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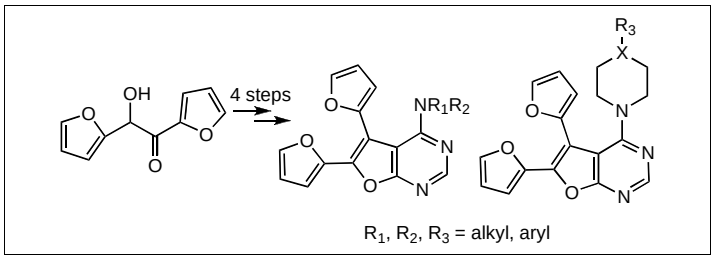

Some substituted furopyrimidine derivatives are prepared in high yield in 4 steps, starting from the reaction of furoin (1,2-di(furan-2-yl)-2-hydroxyethanone) and malonitrile.

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Derivatives of furopyrimidines [1-9] and thieno-pyrimidines moieties are known to possess antitumor [10], analgesic [11], antihypertensive [12], and anti-inflammatory activity [13]. The thienopyrimidine-based analogues were reported to inhibit the Src family of tyrosine kinases [14]. Recently, furopyrimidines were also known to inhibit adenosine kinase in very low concentration [15]. Therefore, we synthesized new furo-pyrimidine derivatives to evaluate their potential as protein kinase inhibitors which in mammals comprises three highly homologous members known as PKBα, PKBβ and PKBγ. PKB is activated in cells exposed to diverse stimuli such as hormones, growth factors, and extracellular matrix components [16].

Furoin reacts with malonitrile in the presence of diethyl amine to give 2-amino-4,5-di-(2-furanyl)-furan-3-carbonitrile (**1**) over 90% yield [5]. The nitrile **1** was stirred for 3 hours with formic acid in the presence of acetic anhydride at 0 °C and refluxed for 24 hours to afford pyrimidine-4-one **2** in 72% yield. Formation of compound **2** is thought to proceed *via* formylation of the amino group and transformation of the cyano group to the amide group, followed by attack of the amino group to the carbonyl group as showed in Scheme 1 [15]. Furopyrimidines (**4a**-**4z**) were obtained in high yield from the reaction of the chloride compound **3** with some amines. Here, the compound **3** was obtained *via* the reaction of pyrimidin-4-one **2** with phosphorus oxychloride under reflux. Structural assignments of all compounds were confirmed on the basis of nmr, infrared and elemental analysis.

At present, we are evaluating the synthesized furo-pyrimidines (**4a**-**4z**) as an inhibitor of protein kinase.

EXPERIMENTAL

^{1}H NMR (300 MHz) was recorded on a Varian Gemini 300 MHz spectrometer with TMS as an internal reference. IR spectra were recorded on a MIDAC 101025 FT-IR Spectrometer. Melting points were acquired using a Thomas-Hoover capillary melting apparatus and are uncorrected. Chemical analyses were carried out by EA 1108 CHNS-O of Fisons Instruments. Column chromatography was performed on Merck silica gel 60 (230 - 400 mesh). TLC was carried out using glass sheets pre-coated with silica gel 60 F_{254} prepared by E. Merck. All the commercially available reagents were obtained from Aldrich and Tokyo Kasei Chemical and generally used without further purification.

5,6-Di-(2-furyl)-furo[2,3-d]pyrimidin-4(1*H*)-one (2).

