A NOVEL ONE-POT SYNTHESIS OF SUBSTITUTED PYRIDAZINES: A GENERAL METHOD OF PREPARATION OF 3,4,6-TRI ARYL PYRIDAZINES.

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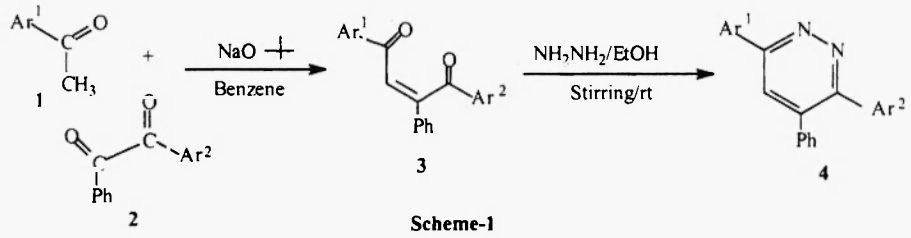
Abstract: 3,4,6-triaryl pyridazines 4 were conveniently prepared in one step by the condensation of aryl methyl ketones and 1,2-diketones in presence of base, followed by cyclisation with hydrazines.

Introduction:

Owing to their wide application as drugs (1,2) and agrochemicals (3) pyridazines have aroused great interest in recent years. The introduction of aryl groups into the ring system allows modulation of their biological activity (4). While 3,6-diaryl pyridazines can be easily obtained using various methods (5a-f) our literature survey showed that there are only a few reports on the synthesis of triaryl pyridazines. Some of the reported syntheses include the following: (i) Cyclisation of dibenzoyl styrene with hydrazine; (6) (ii) Reaction of 3,6-diaryl-sym-tetrazines with phenyl acetylene (7) and phenyl acetaldehyde; (8) (iii) Oxidation of the condensed product of desylacetophenone with hydrazine (9) and (iv) Cyclisation of acetophenone deoxybenzoin azine and subsequent aromatisation. (10) However these methods are limited to triphenyl pyridazines and hence suffered from lack of generality. In 1900, Francis Robert Japp and James Wood (6) first described the preparation of 3, 4, 6-triphenyl 1, 2-diazine by a multi step procedure where each intermediate was isolated and purified. Trisler and coworkers (11) also have reported the synthesis of 3, 4-diphenyl-6-anisylpyridazine from cis α, β-dibenzoylstyrene.

Results and discussions:

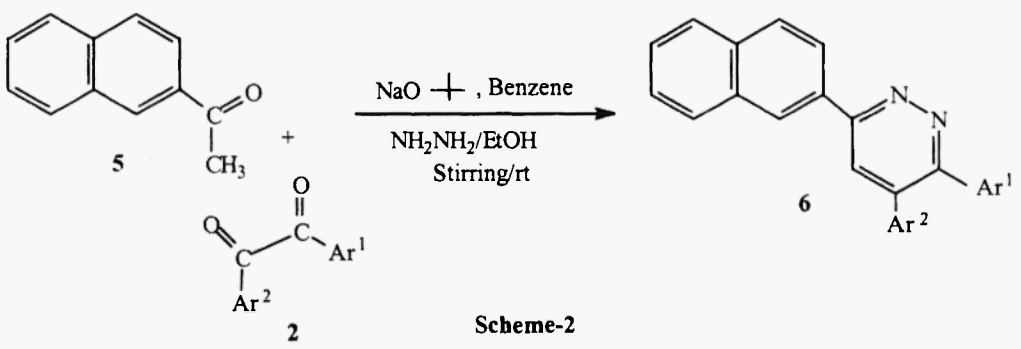
As part of our ongoing work in exploring new synthetic routes for the formation of heterocyclic compounds deriving from the condensation of hydrazine and diketones, we wish to report here a one-pot preparation of 3, 4, 6-triaryl pyridazines starting from simple and easily available starting compounds. Condensation of aryl methyl ketones with 1, 2-diketones in presence of a suitable base yielded but-2-ene-1, 4-dione system as the intermediate which was then further treated with hydrazine hydrate in one pot (sheme-1) to give the expected products (12) in good yields (Table-1). The generality of the procedure was successfully demonstrated when 2-acetyl naphthalene and furil similarly underwent cyclisation to the corresponding heterocyclic compounds.(Table-2 and 3). The reactions proceeded smoothly at room temperature and the products were formed in comparatively shorter reaction time. Earlier reports have also shown similar cyclisation (13) leading to the formation of pyridazines and pyridazinones starting from 1, 4-dicarbonyl compounds. However in all these reactions the reactive intermediates were first isolated before proceeding to the next reaction. Isolation and analysis of one of the reaction intermediate (Ar^1=Ar^2=Ar^3=Ph) confirmed the formation of the condensed product, but-2-ene-1, 4-dione with the trans isomer (m pt 197°C) (6) predominating over the cis isomer (m pt 129°C).(6) However high yields of the products indicate that there is isomerisation around the double bond before cyclisation takes place under basic medium. This is known to occur in α, β-unsaturated carbonyls. (13) Thus when aryl methyl ketones and 1, 2 diketones were condensed in presence of sodium tertiary butoxide in benzene and the resultant mixture treated with ethanol, subsequent treatment with hydrazine hydrate gave 3, 4, 6-triaryl pyridazines in good to excellent yields.



