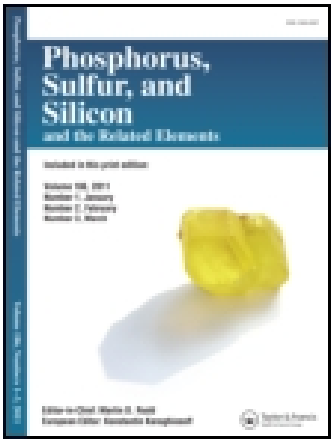

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Iminophosphorane-Mediated Efficient Synthesis of New Fluorine-Containing Triazolo[4,5-d]Pyrimidin-7-Ones

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IMINOPHOSPHORANE-MEDIATED EFFICIENT SYNTHESIS OF NEW FLUORINE-CONTAINING TRIAZOLO[4,5-*d*]PYRIMIDIN-7-ONES

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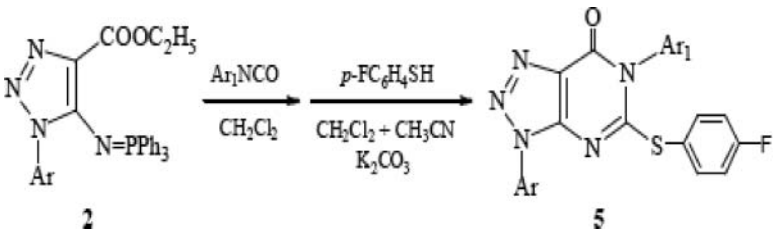
GRAPHICAL ABSTRACT



2 5

Abstract *The carbodiimides **3**, obtained from aza-Wittig reactions of the corresponding iminophosphorane **2** with 1 equiv. of aromatic isocyanates, were allowed to react in the presence of a catalytic amount of potassium carbonate or EtO^-Na^+ with p-fluorothiophenol to give 5,6-disubstituted 1,2,3-triazolo[4,5-d]- pyrimidine-7-ones **5** in satisfactory yields. Further reaction of compounds **5** with H_2O_2 or Na_2WO_4/H_2O_2 generated the corresponding compounds **6** and **7** in good yields, respectively.*

Keywords aza-Wittig reaction; cyclization; synthesis; 1,2,3-Triazolo[4,5-*d*]pyrimidine-7-ones

INTRODUCTION

The synthesis of derivatives of triazolopyrimidines has been the focus of great interest recently. This is due, in part, to the broad spectrum of biological properties of these compounds. Some derivatives of them have shown remarkable biological properties, such as antitumor, antiviral, Adenosine A_{2A} Receptor antibacterial, and anti-HIV activities,[1–5] whereas others exhibit good insecticidal, growth regulator, fungicidal activities, and can act as anti-inflammatory agents.[6–14] However, only a few reports are available on the herbicidal activities of fluorine-containing triazolo[4,5-*d*]pyrimidine derivatives so far.

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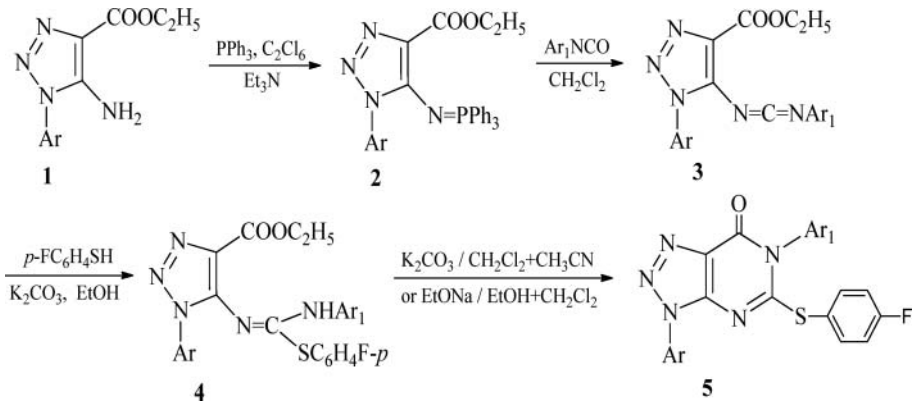
Fluorine is a very unique element with the highest electronegativity as well as high thermal stability and lipophilicity, which imparts various prominent functionalities to organofluorine compounds. Therefore, fluorinated compounds in general and fluorinated heterocycles in particular are the topic of many investigations.[15] By introducing fluorine atoms into organic molecule compounds with improved physical, chemical, and biological properties are obtained.[16,17] Some examples have demonstrated that the incorporation of fluorine atoms or fluorine containing substituents into certain compounds influences their herbicidal,[18,19] fungicidal,[20,21] and insecticidal activity.[22]