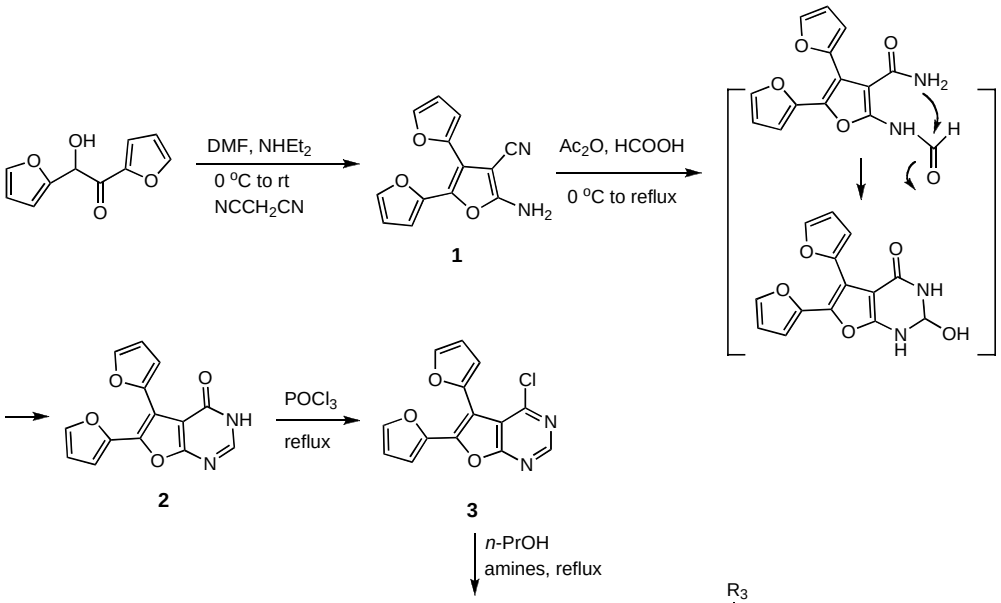
Formic acid 85% (46.0 ml, 1.22 mol) was added to acetic anhydride (93.0 ml, 0.98 mol) while cooling at 0 °C. 2-Amino-4,5-di-(2-furanyl)-furan-3-carbonitrile (1) (10.0 g, 0.049 mol) was added to the cold solution and stirred for 3 h, and the resulting solution was refluxed for 24 hours and evaporated *in vacuo*. The residue was recrystallized with the mixed solvent of *n*-hexane and ethyl acetate to give the black brown crystal in 72% yield; mp 248-249 °; ir (KBr): ν 3152, 2888, 1702, 1584, 1558, 1394, 1360, 1190, 1138, 1014, 984, 872, 748, 592 cm^{-1}; ^{1}H NMR (dimethyl-d_6-sulfoxide): δ 6.65 (d, J = 3.3 Hz, 1H), 6.71 (d, J = 1.8 Hz, 1H), 7.13 (d, J = 2.1 Hz, 1H), 7.49 (d, J = 2.4 Hz, 1H), 7.81 (s, 1H), 7.90 (s, 1H), 8.22 (s, 1H).

Anal. Calcd. for $C_{14}H_8N_2O_4$: C, 61.69; H, 3.01; N, 10.44. Found: C, 61.50; H, 3.00; N, 10.01.

4-Chloro-5,6-di-(2-furyl)-furo[2,3-*d*]pyrimidine (3).

A mixture of 5,6-di-(2-furyl)-furo[2,3-*d*]pyrimidin-4(1*H*)-one (2) (5.0 g, 18.0 mmol), $POCl_3$ (52.0 ml, 53.6 mmol) was refluxed for 2 hours and evaporated *in vacuo*. The residue was purified by chromatography on silicagel with *n*-hexane and ethyl acetate (3:1,v/v) as eluent to give a solid in 69% yield; mp 135-136 °; ir (KBr): ν 3132, 1586, 1552, 1376, 1244, 1150, 1020, 982, 888, 766 cm^{-1}; ^{1}H NMR (deuteriochloroform): δ 6.47-6.85 (m, 4H), 7.48 (s, 1H), 7.57 (s, 1H), 8.67 (s, 1H).