Scheme-1

Table 1: Preparation of 3, 6-diaryl-4-phenylpyridazines.

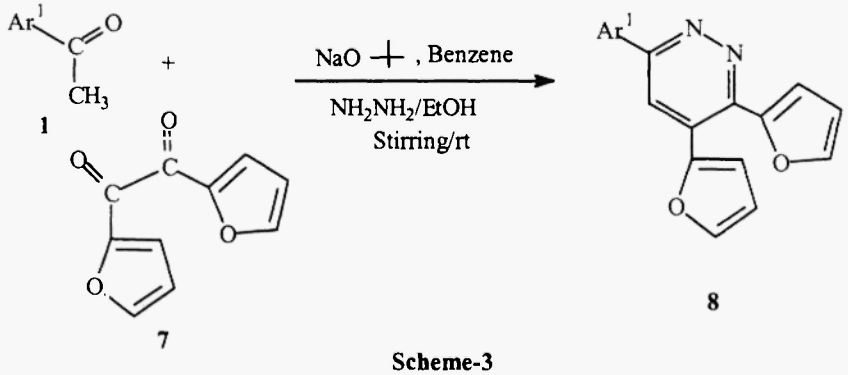
Entry	Products[a]	Ar^1	Ar^2	Time/h	Yield(%)[b]	M.Pt[c](°C)
1	**4a**	C_6H_5	C_6H_5	3	56	170
2	**4b**	4-MeC_6H_4	C_6H_5	4	78	110-111
3	**4c**	4-$OMeC_6H_4$	C_6H_5	4	61	180-181
4	**4d**	4-ClC_6H_4	C_6H_5	5	64	167
5	**4e**	4-BrC_6H_4	C_6H_5	6	58	135-136
6	**4f**	4-$NO_2C_6H_4$	C_6H_5	5	65	152-153
7	**4g**	C_6H_5	4-$OMeC_6H_4$	3	60	118
8	**4h**	4-MeC_6H_4	4-$OMeC_6H_4$	4	61	120
9	**4i**	4-$OMeC_6H_4$	4-$OMeC_6H_4$	5	72	161-162
10	**4j**	4-ClC_6H_4	4-$OMeC_6H_4$	5	57	135
11	**4k**	4-BrC_6H_4	4-$OMeC_6H_4$	6	61	143-144
12	**4l**	4-$NO_2C_6H_4$	4-$OMeC_6H_4$	5	58	162
13	**4m**	C_6H_5	4-ClC_6H_4	6	59	155
14	**4n**	4-MeC_6H_4	4-ClC_6H_4	7	63	141-142
15	**4o**	4-$OMeC_6H_4$	4-ClC_6H_4	7	75	138
16	**4p**	4-ClC_6H_4	4-ClC_6H_4	6	61	183
17	**4q**	4-BrC_6H_4	4-ClC_6H_4	5	59	147
18	**4r**	4-$NO_2C_6H_4$	4-ClC_6H_4	7	56	156



Scheme-2

Table 2: Preparation of 3,4-diaryl-6-naphthylpyridazines:

Entry	Products[a]	Ar^1	Ar^2	Time/h	Yield(%)[b]	M.Pt(°C)[c]
1	**6a**	C_6H_5	C_6H_5	8	60	178
2	**6b**	4-$OMeC_6H_4$	C_6H_5	7	62	161-162
3	**6c**	4-ClC_6H_4	C_6H_5	6	58	173
4	**6d**	Furyl	Furyl	5	57	164



Scheme-3

Table 3: Preparation of 3,4-difuryl-6-phenylpyridazines

Entry	Products[a]	Ar^1	Time/h	Yields[b](%)	M.Pt[c](°C)
1	**8a**	C_6H_5	6	57	96-97
2	**8b**	4-MeC_6H_4	7	64	120
3	**8c**	4-$OMeC_6H_4$	7	70	181-183
4	**8d**	4-ClC_6H_4	6	58	132
5	**8e**	4-BrC_6H_4	5	65	125
6	**8f**	4-$NO_2C_6H_4$	7	57	102-103

a. Products are characterized by IR, NMR, Mass, M.pt and elemental analysis.
b. refer to pure products; **c**. M.pts are uncorrected.