The aza-Wittig reactions of iminophosphoranes have received increasing attention in view of their utility in the synthesis of *N*-heterocyclic compounds.[23–25] Recently, we have become interested in the synthesis of new bioactive heterocycles, such as triazolo[4,5-*d*]pyrimidine-7-ones from various iminophosphoranes, with the aim of evaluating their biological activities. Here, we report on the synthesis of 5,6-disubstituted-3-phenyl-1,2,3-triazolo[4,5-*d*]pyrimidine-7-ones via a tandem aza-Wittig and cyclization reaction. Further, the reaction of corresponding compound **5** with H_2O_2 or Na_2WO_4/H_2O_2 generates the corresponding compounds **6** and **7**, respectively, in good yields.

RESULTS AND DISCUSSION

Synthesis

The iminophosphorane **2** was obtained in satisfactory yield when **1**[26] was treated with triphenylphosphine, hexachloroethane, and Et_3N. Iminophosphorane **2** in dry methylene chloride reacted with aryl isocyanates to give carbodiimides **3**. The direct reaction of carbodiimides **3** with *p*-fluorothiophenol did not produce the 6-aryl-5-arylthio-3,6-dihydro-3-phenyl-1,2,3-triazolo[4,5-*d*]pyrimidin-7-ones **5**. Even in refluxing acetonitrile the intermediate **4** did not cyclize. However, the reaction took place to give **5a–5f** in good yields under heating for 2–3 h in the presence of a catalytic amount of potassium carbonate. The formation of **5** can be rationalized in terms of an initial nucleophilic addition of *p*-fluorothiophenol to the corresponding carbodiimide **3** to give the intermediate **4** which cyclizes to give **5a–5f** (Scheme 1). Irrespective of the substituents at the cyclization was completed smoothly at 40–50 °C. The results are listed in Table 1. It is interesting to note that the carbodiimides **3** react with *p*-fluorothiophenol at room temperature to give



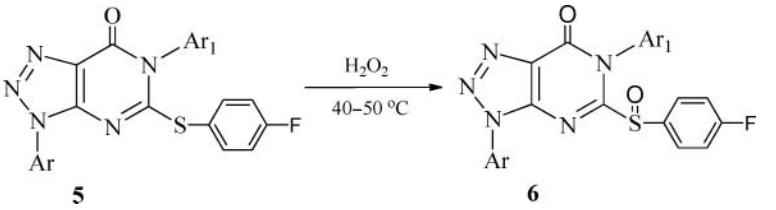
Scheme 1

Table 1 Yields of compounds **5a**-**5f**

5	Ar	Ar_1	Yield (%)
a	Ph	Ph	89
b	Ph	4-ClC_6H_4	96
c	Ph	3-ClC_6H_4	87
d	4-ClC_6H_4	Ph	87
e	4-ClC_6H_4	4-ClC_6H_4	84
f	4-ClC_6H_4	3-ClC_6H_4	83