Scheme 1



4a, R_1 = -$(CH_2)_2$OH, R_2 = H
4b, R_1 = -$(CH_2)_4$OH, R_2 = H
4c, R_1 = -$CH_2CH(OH)CH_3$, R_2 = H
4d, R_1 = -$CH(CH_2OH)CH_2CH_3$, R_2 = H
4e, R_1 = -$CH_2CH(OH)CH_2CH_3$, R_2 = H
4f, R_1 = -$(CH_2)_2O(CH_2)_2OH$, R_2 = H
4g, R_1 = -$(CH_2)_2OCH_3$, R_2 = H
4h, R_1 = -$(CH_2)_3OH$, R_2 = H
4i, R_1 = -CH_2CH_3, R_2 = -CH_2CH_3
4j, R_1 = -$CH_2CH(CH_3)CH_3$, R_2 = H
4k, R_1 = -cycloheptyl, R_2 =H
4l, R_1 = -$(CH_2)_2$Ph, R_2 = H
4m,R_1 = -CH_3, R_2 = H
4n, R_1 = 2-hydroxycyclohexyl, R_2 = H
4o, R_1 = 4-aminophenyl, R_2 = H
4p, R_1 = 3,5-dimethoxyphenyl, R_2 = H
4q, R_1 = 3,4-dimethylphenyl, R_2 = H
4r, R_1 = 3,5-dimethylphenyl, R_2 = H
4s, R_1 = 3,4-dichlorophenyl, R_2 = H
4t, R_1 = 3-trifluoromethylphenyl, R_2 = H

4u, X = O, R_3 = H
4v, X = C, R_3 = H
4w,X = N, R_3 = CH_3
4x, X = S, R_3 = H
4y, X = C, R_3 = OH
4z, X = C, R_3 = CH_3

Anal. Calcd. for $C_{14}H_9ClN_2O_3$: C, 58.66; H, 2.46; N, 9.77. Found: C, 57.99; H, 3.11; N, 9.80.

General Procedure for the Preparations of **4a-4z**.

4-Chloro-5,6-di-(2-furyl)-furo[2,3-*d*]pyrimidine (3) (30 mg, 0.11 mmol) was dissolved in 1-propanol (3 mL), followed by the substituted amines (over 0.11 mmol) and the mixture was refluxed for 24 hours. After the completion of reaction, the mixture was evaporated *in vacuo* and poured into a 2% HCl solution at which time a solid forms. The mixture containing the solid was poured into a saturated $NaHCO_3$ solution and then was filtered and recrystallized in the mixed solvent of diethylether and methylene chloride to give the pure product.

2-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]ethanol (**4a**).

Yield 73%; mp 163-164 °C; ir (KBr): ν 3390, 3266, 1600, 1498, 1332, 1146, 1072, 1010, 742, 594 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.79 (t, J = 5.1 Hz, 2H), 3.92 (t, J = 5.1 Hz, 2H), 6.60-7.00 (m, 4H), 7.54 (s, 1H), 7.65 (s, 1H), 8.40 (s, 1H).

Anal. Calcd. for $C_{16}H_{13}N_3O_4$: C, 61.73; H, 4.21; N, 13.50. Found: C, 60.98; H, 4.08; N, 13.09.

4-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]butan-1-ol (**4b**).

Yield 99%; mp 103-104 °C; ir (KBr): ν 3414, 3266, 2936, 1608, 1490, 1451, 1138, 1012, 890, 746, 594 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.83-1.69 (m, 4H), 3.64-3.68 (m, 2H), 3.77 (t, J = 8.0 Hz, 2H), 6.47 (s, 1H), 6.57-6.96 (m, 4H), 7.55 (s, 1H), 7.66 (s, 1H), 8.42 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_4$: C, 63.71; H, 5.05; N, 12.38. Found: C, 63.90; H, 5.04; N, 12.50.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]propan-2-ol (**4c**).

Yield 71%; mp 157-158 °; ir (KBr): ν 3396, 1604, 1506, 1312, 1156, 742, 594 cm^{-1}; ^1H NMR (deuteriochloroform) δ1.31 (d, J = 6.3 Hz, 3H), 3.48-3.53 (m, 1H), 3.79-3.86 (m, 2H), 4.12 (s, 1H), 6.58 (s, 1H), 6.64 (s, 1H), 6.97-7.05 (m, 2H), 7.56 (s, 1H), 7.64 (s, 1H), 8.39 (s, 1H).

