying method described in (a) 39 mg (37.1%) of **2a**, 6 mg (6.8%) of **5a**, 19 mg (20.2%) of **3a** and 20 mg (22.7%) of **4a** were isolated.

(c) Using method described in (a) and starting with *E*-**15i** (212 mg, 0.61 mmol) (reaction time: 24 h, elution with benzene) 98 mg (60.2%) of **5i**, 25 mg (14.5%) of **3i** and 29 mg (15.3%) of **6i** were obtained.

(d) The reaction of (*Z*)-**15i** (221 mg, 0.63 mmol) using the conditions described in (c) resulted in **5i** (82 mg, 48.3%), **3i** (31 mg, 17.3%) and **6i** (30 mg, 15.2%).

(e) Starting with (*E*)-**17** (300 mg, 0.68 mmol) and using procedure described in (c) (eluant: benzene–petroleum ether (1:1), 119 mg (46.7%) of **12** and 111 mg (40.5%) of **13** were obtained. Traces of **11** could be also detected in the reaction mixture by TLC.

(f) The reaction of (*Z*)-**17** (366 mg, 0.84 mmol) applying the conditions mentioned in (e) afforded **12** (154 mg, 49.5%) and **13** (101 mg, 30.2%). Traces of **11** could be detected again by TLC.

3-*Amino-4′-R*^{1} *flavones* (**9a–h**)

A mixture of **2a–h** (1 mmol) and 0.2 ml of 1% NaOH solution (0.05 mmol) in 5 ml MeOH was kept in the refrigerator for 24 h, the precipitate was filtered off and crystallized from MeOH to give pure **9**. Dilution of the filtrate with water resulted in an additional crop of **9**. **9a** 96.1% yield, m.p. 134–136°, lit[26] 137–138°; **9b** 94.3% yield, m.p. 150–152°, lit[26] 152–153°; **9c** 90.1% yield, m.p. 147–148°, IR 3416, 3317 (NH_2), 1623 (C=O). Found: C, 77.11; H, 5.32; N, 5.31.$C_{16}H_{13}NO_2$ requires: C, 76.48; H, 5.21; N, 5.57%.

9d: due to the instability of the free amine it was isolated as a picrate salt; 53.6% yield, mp 146–149° (dec). Found: N, 10.84. $C_{24}H_{20}N_4O_2$ requires: N, 11.02%.

^{1}H-NMR 8.3–7.2 (m, Ar-H); 4.19 (broad, NH_2); 2.92 (m, $CHMe_2$); 1.25 (d, $CHMe_2$); IR (CCl_4) 3441, 3340 (NH_2); 1638 (C=O); 1382, 1363 ($CHMe_2$). Spectroscopic data are given for the free base. **9e**: 90.2% yield, m.p. 162–164°; IR 3393, 3307 (NH_2); 1640, 1628 (C=O); 1238, 1230 (Ar–F). Found: N, 5.40; F, 7.80. $C_{15}H_{10}FNO_2$ requires: N, 5.49; F, 7.44%. **9f**: 93.0% yield, m.p. 159–161°, lit[4] 160–161°; **9g** 78.0% yield, m.p. 166–168°, IR 3442, 3321 (NH_2); 1627 (C=O); 1068 (Ar–Br). Found: N, 4.38; Br, 25.35. $C_{15}H_{10}BrNO_2$ requires: N, 4.43; Br, 25.27%. **9h**: 91.4% yield, m.p. 198–200°; IR 3389, 3302 (NH_2); 2226 (CN); 1641 (C=O). Found: N, 10.27. $C_{16}H_{10}N_2O_2$ requires: N, 10.68%.

4′-*Isopropylflavone* (**4d**)

A soln of **1d** (1.11 g, 2.6 mmol) in 30 ml cold saturated ammonical MeOH was kept in the refrigerator,[5] poured onto diluted HCl soln and extracted with CH_2Cl_2. The dried and concentrated extract was crystallized from PhH–hexane mixture to obtain **4d** (395 mg, 57.6%), m.p. 76.5–78°; IR 1635 (C=O), 1375 ($CHMe_2$ and flavone skeleton). Found: C, 81.81; H, 6.05. $C_{18}H_{16}O_2$ requires: C, 81.79; H, 6.10%.

4′-*Isopropylaurone* (**5d**)

Compound **7d** (1.33 g, 5.0 mmol) was reacted with trimethylsilyl azide in DMF[6] and the reaction mixture was chromatographed (eluant: CH_2Cl_2–benzene (3:1)) to give 359 mg (27.2%) of **5d**, m.p. 59–62° (hexane); IR 1701 (C = O), 1643 (C=C), 881 (dihydrofuran skeleton). Found: C, 81.35; H, 5.92. $C_{18}H_{16}O_2$ requires: C, 81.79; H, 6.10%.

4′-*Fluoroaurone* (**5e**)

Coumaran-3-one (0.7 g, 5.2 mmol) and 4-fluorobenzaldehyde (0.58 ml, 5.5 mmol) was reacted in boiling EtOH in the presence of HCl[27] to give 190 mg (15.2%) of **5e**, m.p. 161–164° (i-PrOH); IR 1702 (C=O), 1657 (C=C), 880 (dihydrofuran skeleton). Found: F, 7.53. $C_{15}H_9FO_2$ requires: F, 7.91%.

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