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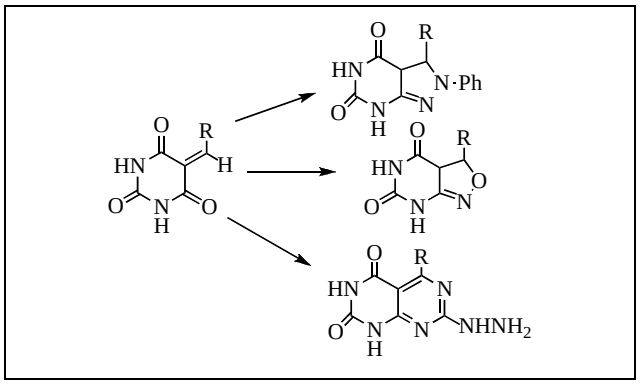

The synthesis of nitrogen containing heterocycles from arylidene barbituric acid and various ammonia derivatives such as phenylhydrazine hydrochloride, hydroxylamine hydrochloride and aminoguanidine hydrochloride *via* a simple and efficient cyclocondensation in an alkaline aqueous medium is described. This improved greener synthetic methodology provides a convenient direct approach using water as a green solvent and potassium carbonate (K_2CO_3) as a green base for the synthesis of pyrazolopyrimidines, isoxazolopyrimidines and pyrimidopyrimidines in excellent yields.

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INTRODUCTION

At the beginning of the new century, green chemistry has become a major driving force for organic chemists to develop environmentally benign routes to a myriad of materials [1]. One of the thrust areas to achieve the target of reducing dependence on ecologically unsafe chemicals is to explore alternate reaction media and energy sources for the accomplishment of the desired chemical transformations with minimum byproducts and waste generations [2]. The use of alternative energy sources and reaction media such as MW (microwave), PEG (polyethylene glycol), ionic liquids *etc*. are gaining interest currently [3]. Organic reactions in water as the reaction media have also attracted considerable attention recently as the aqueous mediated reactions are ecofriendly, devoid of carcinogenicity, simple to handle and comparatively inexpensive with easier manipulation for industrial use [4].

Since the last decade, there has been a revolution in organic transformations using MW which can be attributed to enhanced reaction rates, greater chemo-selectivities and product yields [5]. Among heterocycles, fused pyrimidine derivatives such as pyrazolopyrimidines, isoxazolopyrimidines and pyrimidopyrimidines have generated a widespread interest owing to the vast range of biological activities [6] that these compounds possess. They have been used as preventative and prophylactic drugs in the treatment of male erectile dysfunction [7]. Literature methods [8] for the synthesis of fused pyrimidines generally involve either cyclization of substituted pyrimidines or condensation of specific moieties with pyrimidine [9]. Hirota *et al* [10] used azide derivatives of dimethyluracils for synthesis. These methods have many disadvantages such as multi-step sequences, tedious work ups, complex catalyst loading and long reaction times. Dry media syntheses [11] under MWs have been carried out for the synthesis of pyrimidine derivatives and require an appreciable amount of solvent for adsorption of reactants and elution of products. So, water [12] may serve as an alternate media eliminating the use of volatile and toxic organic solvents. In the context of MW reactions, water has a high dielectric constant and a permanent dipole moment, which allows the coupling between the oscillating electric field and the molecular tumbling resulting in highly efficient heating. Therefore at elevated temperatures, water acts as a pseudo-organic solvent. Isolation of products is also facilitated by the use of water due to the decreased solubility of organic materials.

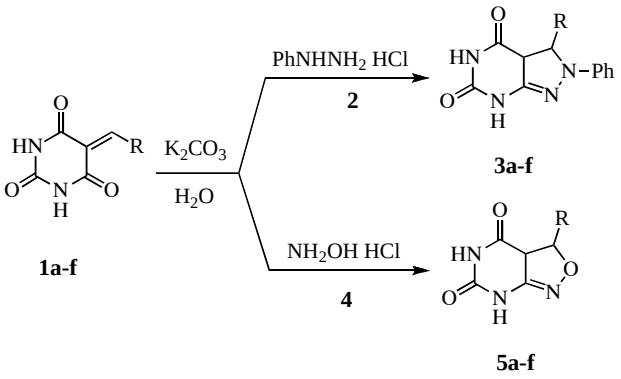
Thus keeping in mind, the green methodology for the synthesis of bioactive moieties such as pyrazolo-pyrimidines, isoxazolopyrimidines and pyrimidopyrim-idines, we report herein an environmentally benign route for the synthesis of fused pyrimidine derivatives in aqueous media.