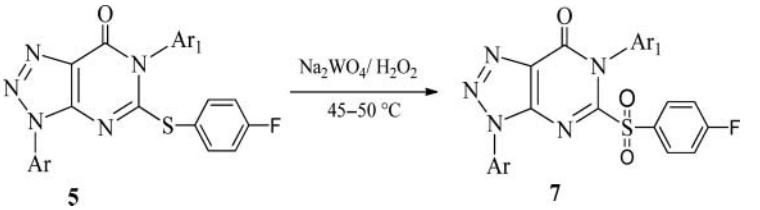
the intermediate **4**, which does not cyclize to give **5** even in refluxing MeCN/CH_2Cl_2 for 24 h. Also in refluxing EtOH/CH_2Cl_2, only the intermediate **4** was formed. However, in the presence of a catalytic amount of EtO^-Na^+, compounds **3** were converted smoothly into the 6-aryl-5-arylthio-3,6-dihydro-3-phenyl-1,2,3-triazolo[4,5-*d*]pyrimidin-7-ones **5a**-**f** in satisfactory yields at 40–50 °C within 0.5–1 h.

The direct reaction of compounds **5** with H_2O_2 gave 6-aryl-5-arylsulfinyl-3,6-dihydro- 3-phenyl-1,2,3-triazolo[4,5-*d*]pyrimidine-7-ones **6** in good yields. The results are listed in Table 2.



5 **6**

When compounds **5** were treated with H_2O_2 in the presence of a catalytic amount of Na_2WO_4, the 6-aryl-5-arylsulfonyl-3,6-dihydro-3-phenyl-1,2,3-triazolo[4,5-*d*]-pyrimidin-7-ones **7** were obtained in satisfactory yields. The results are listed in Table 3.



5 **7**

Scheme 3

The structure of 1,2,3-triazolo[4,5-*d*]pyrimidine-7-ones **5**, **6**, and **7** was confirmed by their spectroscopic data. For example, the IR spectrum of **6a** shows C=O absorption band at 1746 cm^{-1}. The ^1H NMR spectrum of **6a** displays multiplets at $\delta = 7.29$–7.75 ppm due to the aromatic protons. The ^{13}C NMR spectrum of **6a** shows signals for the C=O moiety and the pyrimidine ring at 156 ppm and at 155.9, 155.0, and 116.1 ppm, respectively. The mass spectrum of the compound displays the molecule ion peak. All fragmentation ions are consistent with the structure and can be clearly assigned.

Table 2 Yields of compounds **6a-f**

6	Ar	Ar_1	Yield (%)
a	Ph	Ph	77
b	Ph	4-ClC_6H_4	80
c	Ph	3-ClC_6H_4	79
d	4-ClC_6H_4	Ph	70
e	4-ClC_6H_4	4-ClC_6H_4	77
f	4-ClC_6H_4	3-ClC_6H_4	74

EXPERIMENTAL

Melting points were measured with an electrothermal melting point apparatus and are uncorrected. Mass spectra were measured with a Finnigan Trace MS spectrometer. IR spectra were recorded with an FTS-185 infrared spectrometer as KBr pellets. ^1H and ^{31}C NMR spectra were recorded in $CDCl_3$ or d^6-DMSO as solvent with a Bruker AC-P400 spectrometer. Chemical shifts are given in ppm relative to TMS. Elementary analyses were obtained with a Vario EL III instrument. All of the solvents and materials were reagent grade and purified according to standard procedures.

Synthesis of Iminophosphorane 2

To a solution of **1** (2.26 g, 10 mmol) in MeCN (60 mL) was added Ph_3P (7.86 g, 30 mmol), C_2Cl_6 (7.11 g, 30 mmol), and Et_3N (6.06 g, 60 mmol) in this order. The mixture was stirred for 3 h at ambient temperature. Then, the solvent was evaporated and the residue was recrystallized from EtOH to give **2** in 90.7% yield; mp: 206–208 °C; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 1.05$ (t, $J = 6.8$ Hz, 3H, $CH_2\underline{CH_3}$), 3.91 (q, $J = 7.2$ Hz, 2H, $\underline{CH_2}CH_3$), 7.37–7.75 (m, 20H, arom-H); Anal. Calcd. for $C_{29}H_{25}N_4O_2P$: C, 70.72; H, 5.12; N, 11.38; Found: C, 70.47; H, 5.23; N, 11.57%.