Experimental:

Melting points were obtained on a Thomas Hoover capillary melting point apparatus and are uncorrected. Infrared spectra were recorded on a Perkin-Elmer 983 and BOMEM DA-8 FT-IR Spectrophotometer and the frequencies are expressed in cm^{-1}. ^1H and ^{13}C NMR spectra were recorded on a Bruker ACF-300 spectrometer using $CDCl_3$ as the solvent. Chemical shifts are reported in ppm from internal tetramethylsilane and are given on the δ scale. Mass spectra were obtained on a JEOL D-300 (EI) mass spectrometer. Masses are reported in units of mass upon charge (m/z), the molecular and base peaks are indicated by (M^+) and (%) respectively. Elemental analyses were carried out on a Heraeus CHN-O-Rapid analyzer.

All reactions were monitored by TLC on glass plates coated with silica gel (ACME's) containing 13% calcium sulphate as binder and visualization of compounds was accomplished by exposure to iodine vapour or by spraying acidic potassium permanganate solution. Column chromatography was carried out using ACME's silica gel (60-120 mesh).

General procedure for the preparation of 3, 4, 6-triaryl pyridazines

In a typical experimental procedure, to a stirring solution of sodium tertiary butoxide in benzene or tetrahydro furan at room temperature, substituted acetophenone was added followed by the addition of a solution of 1, 2-diketone (in benzene or THF) in one lot. A jelly mass resulted which made stirring ineffective. The jelly mass was dissolved by stirring with ethanol. Hydrazine hydrate was then added and stirring continued for 3 to 7 hours during which time the cyclisation reaction was completed (monitored by TLC). The reaction mixture was poured in water and extracted with benzene. The organic layer was removed, dried (anhydrous sodium sulphate) and the solvent distilled off. The crude solid product obtained was further purified by recrystallisation from ethanol.

Spectroscopic Data:

3,4,6-triphenylpyridazine 4a.

Transparent white crystals; mp 170°C; ^{1}H NMR: δ 8.17-8.14 (m, 4H), 7.78 (s, 1H), 7.51-7.23 (m, 11H); ^{13}C NMR: δ 158.1, 157.6, 139.3, 137.0, 136.6, 135.9, 129.9, 129.0, 128.9, 128.6, 128.0, 127.1; IR(KBr): 3019, 1614, 1521, 1490; MS (EI) m/z 308 (M^+), 231, 206, 103, 102, 77. Anal. Calcd for $C_{22}H_{16}N_2$: C, 85.71; H, 5.19; N, 9.09. Found: C, 85.60; H, 5.30; N, 9.20.

3,4-diphenyl-6-toloylpyridazine 4b.

Pale yellow crystals; mp 110°C; ^{1}H NMR: δ 8.09-8.07 (m, 2H), 7.80 (s, 1H), 7.49-7.25 (m, 12H), 2.42 (S, 3H); ^{13}C NMR: δ 157.8, 157.3, 140.2, 139.3, 137.1, 136.7, 133.1, 129.9, 129.7, 129.0, 128.6, 128.4, 128.0, 126.6, 124.4, 21.4; IR(KBr): 3023, 2915, 1655, 1497; MS (EI) m/z 322 (M^+), 307, 249, 245, 231, 178, 132, 91, 77, Anal. Calcd for $C_{23}H_{18}N_2$: C, 85.71; H, 5.19; N, 9.09, Found: C, 85.75; H, 5.15; N, 9.14.

3,4-diphenyl -6-anisylpyridazine 4c.

Pale yellow crystals, mp 181°C; ^{1}H NMR: δ 8.15-8.12 (m, 2H), 7.75 (s, 1H), 7.49-7.24 (m, 10H), 7.21-7.17 (m, 2H), 3.88 (s, 3H); ^{13}C NMR: δ 161.2, 157.5, 157.1, 139.3, 137.2, 136.7, 129.9, 129.0, 128.7, 128.5, 128.4, 128.3, 128.0, 127.6, 124.0, 114.3, 55.3; IR(KBr): 3066, 2961, 1615, 1481, 1400, 1043; MS (EI) m/z 338 (M^+) 282, 261, 231, 178, 135, 103, 91, 78. Anal. Calcd. for $C_{23}H_{18}N_2O$: C, 81.65; H, 5.32; N, 8.28; Found: C, 81.69; H, 5.30; N, 8.36.