RESULTS AND DISCUSSION

We have demonstrated that arylidene barbituric acids were used as suitable substrates for pyrazolopyrimidines, isoxazolopyrimidines and pyrimidopyrimidines using water as a solvent.

To carry out the experiment with clean, efficient, economical and green methodology, the reaction was performed in water using potassium carbonate (K_2CO_3) as a base. The chalcones of barbituric acid **(1a-f)** were mixed with phenylhydrazine hydrochloride **(2)** or hydroxylamine hydrochloride **(4)** in an aqueous solution of K_2CO_3 with constant stirring (Scheme 1). Both the salts and arylidene barbituric acids were soluble and later resulted in the formation of 3-aryl-2-phenyl-3,3a-dihydro-2*H*-pyrazolo-[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-diones **(3a-f)** and 3-aryl-3,3a-dihydroisoxazolo[3,4-*d*]-pyrimidine-4,6(5*H*,7*H*)-diones **(5a-f)** respectively in sufficient yield after cooling.

Scheme 1



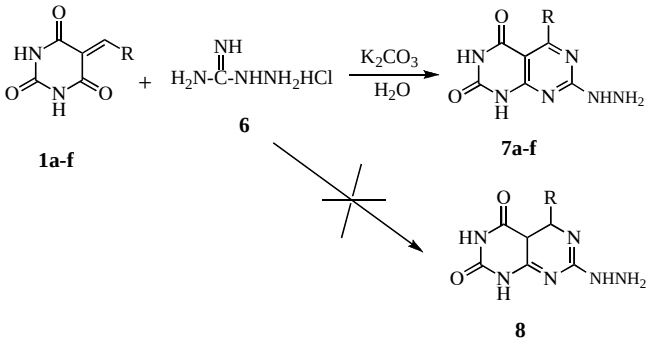
Water is well known for its polarity and therefore the above-mentioned substrates, which were reacted using conventional methodology, were explored using MW assisted conditions. The reaction proceeded efficiently under MW conditions with a reduction in time (Table 1) compared to the conventional method and an increased yield.

The structures of the products **(3a-f)**, which are pyrazolo[3,4-*d*]pyrimidinone derivatives, were assigned on the basis of their elemental and spectral analysis. The diagnostic signal for the α,β-unsaturated carbonyl group in the arylidene barbituric acids **(1a-f)** at 1675 cm^{-1} in the IR spectra was found to be absent in the final products while the appearance of a band at 1595 cm^{-1} due to C=N showed the condensation of carbonyl group to NH_2 group of phenylhydrazine. In addition, proton NMR spectra of the products showed the absence of a singlet at 8.3 ppm due to the vinylic proton of arylidene barbituric acid and the appearance of two signals at 3.2 ppm and 4.8 ppm due to C_{3a}-H and C_3-H respectively, thus confirming the final products.

Similarly the structures of the isoxazolopyrimidine derivatives **(5a-f)** were assigned on the basis of their elemental and spectral analysis. The proton NMR spectra of these compounds showed two signals at 3.2 ppm and 4.8 ppm due to C_{3a}-H and C_3-H respectively with the disappearance of a singlet at 8.3 ppm due to the vinylic protons of arylidene barbituric acid confirmed the products.

A detailed study of the protocol (Scheme 1) revealed that a variety of aromatic and heteroaromatic aldehydes as well as different salts were tolerated by the reaction conditions of a mild base in aqueous media. To investigate the synthetic scope of Michael condensation reactions further, we then reacted various arylidene barbituric acids **(1a-f)** with aminoguanidine hydrochloride, **(6)** in refluxing water (Scheme 2).

Scheme 2



We isolated the corresponding 5-aryl-7-hydrazino-pyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-diones **(7a-f)** thereby introducing the amidine moiety in the ring system and extended the range of new compounds which are of particular biological and pharmacological interest. We were surprised that compound **8** was not the product indicating that the mechanism is different than the mechanism that occurs in (Scheme 1). Elemental analysis, analytical and the proton NMR data also characterized the structures of **(7a-f)**, as aromatic compounds which may be attributed to the increased stability and aromaticity. In the proton NMR spectra, the absence of peaks due to C_5-H and C_{4a}-H confirms **(7a-f)** as the products.