Anal. Calcd. for $C_{17}H_{15}N_3O_4$: C, 62.76; H, 4.65; N, 12.92. Found: C, 62.60; H, 4.60; N, 12.90.

2-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]butan-1-ol (**4d**).

Yield 50%; mp 135-136 °C; ir (KBr): ν 3380, 2930, 1604, 1496, 1314, 1146, 1016, 894, 740, 592 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.04 (t, J = 7.8 Hz, 3H), 1.64-1.77 (m, 2H), 3.71-3.91 (m, 2H), 4.21-4.23 (m, 1H), 6.58-7.00 (m, 5H), 7.55 (s, 1H), 7.61 (s, 1H), 8.37 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_4$: C, 63.71; H, 5.05; N, 12.38. Found: C, 63.90; H, 5.04; N, 12.00.

4-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]butan-2-ol (**4e**).

Yield 8%; mp 109-110 °C; ir (KBr): ν 3398, 2924, 1610, 1500, 1458, 1300, 1150, 1018, 744, 592 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): δ 1.43 (t, J = 7.8 Hz, 3H), 1.56-1.66 (m, 2H), 3.48-3.54 (m, 1H), 3.80-3.90 (m, 2H), 6.55-7.10 (m, 5H), 7.54 (s, 1H), 7.63 (s, 1H), 8.37 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_4$: C, 63.71; H, 5.05; N, 12.38. Found: C, 63.90; H, 5.00; N, 12.00.

2-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)aminoethoxy]-ethanol (**4f**).

Yield 90%; mp 128-129 °C; ir (KBr): ν 3406, 2872, 1608, 1502, 1338, 1230, 1120, 1068, 888, 744 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.64-3.88 (m, 8H), 6.55-6.93 (m, 4H), 7.53 (s, 1H), 7.69 (s, 1H), 8.04 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_5$: C, 60.84; H, 4.82; N, 11.83. Found: C, 60.70; H, 4.50; N, 11.90.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-2-methoxy-ethane (**4g**).

Yield 43%; mp 80-82 °C; ir (KBr): ν 3406, 2924, 1604, 1500, 1448, 1336, 1114, 1018, 886, 794, 740 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.46 (s, 3H), 3.47-3.71 (m, 2H), 3.96-3.98 (m, 2H), 6.60-7.05 (m, 4H), 7.60 (s, 1H), 7.65 (s, 1H), 8.50 (s, 1H).

Anal. Calcd. for $C_{17}H_{15}N_3O_4$: C, 62.76; H, 4.65; N, 12.92. Found: C, 62.80; H, 4.60; N, 12.80.

3-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]propan-1-ol (**4h**).

Yield 38%; mp 105-106 °C; ir (KBr): ν 3416, 2930, 1606, 1504, 1442, 1138, 1018, 890, 742 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.84-1.88 (m, 2H), 3.70 (t, J = 6 Hz, 2H), 3.82 (t, J = 6 Hz, 2H), 6.58-6.90 (m, 4H), 7.56 (s, 1H), 7.65 (s, 1H), 8.50 (s, 1H).

Anal. Calcd. for $C_{17}H_{15}N_3O_4$: C, 62.76; H, 4.65; N, 12.92. Found: C, 62.80; H, 4.60; N, 12.91.

N-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl]diethylamine (**4i**).

Yield 77%; mp 108-109 °C; ir (KBr): ν 2974, 1584, 1542, 1466, 1360, 1280, 1078, 1018, 742, 599 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.07 (t, J = 6.6 Hz, 6H), 3.41 (q, J = 6.6 Hz, 4H), 6.48-6.60 (m, 4H), 7.48 (s, 1H), 7.62 (s, 1H), 8.41 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_4$: C, 66.86; H, 5.30; N, 13.00. Found: C, 6.87; H, 5.29; N, 12.99.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]isobutane (**4j**).