3,4-diphenyl-6-(p-chlorophenyl)pyridazine 4d.

Yellowish white crystals; mp 165-168°C; ^{1}H NMR: δ 8.18-8.14 (m, 2H), 7.80 (s, 1H), 7.50-7.31 (m, 12H); ^{13}C NMR: δ 158.3, 156.5, 139.5, 136.9, 136.5, 136.3, 134.5, 129.9, 129.2, 129.0, 128.7, 128.2, 128.1, 124.5; IR(KBr): 3020, 1608, 1528, 1477; MS (EI) m/z 342 (M^+), 307, 265, 231, 194, 188, 103, 76. Anal. Calcd. for $C_{22}H_{15}N_2Cl$: C, 77.08; H, 4.38; N, 8.17; Found: C, 77.15; H, 4.41; N, 8.13.

3,4-diphenyl-6-(p-bromophenyl)pyridazine 4e.

Yellowish white crystalline solids; mp 135°C; ^{1}H NMR: δ 8.06-8.00 (m, 2H), 7.79 (s, 1H), 7.64-7.21 (m, 12H). ^{13}C NMR: δ 158.3, 156.6, 138.1, 136.8, 136.4, 134.9, 133.7, 132.1, 131.4, 130.1, 129.9, 128.9, 128.7, 128.4, 127.7, 126.3; IR(KBr): 3045, 1649, 1494, 1437; MS (EI) m/z 387 (M^+), 310, 307, 231, 182, 103, 80, 77. Anal. Calcd. for $C_{22}H_{25}N_2Br$: C, 68.21; H, 3.87; N, 7.23; Found: C, 68.30; H, 3.84; N, 7.25.

3,4-diphenyl- 6-(p-nitrophenyl)pyridazine 4f.

Pale yellow crystalline solid; mp 152°C; ^{1}H NMR: δ 8.21-8.39 (m, 4H), 7.93 (s, 1H), 7.52-7.29 (m, 10H); ^{13}C NMR: δ 159.1, 155.5, 148.8, 142.0, 139.7, 136.6, 136.2, 130.0, 129.4 129.0, 128.9, 128.2, 127.9, 128.2, 127.9, 125.3, 124.2. IR(KBr): 3067, 1602, 1522, 1446, 857, 701.; MS (EI) m/z 353 (M^+), 307, 276, 231, 122, 103, 77, 46. Anal. Calcd. for $C_{22}H_{15}N_3O_2$: C, 74.78; H, 4.24; N, 11.89; Found C, 74.50; H, 4.33; N, 11.71.

3-anisyl-4,6-diphenylpyridazine 4g.

Yellow crystalline solid; mp 118°C; ^{1}H NMR: δ 7.72-7.65 (m, 11H), 7.60-7.09 (m, 4H), 3.96 (s, 3H); ^{13}C NMR: δ 154.3, 144.0, 137.0, 135.6, 132.8, 131.1, 130.9, 130.0, 129.7, 129.1, 128.9, 128.2, 127.0, 126.6, 114.1, 112.3, 55.9; IR(KBr): 3076, 2961, 1641, 1483, 1033; MS (EI) m/z 338 (M^+), 282, 178, 135, 78, 51, 44. Anal. Calcd. for $C_{23}H_{18}N_2O$: C, 81.65; H, 5.32; N, 8.28; Found: C, 81.60; H, 5.37; N, 8.25.

3-anisyl-4-phenyl-6-toloylpyridazine 4h.

Yellowish white solid; mp 120°C; ^{1}H NMR: δ 7.69 (s,1H), 7.59-7.12 (m, 13H), 3.97 (s, 3H), 2.38 (s, 3H): ^{13}C NMR: δ.155.2, 144.9, 136.3, 135.5, 131.8, 130.2, 129.5, 129.2, 129.0, 128.9, 128.8, 128.3, 127.8, 126.6, 114.4, 112.6, 56.7, 21.3; IR(KBr): 3012, 2976, 1634, 1487, 1036; MS (EI) m/z 352(M^+), 337, 321, 275, 245, 184, 117, 102, 77. Anal. Calcd. for $C_{24}H_{20}N_2O$: C, 81.81; H, 5.68; N, 7.95; Found: C, 81.90; H, 5.62; N, 7.97.