Synthesis of 3,6-diaryl-3,6-dihydro-5-[(4-fluorophenyl)thio]-1,2,3-triazolo[4,5-*d*]- pyrimidin-7-ones (5): General Procedure

To a solution of iminophosphorane **2** (3 mmol) in dry methylene chloride (15 mL), the respective phenylisocyanate (3 mmol) was added under nitrogen at room temperature. After the reaction mixture was left unstirred for 12–13 h the solvent was removed in vacuo and anhydrous ethanol (10 mL) was added to precipitate triphenylphosphine oxide. After triphenylphosphine oxide was separated by filtration from the filtrate the solvent was

Table 3 Yields of compounds **7a-f**

7	Ar	Ar_1	Yield (%)
A	Ph	Ph	83
B	Ph	4-ClC_6H_4	85
C	Ph	3-ClC_6H_4	82
D	4-ClC_6H_4	Ph	75
E	4-ClC_6H_4	4-ClC_6H_4	79
F	4-ClC_6H_4	3-ClC_6H_4	75

evaporated to give the corresponding carbodiimide **3**, which was used directly without further purification.

To a solution of **3**, prepared as described above, in MeCN (25 mL) was added *p*-fluorothiophenol (3 mmol) and a catalytic amount of solid K_2CO_3 (0.24 g, 2 mmol). The mixture was stirred for 2–3 h at 50°C and filtered. From the filtrate the solvent was evaporated and the residue was recrystallized from dichloromethane/petroleum ether to give the corresponding pure 6-aryl-5-arylthio-3,6-dihydro-3-phenyl-1,2,3- triazolo[4, 5-*d*]pyrimidin-7-one **5**.

3,6-Dihydro-3,6-diphenyl-5-[(*p*-fluorophenyl)thio]-1,2,3-triazolo[4,5-*d*]pyrimi- dine-7-one (5a)

White solid; yield 89%; mp: 250–252 °C; IR (KBr): $\nu = 1734$ (C=O); 1592, 1527, 1218, 714 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.19$–7.83 (m, 14H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 165.3$ (C=O), 155.3, 146.5, 137.8, 137.7, 137.6, 137.0, 135.8, 134.8, 130.7, 130.3, 130.2, 129.9, 129.8, 129.7, 129.3, 129.1, 128.4, 127.8, 126.4, 120.1, 120.0; MS (EI, m/z,%): 415 (M^+ 23), 414 (9), 386 (13), 219 (43), 95 (78), 92 (57), 77 (100); Anal. Calcd. for $C_{22}H_{14}FN_5OS$: C 63.60, H 3.40, N 16.86; Found C 63.22, H 3.59, N 16.97%.

6-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)thio]-3-phenyl-1,2,3-triazolo-[4,5-*d*]pyrimidine-7-one (5b)

White solid; yield 96%; mp: 220–222 °C; IR (KBr): $\nu = 1737$ (C=O), 1591, 1524, 1216, 735 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.27$–7.79 (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): 166.1 (C=O), 155.2, 145.4, 137.9, 137.6, 137.3, 137.0, 135.7, 134.6, 130.7, 130.5, 130.4, 129.8, 129.6, 129.5, 129.2, 129.0, 128.5, 127.7, 126.4, 120.2, 120.0; MS (EI, m/z,%): 449 (M^+ 27), 414 (10), 386 (5), 219 (41), 111 (100), 95 (49), 92 (78), 77 (69); Anal. Calcd. for $C_{22}H_{13}ClFN_5OS$: C 58.73, H 2.91, N 15.57; Found C 58.87, H 3.04, N 15.77%.