Yield 94%; mp 105-106 °C; ir (KBr): ν 3418, 2956, 1602, 1498, 1302, 1152, 1018, 888, 730, 599 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.03 (d, J = 6.6 Hz, 6H), 1.91-2.00 (m, 1H), 3.47 (t, J = 5.4 Hz, 2H), 6.43 (s, 1H), 6.57-6.96 (m, 4H), 7.54 (s, 1H), 7.62 (d, J = 2.7 Hz, 1H), 8.42 (s, 1H).

Anal. Calcd. for $C_{18}H_{17}N_3O_3$: C, 66.86; H, 5.30; N, 13.00. Found: C, 66.80; H, 5.35; N, 12.99.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]cyclo-heptane (**4k**).

Yield 89%; mp 126-127 °C; ir (KBr): ν 3414, 2926, 1602, 1492, 1370, 1296, 1138, 1016, 888, 754, 592, 494 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.59-1.63 (m, 10H), 2.05-2.10 (m 2H), 6.40 (d, J = 7.2 Hz, 1H), 6.57-6.95 (m, 4H), 7.54 (s, 1H), 7.64 (s, 1H), 8.42 (s, 1H).

Anal. Calcd. for $C_{21}H_{21}N_3O_4$: C, 69.41; H, 5.82; N, 11.56. Found: C, 69.40; H, 5.80; N, 11.55.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-2-phenyl-ethane (**4l**).

Yield 83%; mp 120-121 °C; ir (KBr): ν 3418, 3126, 2872, 1600, 1492, 1452, 1340, 1298, 1122, 1010, 884, 744, 700 cm^{-1}; ^1H NMR (deuteriochloroform): δ 2.98 (t, J = 6.6 Hz, 2H), 3.93-3.99 (m, 2H), 6.40-7.50 (m, 12H), 8.40 (s, 1H).

Anal. Calcd. for $C_{22}H_{17}N_3O_4$: C, 71.15; H, 4.61; N, 11.31. Found: C, 71.10; H, 4.65; N, 11.30.

1-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]methane (**4m**).

Yield 53%; mp 116-117 °C; ir (KBr): ν 3436, 3104, 2918, 1606, 1504, 1412, 1300, 1144, 1020, 886, 792, 732, 588 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.18 (d, J = 4.5 Hz, 3H), 6.40 (s, 1H), 6.56-6.90 (m, 4H), 7.51 (s, 1H), 7.62 (s, 1H), 8.44 (s, 1H).

Anal. Calcd. for $C_{15}H_{11}N_3O_3$: C, 64.05; H, 3.94; N, 14.94. Found: C, 64.04; H, 3.88; N, 14.90.

2-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]cyclo-hexanol (**4n**).

Yield 81%; mp 204-205 °C; ir (KBr): ν 3382, 2927, 1610, 1501, 1152, 1087, 1023, 746 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.28-1.49 (m, 4H), 1.78-1.84 (m, 2H), 2.10-2.20 (m, 2H), 3.48-3.49 (m, 2H), 3.98-4.05 (m, 2H), 6.50-7.00 (m, 5H), 7.56 (s, 1H), 7.62 (s, 1H), 8.36 (s, 1H).

Anal. Calcd. for $C_{20}H_{19}N_3O_4$: C, 65.74; H, 5.24; N, 11.50. Found: C, 65.70; H, 5.23; N, 11.49.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-4-aminobenzene (**4o**).

Yield 71%; mp 192-193 °C; ir (KBr): ν 3390, 1592, 1514, 1458, 1292, 1152, 1082, 818, 742, 599, 534 cm^{-1}; ^1H NMR (deuteriochloroform): δ 6.59-7.44 (m, 7H), 7.57 (d, J = 1.8 Hz, 1H), 7.71 (s, 1H), 8.10 (s, 1H), 8.48 (s, 1H).

Anal. Calcd. for $C_{20}H_{14}N_4O_3$: C, 67.03; H, 3.94; N, 15.63. Found: C, 67.02; H, 3.93; N, 15.67.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-3,5-dimethoxybenzene (**4p**).