3, 6-dianisyl-4-phenylpyridazine 4i.

Pale yellow solid; mp 108°C; ^{1}H NMR: δ 7.95-7.86 (m, 4H), 7.80(s, 1H), 7.60-7.26 (m, 4H), 6.95-6.86 (m, 5H), 3.95 (s, 3H), 3.85 (s, 3H); ^{13}C NMR: δ 160.8, 159.6, 157.8, 147.6, 145.6, 143.5, 132.1, 130.6, 128.3, 128.1, 126.8, 113.6, 55.7, 55.3; IR(KBr): 3010, 2968, 1616, 1525, 1491, 1023; MS (EI)m/z 368 (M^+), 337, 306, 291, 261, 239, 162, 133, 76; Anal. Calcd. for $C_{24}H_{20}N_2O_2$: C, 78.26; H, 5.43; N, 7.60; Found: C, 78.26; H, 5.46; N, 7.65.

3-anisyl-4-phenyl-6-(p-chlorophenyl)pyridazine 4j.

Pale yellow solid; mp 135°C; ^{1}H NMR: δ 8.66-8.20 (m, 4H), 7.55-7.46 (m, 4H), 7.84 (s, 1H), 7.36-7.12 (m, 5H), 3.99 (s, 3H); ^{13}C NMR: δ 158.6, 157.2, 155.1, 141.2, 139.3, 137.2, 136.7, 132.2, 129.9, 129.6, 129.0, 128.6, 128.4, 128.0, 126.6, 124.3, 56.8; IR(KBr): 3090, 1631, 1489, 1075, 1054; MS (EI) m/z 372 (M^+), 341, 337, 306, 295, 261, 134, 76; Anal. Calcd. for $C_{23}H_{17}N_2OCl$: C, 74.09; H, 4.56; N, 7.51; Found: C, 74.12; H, 4.60; N, 7.48.

3-anisyl-4-phenyl-6-(p-bromophenyl)pyridazine 4k.

Pale brown solid; mp 143°C; ^{1}H NMR: δ 8.08-7.91 (m, 9H), 7.75(s,1H), 7.56-7.30 (m, 4H), 3.98 (s, 3H); ^{13}C NMR: δ 158.7, 157.3, 143.3, 140.3, 138.1, 136.4, 134.9, 133.0, 132.6, 131.7, 129.1, 128.7, 128.1, 127.3, 126.5, 126.0, 55.7; IR(KBr): 3088, 2977, 1639, 1496, 1038; MS (EI) m/z 417(M^+), 386, 340, 310, 261, 184, 107, 77. Anal. Calcd. for $C_{23}H_{17}N_2BrO$: C, 66.18; H, 4.07; N, 6.71; Found: C, 66.28; H, 4.18; N, 6.60.

3-anisyl-4-phenyl-6-(p-nitrophenyl)pyridazine 4l.

Yellowish brown solid: mp 162°C; ^{1}H NMR: δ 8.44-8.22 (m, 4H), 7.79-7.33 (m, 10H), 4.95 (s, 3H); ^{13}C NMR: δ 159.4, 158.3, 155.2, 149.1, 147.0, 143.0, 141.0, 139.9, 137.6, 136.3, 136.0, 133.1, 131.0, 129.9, 129.2, 127.3, 55.8; IR(KBr): 3091, 2966, 1637, 1489, 1038, 858; MS (EI) m/z 383(M^+), 352, 337, 306, 276, 199, 148, 122, 77; Anal. Calcd. for $C_{23}H_{17}N_3O_3$: C, 72.06; H, 4.43; N, 10.96; Found: C, 72.00; H, 4.47; N, 10.95.

3-(p-chlorophenyl)-4,6-diphenylpyridazine 4m.

Pale brown crystals; mp 155°C; ^{1}H NMR: δ 8.15-7.34 (m, 4H), 7.80 (s, 1H), 7.70-7.34 (m, 10H), ^{13}C NMR: δ 158.1, 157.4, 141.3, 139.8, 137.0, 136.5, 136.2, 134.3, 131.3, 129.9, 129.4, 129.0, 128.7, 128.2, 127.4, 125.0. IR(KBr): 3035, 1617, 1530, 1461. MS (EI) m/z 342 (M^+), 265, 188, 111, 77. Anal. Calcd. for $C_{22}H_{15}N_2Cl$: C, 77.08; H, 4.37; N, 8.17; Found: C, 77.30; H, 4.27; N, 8.01.

3-(p-chlorophenyl)-4-phenyl-6-tolylpyridazine 4n.