In brief, a practical, convenient and ecofriendly synthesis of pyrazolopyrimidine, isoxazolopyrimidines and pyrimidopyrimidines has been developed in an aqueous media using a mild base which completely circumvents the use of hazardous organic solvents and caustic organic bases. In addition, the results delineated above have demonstrated that microwave-assisted aqueous reactions can replace the classical methods allowing minimum reaction time providing rapid access to large libraries of diverse biologically active molecules and eliminating many side reactions.

Table 1

Comparison of reaction time and yields for compounds **3a-f, 5a-f, 7a-f**.

Comp. No.	R	METHOD A[a]		METHOD B[b]	
		Time (hrs)	Yield[c] (%)	Time (min.)	Yield[c] (%)
3a	Phenyl	1.5	82	2	88
3b	4-Methoxy phenyl	2.0	70	2	90
3c	Piperonyl	1.0	83	2.5	92
3d	2-Cl-3-quinolinyl	1.5	80	2.8	88
3e	4-Cl-phenyl	2.5	76	3.0	87
3f	2-Thienyl	2.0	82	2.5	83
5a	Phenyl	2.0	80	3.5	89
5b	4-Methoxy phenyl	2.5	70	2.5	89
5c	Piperonyl	1.5	85	4.0	92
5d	2-Cl-3-quinolinyl	3.0	80	5.5	80
5e	4-Cl-phenyl	3.5	76	4.0	82
5f	2-Thienyl	2.5	80	3.5	90
7a	Phenyl	3.5	87	2.5	90
7b	4-Methoxy phenyl	2.5	77	1.5	85
7c	Piperonyl	1.0	84	2.0	82
7d	2-Cl-3-quinolinyl	2.5	72	2.5	85
7e	4-Cl-phenyl	2.0	90	2.5	88
7f	2-Thienyl	2.5	79	2.0	82

[a] Conventional procedure. [b] Microwave-assisted procedure. [c] isolated yields.

EXPERIMENTAL

Melting points were taken on a Thomas Hoover melting point apparatus and are uncorrected. IR (Nujol) was recorded on a model Perkin-Elmer FTIR-1710 spectrophotometer. Proton NMR was recorded on a Bruker Avance Spectrospin 300 (300 MHz) using TMS as internal standard in deuteriochloroform and deuterated methanol. Elemental analysis was performed on a Heraeus CHN Rapid Analyser. The purity of compounds was checked on silica gel coated aluminium plates (Merck). A Kenstar microwave oven, Model No. OM9925E at (2450 MHz, 800W) was used for MWI (microwave irradiation).

General procedure for the synthesis of arylidene barbituric acid derivatives 1a-f. To the stirred solution of barbituric acid (0.01 mmol) in water (10 mL), aromatic and heteroaromatic aldehydes (0.01 mmol) were added rapidly. After 5 min., the solid produced was isolated by simple filtration, washed with water and dried. The spectral and analytical data of these compounds **1a-f** were found in close agreement with the earlier reported literature compounds [13].

General procedure for the synthesis of pyrimidine derivatives 3a-f, 5a-f, 7a-f.

Method A (Conventional). To the mixture of arylidene barbituric acid **1a-f** (0.01 mmol) and phenylhydrazine hydrochloride **2** (0.015 mmol) or hydroxylamine hydrochloride **4** (0.015 mmol) or aminoguanidine hydrochloride **6** (0.015 mmol) and potassium carbonate (0.1 mmol), 10 mL of water was added. The reaction mixture was refluxed for 1-3.5 h (Table 1) with constant stirring. The solid obtained was collected by filtration and washed with water. The isolated yields are shown in Table 1.

Method B (Microwave). In an Erlenmeyer flask, equimolar amounts of reactants, arylidene barbituric acid **1a-f** (0.01 mmol) and phenylhydrazine hydrochloride **2** (0.015 mmol) or hydroxylamine hydrochloride **4** (0.015 mmol) or aminoguanidine hydrochloride **6** (0.012 mmol) and K_2CO_3, with 2-3 mL of water were mixed. The reaction mixture was subjected to MWI for the specified time (Table 1) at low power (560 W). Reaction progress was monitored by TLC at an interval of every 30 sec. Upon completion, the reaction mixture was cooled, the solid collected by filtration, washed with cold water and dried.