6-(3-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)thio]-3-phenyl-1,2,3-triazolo-[4,5-*d*]pyrimidine-7-one (5c)

White solid; yield 87%; mp: 140–142 °C; IR (KBr): $\nu = 1750$ (C=O); 1594, 1524, 1215, 734 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.20$–7.81 (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 165.5$ (C=O), 155.3, 146.6, 137.9, 137.7, 137.5, 137.0, 135.7, 134.5, 131.3, 130.2, 130.0, 129.7, 129.5, 129.3, 129.1, 128.8, 128.4, 127.4, 126.6, 120.6, 120.1; MS (EI, m/z,%): 449 (M^+ 43), 414 (32), 386 (6), 219 (42), 111 (100), 95 (52), 92 (79), 77 (72); Anal. Calcd. for $C_{22}H_{13}ClFN_5OS$: C 58.73, H 2.91, N 15.57; Found C 58.82, H 3.02, N 15.62%.

3-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)thio]-6-phenyl-1,2,3-triazolo-[4,5-*d*]pyrimidine-7-one (5d)

White solid; yield 87%; mp: 272–274 °C; IR (KBr): $\nu = 1739$ (C=O), 1592, 1523, 1215, 719 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.03$–7.60 (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 165.2$ (C=O), 155.1, 146.5, 137.7, 137.6, 137.4, 137.1, 135.2, 134.6, 130.9, 130.2, 130.0, 129.9, 129.7, 129.6, 129.3, 129.1, 128.3, 127.7, 126.3, 120.2, 120.0; MS (EI, m/z,%): 449 (M^+ 28), 414 (12), 386 (9), 219 (47), 111 (100), 95 (58), 92 (72), 77

(65); Anal. Calcd. for $C_{22}H_{13}ClFN_5OS$: C 58.73, H 2.91, N 15.57; Found C 58.60, H 2.98, N 15.76%.

3,6-Bis(4-chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)thio]-1,2,3-triazolo[4,5-*d*]pyrimidine-7-one (5e)

White solid; yield 84%; mp: 241–243 °C; IR (KBr): $\nu = 1733$ (C=O); 1591, 1523, 1218, 742 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.22–7.77$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 166.2$ (C=O), 155.5, 146.7, 140.7, 137.7, 136.3, 136.1, 135.0, 134.8, 130.7, 130.3, 130.2, 129.9, 129.8, 129.7, 129.3, 129.1, 128.4, 127.9, 124.5, 120.1, 120.0; MS (EI, m/z,%): 485/483 (M^+ 11/32), 448 (9), 420 (3), 309 (21), 219 (32), 111 (100), 95 (62), 92 (81), 77 (45); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5OS$: C 54.56, H 2.50, N 14.46; Found C 54.41, H 2.30, N 14.57%.

3-(4-Chlorophenyl)-6-(3-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)thio]-1,2,3-triazolo[4, 5-*d*]pyrimidine-7-one (5f)

White solid; yield 83%; mp: 216–217 °C; IR (KBr): $\nu = 1742$ (C=O); 1589, 1504, 1214, 735 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.22–7.79$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 164.9$ (C=O), 155.2, 146.5, 137.9, 137.8, 137.7, 137.6, 137.2, 137.1, 135.8, 133.1, 130.6, 130.5, 130.0, 129.9, 129.8, 129.2, 129.1, 127.7, 126.0, 120.2, 120.1; MS (EI, m/z,%): 485/483 (M^+ 8/29), 448 (6), 420 (4), 309 (16), 219 (42), 111 (100), 95 (56), 92 (78), 77 (25); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5OS$: C 54.56, H 2.50, N 14.46; Found C 54.41, H 2.62, N 14.58%.

Synthesis of 3,6-Diaryl-3,6-dihydro-5-[(*p*-fluorophenyl)sulfinyl]-1,2,3-triazolo[4, 5-*d*]pyrimidin-7-ones (6): General Procedure

Compound **5** (27 mmol) and 20 mL of anhydrous acetic acid were poured into a 50 mL flask. After mixing 30% H_2O_2 (6.12 g, 54 mmol) was added dropwise to the reaction mixture. The reaction mixture was stirred at 45–50 °C for 3 h. The progress of the reaction was monitored by TLC. After stirring for another 0.5 h at room temperature 3.4 g of Na_2SO_3 in 60 mL of water was added. The solid formed was filtered and recrystallized from DMSO/ethanol to give pure compound **6** as a white crystalline solid.