Pale yellow crystals; mp 141°C; ^{1}H NMR: δ 8.10-7.81 (m, 4H), 7.78 (s, 1H), 7.68-7.20 (m, 9H), 2.40 (s, 3H). ^{13}C NMR: δ 157.7, 156.8, 142.6, 140.3, 139.4, 137.1, 136.5, 143.8, 132.1, 130.4, 129.7, 129.0, 128.6, 128.4, 128.0, 126.1, 21.4. IR(KBr): 3030, 2920, 1637, 1471. MS (EI) m/z 356 (M^+), 279, 168, 137, 117, 91. Anal. Calcd. for $C_{23}H_{17}N_2Cl$: C, 77.41; H, 4.76; N, 7.85; Found: C, 77.57; H, 4.61; N, 7.70.

3-(p-chlorophenyl)-4-phenyl-6-anisylpyridazine 4o.

Pale yellow solid; mp 138°C; ^{1}H NMR: δ 7.58 (m, 9H), 7.55-7.25 (m, 5H), 3.85 (s, 3H). ^{13}C NMR: δ 158.0, 157.1, 141.3, 140.7, 139.3, 137.6, 136.0, 133.7, 131.3, 130.0, 129.8, 128.9, 128.4, 127.8, 126.0, 125.7, 54.9. IR(KBr): 3064, 1648, 1471, 1038. MS (EI) m/z 372 (M^+), 295, 184, 137, 107, 77. Anal. Calcd. for $C_{23}H_{17}N_2ClO$: C, 74.09; H, 4.56; N, 7.51; Found: C, 74.25; H, 4.41; N, 7.76.

3,6-Bis(p-chlorophenyl)-4-phenylpyridazine 4p.

Brown solid; mp 183°C; ^{1}H NMR: δ 8.47-7.70 (m, 9H), 7.60-7.45 (m, 5H). ^{13}C NMR: δ 159.6, 158.9, 157.4, 144.8, 142.6, 139.6, 137.4, 136.8, 135.7, 133.8, 131.7, 130.8, 129.0, 128.5, 128.0, 127.6. IR(KBr): 3080, 1629, 1476. MS (EI) m/z: 377 (M^+), 265, 154, 137, 77. Anal. Calcd. for $C_{22}H_{14}N_2Cl_2$: C, 70.02; H, 3.71; N, 7.42; Found: C, 70.34; H, 3.60; N, 7.33.

3-(p-chlorophenyl)-4-phenyl-6-(p-bromophenyl)pyridazine 4q.

Yellow solid; mp 147°C; ^{1}H NMR: δ 8.31-7.67 (m, 9H), 7.60-7.30 (m, 5H). ^{13}C NMR: δ 158.8, 157.4, 145.3, 144.7, 142.1, 140.8, 139.6, 136.4, 135.7, 132.8, 131.7, 130.8, 129.3, 128.8, 128.0, 126.1. IR(KBr): 3075, 1616, 1474. MS (EI) m/z 420 (M^+), 309, 265, 181, 155. Anal. Calcd. for $C_{22}H_{14}N_2ClBr$: C, 62.78; H, 3.32; N, 6.65; Found: C, 62.62; H, 3.44; N, 6.84.

3-(p-chlorophenyl)-4-phenyl-6-(p-nitrophenyl)pyridazine 4r.

Dark brown solid; mp 156°C; ^{1}H NMR: δ 8.5-7.8 (m, 9H), 7.68-7.35 (m, 5H). ^{13}C NMR: δ 159.2, 158.4, 146.1, 145.7, 143.3, 141.3, 137.1, 136.4, 133.4, 132.7, 131.8, 130.9, 129.4, 128.8, 128.6, 127.9. IR(KBr): 3027, 1618, 1587, 1496; MS (EI) m/z 387(M^+), 341, 276, 265, 148, 137. Anal. Calcd. for $C_{22}H_{14}N_3ClO_2$: C, 68.12; H, 3.61; N, 10.83; Found: C, 67.98; H, 3.50; N, 10.94.

3, 4-difuryl-6-phenylpyridazine 8a.