Yield 69%; mp 166-167 °C; ir (KBr): ν 3392, 3134, 2936, 1584, 1484, 1200, 1154, 1066, 1020, 888, 790, 754, 678, 592 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.86 (s, 6H), 6.28-7.58 (m 8H), 8.34 (s, 1H), 8.57 (s, 1H).

Anal. Calcd. for $C_{22}H_{17}N_3O_5$: C, 65.50; H, 4.25; N, 10.42. Found: C, 65.60; H, 4.23; N, 10.32.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-3,4-dimethylbenzene (**4q**).

Yield 57%; mp 139-140 °C; ir (KBr): ν 3394, 3116, 2927, 1590, 1504, 1454, 1312, 1150, 1018, 888, 734, 594 cm^{-1}; ^1H NMR (deuteriochloroform): δ 2.23 (s, 3H), 2.33 (s, 3H), 6.60-7.58 (m, 8H), 8.21 (s, 1H), 8.53 (s, 1H).

Anal. Calcd. for $C_{22}H_{17}N_3O_3$: C, 71.15; H, 4.61; N, 11.31. Found: C, 71.14; H, 4.65; N, 11.30.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-3,5-dimethylbenzene (**4r**).

Yield 84%; mp 179-180 °C; ir (KBr): ν 3400, 1634, 1584, 1480, 1158, 1092, 1018, 888, 746, 594 cm^{-1}; ^1H NMR (deuteriochloroform): δ 2.39 (s, 6H), 6.60-7.02 (m, 6H), 7.57 (s, 1H), 7.75 (s, 1H), 8.23 (s, 1H), 8.55 (s, 1H).

Anal. Calcd. for $C_{22}H_{17}N_3O_3$: C, 71.15; H, 4.61; N, 11.31. Found: C, 71.13; H, 4.63; N, 11.29.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl)amino]-3,4-dichlorobenzene (**4s**).

Yield 33%; mp 214-215 °C; ir (KBr): ν 3396, 1636, 1588, 1470, 1478, 1327, 1020, 888, 803, 734 cm^{-1}; ^1H NMR (deuteriochloroform): δ 6.62-7.06 (m, 4H), 7.41-7.60 (m 3H), 8.05 (d, J = 2.1 Hz, 1H), 8.43 (s, 1H), 8.59 (s, 1H).

Anal. Calcd. for $C_{20}H_{11}N_3O_3Cl_2$: C, 58.27; H, 2.69; N, 10.19. Found: C, 58.20; H, 2.68; N, 10.15.

N-[(5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl)amino]-3-trifluoromethylbenzene (**4t**).

Yield 66%; mp 174-175 °C; ir (KBr): ν 3388, 2920, 1632, 1588, 1496, 1340, 1154, 1114, 1018, 870, 792, 736, 696, 592 cm^{-1}; ^1H NMR (deuteriochloroform): δ 6.62-8.10 (m, 10H), 8.57 (s, 1H).

Anal. Calcd. for $C_{21}H_{12}F_3N_3O_3$: C, 61.32; H, 2.94; N, 10.22. Found: C, 61.20; H, 2.92; N, 10.11.

N-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl]morpholine (**4u**).

Yield 99%; mp 170-171 °C; ir (KBr): ν 3098, 2856, 1588, 1546, 1444, 1362, 1254, 1112, 930, 884, 750, 596 cm^{-1}; ^1H NMR (deuteriochloroform): δ 3.40 (t, J = 4.5 Hz, 4H), 3.62 (t, J = 4.5 Hz, 4H), 6.51-6.82 (m, 4H), 7.51 (d, J = 2.7 Hz, 1H), 7.64 (d, J = 2.7 Hz, 1H), 8.47 (s, 1H).

Anal. Calcd. for $C_{18}H_{15}N_3O_4$: C, 64.09; H, 4.48; N, 12.46. Found: C, 64.07; H, 4.46; N, 12.44.