3,6-Dihydro-3,6-diphenyl-5-[(*p*-fluorophenyl)sulfinyl]-1,2,3-triazolo[4,5-*d*]pyri- midine-7-one (6a)

White solid; yield 77%; mp: 283–285 °C; IR (KBr): $\nu = 1746$ (C=O); 1595, 1524, 1218, 752 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.29–7.75$ (m, 14H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 156.0$ (C=O), 155.9, 155.0, 150.5, 144.1, 140.6, 135.6, 134.5, 133.6, 133.1, 133.0, 132.6, 132.2, 130.3, 130.1, 129.7, 129.4, 128.7, 127.2, 124.4, 120.8, 116.1; MS (EI, m/z,%): 431 (M^+ 14), 403 (6), 312 (11), 235 (44), 95 (68), 92 (18), 77 (100); Anal. Calcd. for $C_{22}H_{14}FN_5O_2S$: C 61.24, H 3.27, N 16.23; Found C 61.11, H 3.32, N 16.33%.

6-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfinyl]-3-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (6b)

White solid; yield 80%; mp: >300 °C; IR (KBr): $\nu = 1745$ (C=O); 1593, 1524, 1214, 737 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.32–7.68$ (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 155.8$ (C=O), 155.0, 152.2, 150.3, 140.7, 135.9, 135.2, 134.5, 134.0, 133.5, 132.9, 131.1, 130.2, 129.7, 129.0, 128.6, 128.3, 127.4, 124.8, 124.4, 123.2, 116.4;

MS (EI, m/z,%): 465 (M^+ 9), 437 (2), 326 (22), 235 (34), 111 (100), 95 (66), 92 (78), 77 (85); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_2S$: C 56.72, H 2.81, N 15.03; Found C 56.84, H 2.94, N 15.17%.

6-(3-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfinyl]-3-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (6c)

White solid; yield 79%; mp: 263–265 °C; IR (KBr): $\nu = 1742$ (C=O); 1592, 1526, 1222, 744 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.21–7.80$ (m, 13H, arom-H); ^{13}C NMR ($CDCl_3$): $\delta = 165.5$ (C=O), 165.1, 163.0, 155.1, 146.5, 138.6, 135.8, 135.6, 132.8, 131.1, 129.5, 129.1, 128.4, 127.6, 127.4, 126.8, 123.3, 122.9, 122.8, 120.2, 117.0, 116.7; MS (EI, m/z,%): 465 (M^+ 17), 437 (7), 326 (19), 235 (43), 111 (100), 95 (36), 92 (58), 77 (80); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_2S$: C 56.72, H 2.81, N 15.03; Found C 56.79, H 2.91, N 15.08%.

3-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfinyl]-6-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (6d)

White solid; yield 70%; mp: 257–259 °C; IR (KBr): $\nu = 1742$ (C=O); 1593, 1529, 1214, 736 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.11–7.75$ (m, 13H, arom-H); MS (EI, m/z,%): 465 (M^+ 12), 437 (5), 326 (13), 235 (23), 111 (100), 95 (61), 92 (79), 77 (75); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_2S$: C 56.72, H 2.81, N 15.03; Found C 56.81, H 2.95, N 15.26%.

3,6-Bis(4-chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl) sulfinyl]-1,2,3-triazolo[4,5-*d*]pyrimidine-7-one (6e)

White solid; yield 77%; mp: 282–284 °C; IR (KBr): $\nu = 1741$ (C=O); 1591, 1526, 1216, 754 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.26–7.84$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 155.8$ (C=O), 150.5, 149.7, 141.1, 134.8, 134.4, 132.9, 132.3, 131.0, 129.7, 129.2, 129.0, 128.3, 126.8, 124.3, 123.2, 121.6, 120.2, 120.0, 117.8, 116.4, 115.8; MS (EI, m/z,%): 501/499 (M^+ 4/16), 464 (2), 436 (7), 325 (26), 235 (41), 111 (100), 95 (36), 92 (48), 77 (55); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5O_2S$: C 52.81, H 2.42, N 14.00; Found C 52.92, H 2.35, N 14.23%.