Dark brown crystals; mp 94-96°C; ^{1}H NMR: δ 8.17-8.15 (m, 3H), 7.58-7.50 (m, 5H), 7.01 (s, 1H), 6.61-6.60 (t, 1H), 6.49-6.48 (d, 1H), 6.26-6.25 (d, 1H); ^{13}C NMR: δ 157.2, 156.4, 150.3, 147.7, 146.5, 144.5, 143.5, 135.9, 130.1, 129.0, 127.1, 120.0, 113.2, 112.4, 112.1, 112.0; IR(KBr): 3013, 1618, 1522, 1480, 1033; MS (EI) m/z 288(M^+), 221, 211, 154, 103, 93, 77. Anal. Calcd. for $C_{18}H_{12}N_2O_2$: C, 75.00; H, 4.16; N, 9.72. Found: C, 75.15; H, 4.20; N, 9.76.

3, 4-difuryl-6-toloylpyridazine 8b.

Dirty white crystals; mp 120°C; ^{1}H NMR: δ 8.11-8.06 (m, 3H), 7.59-7.32 (m, 4H), 7.00 (s, 1H), 6.62-6.61 (d, 1H), 6.50-6.48 (t, 1H), 6.25-6.24 (d, 1H), 2.43 (s, 3H); ^{13}C NMR: δ 157.8, 150.4, 147.8, 146.5, 144.4, 143.4, 140.4, 133.0, 129.7, 127.6, 126.9, 119.7, 113.1, 112.4, 112.0, 111.9, 21.4; IR(KBr): 3044, 2923, 1626, 1481, 1061; MS (EI) m/z 302(M^+), 287, 220, 196, 168, 144, 117, 77, 67. Anal. Calcd. for $C_{19}H_{14}N_2O_2$: C, 75.49; H, 4.63; N, 9.27; Found: C, 75.61; H, 4.51; N, 9.35.

3, 4-difuryl-6-anisylpyridazine 8c.

Yellowish brown crystals; mp 183°; ^{1}H NMR: δ 8.13-8.05 (m, 3H), 7.79-7.52 (m, 4H), 7.04 (s, 1H), 6.65-6.63 (d, 1H), 6.53-6.52 (t, 1H), 6.30-6.29 (d, 1H), 3.83 (s, 3H). ^{13}C NMR: 157.3, 156.8, 150.3, 147.6, 144.6, 143.5, 137.1, 134.8, 132.2, 131.5, 128.5, 128.0, 124.8, 119.7, 113.4, 112.5, 52.1. IR(KBr): 3047, 2824, 1635, 1462, 1031; MS (EI) m/z 318(M^+), 287, 251, 211, 133, 93, 77, 67. Anal. Calcd. for $C_{19}H_{14}N_2O_3$: C, 71.69; H, 4.40; N, 8.80. Found: C, 71.60; H, 4.45; N, 8.86.

3, 4-difuryl-6-(p-chlorophenyl)pyridazine 8d.

Light brown crystals; mp 132°; ^{1}H NMR: δ 8.13-8.09 (m, 3H), 7.60-7.48 (m, 4H), 7.02 (s, 1H), 6.63-6.61 (d, 1H), 6.51-6.50 (t, 1H), 6.29-6.28 (d, 1H). ^{13}C NMR: δ 157.6, 156.6, 147.5, 146.7, 144.7, 143.6, 136.5, 134.2, 129.3, 128.3, 128.2, 119.8,113.6, 112.6, 112.4, 112.5. IR(KBr): 3091, 1662, 1494, 1410, 1091. MS (EI) m/z 322 (M^+), 287, 255, 211, 188, 144, 111, 93, 77, 67. Anal. Calcd. for $C_{18}H_{11}N_2O_2Cl$: C, 66.97; H, 3.41; N, 8.68. Found: C, 66.93; H, 3.45; N, 8.74.

3, 4-difuryl-4-(p-bromophenyl)pyridazine 8e.

Yellow brown crystals; mp 125°. ^{1}H NMR: δ 8.14-8.11 (m, 3H), 7.61-7.49 (m, 4H), 7.03 (s, 1H), 6.64-6.62 (d, 1H), 6.52-6.50 (t, 1H), 6.28-6.27 (d, 1H). ^{13}C NMR: δ 157.8, 156.6,151.5, 150.2, 147.8, 144.6, 143.51 36.4, 134.3, 129.4, 128.3, 128.0, 119.6, 113.4, 112.5, 112.2. I.R(KBr): 3065, 1648, 1477, 1064. MS (EI) m/z 367 (M^+), 300, 287, 233, 211, 182, 156, 144, 93, 77, 67. Anal. Calcd. for $C_{18}H_{11}N_2O_2Br$: C, 58.85; H, 2.99; N, 7.62. Found: C, 58.80; H, 2.96; N, 7.65.

3, 4-difuryl-6-(p-nitrophenyl)pyridazine 8f.