N-[5.6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl]piperidine (**4v**).

Yield 60%; mp 155-156 °C; ir (KBr): ν 3156, 2930, 1586, 1538, 1458, 1368, 1254, 1152, 1094, 1010, 913, 752 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.28-1.62 (m, 6H), 3.38-3.42 (m, 4H), 6.49-6.76 (m, 4H), 7.50 (s, 1H), 7.62 (d, J = 3.0 Hz, 1H), 8.44 (s, 1H).

Anal. Calcd. for $C_{19}H_{17}N_3O_3$: C, 68.05; H, 5.11; N, 12.53. Found: C, 68.09; H, 5.11; N, 12.40.

N-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl]-*N*'-methylpiperazine (**4w**).

Yield 29%; mp 260< ; ir (KBr): ν 2930, 1586, 1548, 1446, 1369, 1263, 1148, 1019, 752 cm^{-1}; ^1H NMR (deuteriochloroform): δ 2.30 (s, 3H), 2.36 (t, J = 4.8 Hz, 4H), 3.49 (t, J = 4.8 Hz, 4H), 6.52-6.81 (m, 4H), 7.52 (d, J = 1.5 Hz, 1H), 7.64 (d, J = 2.1 Hz, 1H), 8.46 (s, 1H).

Anal. Calcd. for $C_{19}H_{18}N_4O_3$: C, 65.13; H, 5.18; N, 15.99. Found: C, 65.13; H, 5.17; N, 15.89.

N-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl]thiomorpholine (**4x**).

Yield 84%; mp 161-162 °C; ir (KBr): ν 3118, 2918, 2846, 1584, 1544, 1446, 1368, 1284, 1244, 1146, 1098, 1018, 960, 894, 742 cm^{-1}; ^1H NMR (deuteriochloroform): δ 2.55 (t, J = 2.7 Hz, 4H), 3.75 (t, J = 2.7 Hz, 4H), 6.51-6.78 (m, 4H), 7.51 (s, 1H), 7.65 (s, 1H), 8.47 (s, 1H).

Anal. Calcd. for $C_{18}H_{15}N_3O_3S$: C, 61.18; H, 4.28; N, 11.89. Found: C, 61.10; H, 4.28; N, 11.87.

1-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidin-4-yl]-4-hydroxypiperidine (**4y**).

Yield 57%; mp 140-141 °C; ir (KBr): ν 3318, 2926, 1592, 1548, 1496, 1450, 1366, 1230, 1148, 1068, 1014, 746 cm^{-1}; ^1H NMR (deuteriochloroform): δ 1.44-1.50 (m, 2H), 1.80-1.85 (m, 2H), 3.08-3.16 (m, 2H), 3.79-3.89 (m, 2H), 6.51-6.79 (m, 4H), 7.51 (s, 1H), 7.63 (s, 1H), 8.44 (s, 1H).

Anal. Calcd. for $C_{19}H_{17}N_3O_4$: C, 64.95; H, 4.88; N, 11.96. Found: C, 64.95; H, 4.77; N, 11.90.

N-[5,6-Di-(2-furyl)-furo[2,3-*d*]pyrimidine-4-yl]-4-methylpiperidine (**4z**).

Yield 86%; mp 164-165 °C; ir (KBr): ν 3136, 2926, 1584, 1534, 1454, 1368, 1250, 1152, 1084, 1020, 976, 888, 750 cm-1; 1H NMR (deuteriochloroform): δ 0.91 (d, J = 6.0 Hz, 3H), 1.07-1.12 (m, 1H), 1.54-1.57 (m, 4H), 2.76-2.85 (m, 2H), 4.00-4.09 (m, 2H), 6.50-6.83 (m, 4H), 7.48 (s, 1H), 7.60 (s, 1H), 8.42 (s, 1H).

Anal. Calcd. for $C_{20}H_{19}N_3O_3$: C, 68.75; H, 5.48; N, 12.03. Found: C, 68.77; H, 5.47; N, 12.11.

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