3-(4-Chlorophenyl)-6-(3-chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl) sulfinyl]- 1,2,3-triazolo[4,5-*d*]pyrimidine-7-one (6f)

White solid; yield 74%; mp: 259–261 °C; IR (KBr): $\nu = 1741$ (C=O); 1595, 1523, 1226, 751 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.33–7.81$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 156.0$ (C=O), 154.8, 150.6, 145.9, 134.8, 134.1, 133.1, 132.7, 132.5, 130.7, 130.4, 130.0, 129.7, 129.3, 129.0, 128.8, 128.3, 127.7, 124.8, 124.4, 121.6, 120.0; MS (EI, m/z,%): 501/499 (M^+ 5/9), 464 (6), 436 (3), 325 (12), 235 (27), 111 (100), 95 (42), 92 (58), 77 (72); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5O_2S$: C 52.81, H 2.42, N 14.00; Found C 52.93, H 2.49, N 14.15%.

Synthesis of 3,6-diaryl-3,6-dihydro-5-[(*p*-fluorophenyl)sulfonyl]-1,2,3-triazolo [4,5-*d*]pyrimidin-7-ones (7): General Procedure

Compound **5** (27 mmol) and 20 mL of anhydrous acetic acid were poured into a 50 mL flask. The catalyst, solid Na_2WO_4 (0.27 g, 0.8 mmol), was added at room temperature. After mixing 30% H_2O_2 (6.12 g, 54 mmol) was added dropwise to the reaction mixture.

The reaction mixture was stirred at 45–50 °C for 5 h, the progress of the reaction was monitored by TLC. After stirring for another 0.5 h at room temperature 3.4g of Na_2SO_3 dissolved in 60 mL of water was added. The solid formed was filtered and recrystallized from DMSO/ethanol to give pure compound **7** as a white crystalline solid.

3,6-Dihydro-3,6-diphenyl-5-[(*p*-fluorophenyl)sulfonyl]-1,2,3-triazolo[4,5-*d*]pyri-midine-7-one (7a)

White solid; yield 83%; mp: 275–276 °C; IR (KBr): $\nu = 1742$ (C=O); 1594, 1526, 1327, 737 cm^{-1}; ^1H NMR (d^6-DMSO, 400 MHz): $\delta = 7.28–8.15$ (m, 14H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 165.4$ (C=O), 165.1, 162.8, 155.1, 146.5, 138.6, 138.4, 135.8, 135.6, 131.1, 131.0, 129.6, 129.4, 129.2, 127.6, 126.8, 122.8, 120.2, 120.1, 116.6, 116.2, 115.8; MS (EI, m/z,%): 447 (M^+ 13), 419 (7), 370 (12), 342 (37), 250 (34), 95 (100), 92 (78), 77 (52); Anal. Calcd. for $C_{22}H_{14}FN_5O_3S$: C 59.05, H 3.15, N 15.65; Found C 59.21, H 3.26, N 15.72%.

6-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfonyl]-3-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (7b)

White solid; yield 85%; mp: 271–272 °C; IR (KBr): $\nu = 1747$ (C=O); 1566, 1525, 1334, 739 cm^{-1}; ^1H NMR (d^6-DMSO, 400 MHz): $\delta = 7.27–7.76$ (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 156.8$ (C=O), 155.2, 152.4, 150.1, 143.9, 135.8, 135.4, 134.8, 134.6, 133.7, 133.0, 131.7, 131.4, 130.7, 129.8, 129.6, 129.3, 127.0, 124.7, 124.3, 122.0, 118.2; MS (EI, m/z,%): 481 (M^+ 18), 446 (9), 418 (5), 342 (27), 250 (64), 111 (100), 95 (68), 92 (51), 77 (75); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_3S$: C 54.83, H 2.72, N 14.53; Found C 54.90, H 2.88, N 14.66%.