Dark brown crystals; mp 102°C. ^{1}H NMR: δ 8.38-8.22 (m, 3H), 7.65-7.60 (m, 4H), 7.10 (s, 1H), 6.66-6.65 (d, 1H), 6.55-6.54 (t, 1H), 6.37-6.36 (d, 1H). ^{13}C NMR: δ 158.8, 158.0, 149.9, 148.8, 147.2, 144.9, 143.9, 141.8, 128.3, 127.9, 124.2, 120.5, 113.9, 112.9, 112.7, 112.2. IR(KBr): 3041, 1594, 1490, 1053. MS (EI) m/z

333(M^+), 287, 266, 211, 199, 179, 148, 122, 93. Anal. Calcd. for $C_{18}H_{11}N_3O_4$: C, 64.86; H, 3.30; N, 12.61; Found C, 64.80; H, 3.35, N, 12.73.

3, 4-diphenyl-6-naphthylpyridazine 6a.

Yellowish white solid; mp 178°C; ^{1}H NMR: δ 8.33-7.80 (m, 5H), 7.72 (s, 1H), 7.50-7.45 (m, 5H), 7.32-7.20 (m, 7H); ^{13}C NMR: δ 158.8, 157.4, 139.3, 137.0, 136.6, 134.0, 133.2, 129.9, 129.0, 128.7, 128.6, 128.2, 128.0, 127.6, 127.0, 126.7, 126.5, 124.8, 124.1; IR(KBr): 3036, 1622, 1488, 1447; MS (EI) m/z 358(M^+), 231, 281, 204, 183, 103, 77. Anal. Calcd. for $C_{26}H_{18}N_2$: C, 87.15; H, 5.02; N, 7.82; Found: C, 87.07; H, 5.08; N, 7.71.

3-anisyl-4-phenyl-6-naphthylpyridazine 6b.

Yellowish solid; mp 161°C; ^{1}H NMR: δ 7.94-7.90 (m, 4H), 7.71 (s, 1H), 7.57-7.22 (m, 12H), 3.96 (s, 3H); ^{13}C NMR: δ 158.0, 157.5, 156.1, 138.3, 137.4, 136.3, 134.2, 133.9, 131.4, 130.2, 129.2, 128.7, 128.2, 128.0, 127.8, 127.0, 126.4, 126.1, 124.8, 123.1, 55.1; IR(KBr): 3013, 2937, 1585, 1464, 1427, 1062. MS (EI) m/z 388(M^+), 357, 311, 261, 203, 133, 108. Anal. Calcd. for $C_{27}H_{20}N_20$: C, 83.50; H, 5.15; N, 7.21; Found: C, 83.40; H, 5.21; N, 7.25.

3-(p-chlorophenyl)-4-phenyl-6-napthylpyridazine 6c.

Pale brown solid; mp 173°C; ^{1}H NMR: δ 8.30-7.85 (m, 4H), 7.80 (s, 1H), 7.61-7.30 (m, 12H). ^{13}C NMR: δ 158.7, 157.8, 141.3, 140.0, 139.1, 137.9, 136.5, 135.8, 132.1, 131.4, 130.3, 129.9, 129.4, 128.7, 128.3,128.0, 127.6, 126.0, 125.3, 124.8. IR(KBr): 3067, 1602, 1498, 1451. MS (EI) m/z: 368.5 (M^+), 257, 241.5, 153, 127, 111.5. Anal. Calcd. for $C_{24}H_{17}N_2Cl$: C, 78.15; H, 4.61; N, 7.59; Found: C, 79.03; H, 4.48; N, 7.66.

3, 4-difuryl-6-naphthylpyridazine 6d.

Brown solid; mp 164°C; ^{1}H NMR: δ 8.11-8.04 (m, 3H), 7.78-7.52 (m, 7H), 7.03 (s, 1H), 6.64-6.62 (d, 1H), 6.52-6.50 (t, 1H), 6.28-6.27 (d, 1H). ^{13}C NMR: δ 157.0, 156.7, 150.2, 147.5, 146.8, 144.6, 143.6, 138.1, 134.8, 132.2, 131.5, 128.5, 128.0, 124.8, 124.1, 119.6, 113.4, 112.5, 112.2, 112.1. IR (KBr): 3033, 1643, 1471, 1064. MS (EI) m/z 340 (M^+), 273, 213, 206, 153, 146, 127, 92, 67. Anal. Calcd. for $C_{22}H_{14}N_2O_2$: C, 78.10; H, 4.14; N, 8.28; Found: C, 78.01; H, 4.19; N, 8.20.

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