2,3-Diphenyl-3,3a-dihydro-2*H*-pyrazolo[3,4-*d*] pyrimidine-4,6(5*H*,7*H*)-dione (3a). mp 94-96°; ir: 3315, 3213, 1730, 1672, 1597 cm^{-1}; ^1H nmr: δ 3.2 (d, *J* = 3.3 Hz, 1H, C_{3a}-H), 4.76 (d, *J* = 3.3 Hz, 1H, C_3-H), 7.32-7.59 (m, 10H, Ar-H), 10.32 (s, 1H, NH), 11.28 (s, 1H, NH). *Anal*. Calcd. for $C_{17}H_{14}N_4O_2$: C, 66.66; H, 4.57; N, 18.30; Found: C, 66.58; H, 4.62; N, 18.21.

3-(4-Methoxyphenyl)-2-phenyl-3,3a-dihydro-2*H*-pyrazolo-[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (3b). mp 86-88°; ir: 3308, 3201, 1731, 1676, 1595 cm^{-1}; ^1H nmr: δ 3.2 (d, *J* = 3.3 Hz, 1H, C_{3a}-H), 3.83 (s, 3H, OCH_3), 4.79 (d, *J* = 3.3 Hz, 1H, C_3-H), 7.26-7.37 (m, 9H, Ar-H), 10.29 (s, 1H, NH), 11.31 (s, 1H, NH). *Anal*. Calcd. for $C_{18}H_{16}N_4O_3$: C, 64.28; H, 4.76; N, 18.30; Found: C, 66.58; H,4.62; N, 18.21.

3-(1,3-Benzodioxol-5-yl)-2-phenyl-3,3a-dihydro-2*H*-pyrazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (3c). mp 118-120°; ir: 3312, 3215, 1730, 1672, 1599 cm^{-1}; ^1H nmr: δ 3.22 (d, *J* = 3.1 Hz, 1H, C_{3a}-H), 4.77 (d, *J* = 3.1 Hz, 1H, C_3-H), 5.89 (s, 2H, OCH_2O), 6.71 (d, *J* = 7.9 Hz, 1H, Ar-H), 6.87 (d, *J* = 7.9 Hz, 1H, Ar-H), 7.04 (s, 1H, Ar-H), 7.29-7.35 (m, 5H, Ar-H), 10.28 (s, 1H, NH), 11.30 (s, 1H, NH). *Anal*. Calcd. for $C_{20}H_{14}N_5O_2Cl$: C, 61.71; H, 4.00; N, 16.00; Found: C, 61.59; H, 4.12; N, 15.91.

3-(2-Chloroquinolinyl)-2-phenyl-3,3a-dihydro-2*H*-pyrazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (3d). mp 220-224°; ir: 3315, 3208, 1726, 1668, 1595 cm^{-1}; ^1H nmr: δ 3.21 (d, *J* = 3.3 Hz, 1H, C_{3a}-H), 4.78 (d, *J* = 3.3 Hz, 1H, C_3-H), 7.43-7.75 (m, 10H, Ar-H), 10.29 (s, 1H, NH), 11.33 (s, 1H, NH). *Anal*. Calcd. for $C_{20}H_{14}N_5O_2Cl$: C, 61.30; H, 3.57; N, 17.87; Found: C, 61.21; H, 3.63; N, 17.89.

3-(4-Chlorophenyl)-2-phenyl-3,3a-dihydro-2*H*-pyrazolo-[3,4-*d*]pyrimidine-4,6-(5*H*,7*H*)-dione (3e). mp 182-184°; ir: 3213, 1730, 1672, 1597 cm^{-1}; ^1H nmr: δ 3.18 (d, *J* = 3.2 Hz, 1H, C_{3a}-H), 4.80 (d, *J* = 3.2 Hz, 1H, C_3-H), 7.47-7.60 (m, 9H, Ar-H), 10.31 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_{17}H_{13}N_4O_2Cl$: C, 59.91; H, 3.81; N, 16.44; Found: C, 59.87; H, 3.86; N, 16.35.