6-(3-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfonyl]-3-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (7c)

White solid; yield 82%; mp: 266–267 °C; IR (KBr): $\nu = 1741$ (C=O); 1593, 1524, 1335, 754 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.13–8.17$ (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 155.9$ (C=O), 155.0, 150.4, 146.4, 140.5, 138.5, 138.3, 135.5, 133.5, 130.4, 129.9, 129.6, 129.3, 129.0, 128.9, 128.2, 124.7, 124.3, 122.0, 120.3, 116.7, 116.4; MS (EI, m/z,%): 481 (M^+ 15), 446 (8), 418 (9), 342 (32), 250 (59), 111 (100), 95 (72), 92 (54), 77 (75); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_3S$: C 54.83, H 2.72, N 14.53; Found C 54.90, H 2.89, N 14.70%.

3-(4-Chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfonyl]-6-phenyl-1,2,3-tri- azolo[4,5-*d*]pyrimidine-7-one (7d)

White solid; yield 75%; mp: 264–265 °C; IR (KBr): $\nu = 1742$ (C=O); 1592, 1524, 1337, 724 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.26–7.78$ (m, 13H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 156.0$ (C=O), 154.7, 149.7, 140.6, 135.5, 134.9, 133.7, 129.7, 129.1, 129.0, 128.9, 128.6, 128.4, 128.1, 126.6, 123.6, 121.9, 120.5, 120.3, 117.6, 116.6, 115.9; MS (EI, m/z,%): 481 (M^+ 28), 446 (3), 418 (6), 342 (37), 250 (54), 111 (100), 95 (78), 92 (58), 77 (45); Anal. Calcd. for $C_{22}H_{13}ClFN_5O_3S$: C 54.83, H 2.72, N 14.53; Found C 54.91, H 2.84, N 14.60%.

3,6-Bis(4-chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl)sulfonyl]-1,2,3-triazolo- [4,5-*d*]pyrimidine-7-one (7e)

White solid; yield 79%; mp: 273–275 °C; IR (KBr): $\nu = 1739$ (C=O); 1595, 1526, 1334, 734 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.29–7.80$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 155.9$ (C=O), 154.2, 151.0, 149.1, 142.3, 140.5, 135.0, 134.6, 134.3, 132.8, 131.0, 130.7, 129.7, 129.2, 129.0, 128.8, 128.3, 126.4, 124.3, 123.2, 117.6, 116.4; MS (EI, m/z,%): 517/515 (M^+ 3/12), 480 (6), 404 (3), 376 (17), 250 (34), 111 (100), 95 (48), 92 (54), 77 (61); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5O_3S$: C 51.18, H 2.34, N 13.56; Found C 51.32, H 2.43, N 13.66%.

3-(4-Chlorophenyl)-6-(3-chlorophenyl)-3,6-dihydro-5-[(*p*-fluorophenyl) sulfonyl]-1,2,3-triazolo[4,5-*d*]pyrimidine-7-one (7f)

White solid; yield 75%; mp: 257–259 °C; IR (KBr): $\nu = 1743$ (C=O); 1591, 1523, 1327, 762 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz): $\delta = 7.11–8.26$ (m, 12H, arom-H); ^{13}C NMR (d^6-DMSO): $\delta = 156.5$ (C=O), 155.1, 151.5, 150.0, 142.5, 141.1, 135.4, 135.1, 134.8, 134.1, 133.3, 133.1, 131.6, 131.4, 130.2, 129.7, 129.5, 129.5, 128.8, 126.9, 124.8, 124.0; MS (EI, m/z,%): 517/515 (M^+ 11/23), 480 (4), 404 (7), 376 (27), 250 (39), 111 (100), 95 (78), 92 (45), 77 (52); Anal. Calcd. for $C_{22}H_{12}Cl_2FN_5O_3S$: C 51.18, H 2.34, N 13.56; Found C 51.27, H 2.44, N 13.62%.

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