3-(2-Thienyl)-2-phenyl-3,3a-dihydro-2*H*-pyrazolo[3,4-*d*]-pyrimidine-4,6(5*H*,7*H*)-dione (3f). mp 194°(d); ir: 3306, 3210, 1733, 1666, 1597 cm^{-1}; ^1H nmr: δ 3.21 (d, *J* = 3.1 Hz, 1H, C_{3a}-H), 4.79 (d, *J* = 3.1 Hz, 1H, C_3-H), 7.48-7.53 (m, 6H, Ar-H + thienyl), 8.11 (d, *J* = 3.0 Hz, 1H, thienyl-H), 8.36 (d, *J* = 4.6 Hz, 1H, thienyl-H) 10.31 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_{15}H_{12}N_4O_2S$: C, 57.69; H, 3.84; N, 17.94; Found: C, 57.77; H, 3.81; N, 17.86.

3-Phenyl-3,3a-dihydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5a). mp 112-114°; ir: 3410, 3394, 3230, 1698, 1599, 1260 cm^{-1}; ^1H nmr: δ 3.21 (d, *J* = 3.2 Hz, 1H, C_{3a}-H), 4.79 (d, *J* = 3.2 Hz, 1H, C_3-H), 7.24-7.26 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.63-7.66 (m, 3H, Ar-H), 10.29 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_{11}H_9N_3O_3$: C, 57.14; H, 3.89; N, 18.18; Found: C, 57.22; H, 3.92; N, 18.10.

3-(4-Methoxyphenyl)-3,3a-dihydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5b). mp 98-100°; ir: 3416, 3390, 3216, 1698, 1595, 1264 cm^{-1}; ^1H nmr: δ 3.19 (d, *J* = 3.2 Hz, 1H, C_{3a}-H), 3.81 (s, 3H, OCH_3), 4.80 (d, *J* = 3.2 Hz, 1H, C_3-H), 7.24-7.37 (m, 4H, Ar-H), 10.29 (s, 1H, NH), 11.31 (s, 1H, NH). *Anal*. Calcd. for $C_{12}H_{11}N_3O_4$: C, 55.17; H, 4.21; N, 16.09; Found: C, 55.24; H, 4.16; N, 16.01.

3-(1,3-Benzodioxol-5-yl)-3,3a-hydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5c). mp 88-90°; ir: 3420, 3390, 3223, 1700, 1605, 1258 cm^{-1}; ^1H nmr: δ 3.18 (d, *J* = 3.1 Hz, 1H, C_{3a}-H), 4.79 (d, *J* = 3.1 Hz, 1H, C_3-H), 5.8 (s, 2H, OCH_2O), 6.70 (d, 1H, *J* = 8.0, Ar-H), 6.87 (d, 1H, *J* = 8.0, Ar-H), 7.02 (s, 1H, Ar-H), 10.28 (s, 1H, NH), 11.31 (s, 1H, NH). *Anal*. Calcd. for $C_{12}H_9N_3O_5$: C, 52.36; H, 3.27; N 15.27; Found: C, 52.28; H, 3.23; N, 15.35.

3-(2-Chloroquinolinyl)-3,3a-dihydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5d). mp 166-168°; ir: 3420, 3391, 3220, 1699, 1595, 1258 cm^{-1}; ^1H nmr: δ 3.21 (d, *J* = 3.2 Hz, 1H, C_{3a}-H), 4.80 (d, *J* = 3.2 Hz, 1H, C_3-H), 7.68-7.74 (m, 5H, Ar-H), 10.27 (s, 1H, NH), 11.29 (s, 1H, NH). *Anal*. Calcd. for $C_{14}H_9N_4O_3Cl$: C, 53.08; H, 2.84; N, 17.69; Found: C, 53.14; H, 2.76; N, 17.54.

3-(4-Chlorophenyl)-3,3a-dihydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5e). mp 104-106°; ir: 3418, 3394, 3223, 1699, 1598, 1260 cm^{-1}; ^1H nmr: δ 3.20 (d, *J* = 3.3 Hz, 1H, C_{3a}-H), 4.81 (d, *J* = 3.3 Hz, 1H, C_3-H), 7.45 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.56 (d, *J* = 8.0 Hz, 2H, Ar-H), 10.31 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_{11}H_8N_3O_3Cl$: C, 49.71; H, 3.01; N, 15.81; Found: C, 49.66; H, 3.08; N, 15.89.

3-(2-Thienyl)-3,3a-dihydroisoxazolo[3,4-*d*]pyrimidine-4,6(5*H*,7*H*)-dione (5f). mp >300°; ir: 3402, 3390, 3220, 1698, 1600, 1262 cm^{-1}; ^1H nmr: δ 3.1 (d, *J* = 3.2 Hz, 1H, C_{3a}-H), 4.83 (d, *J* = 3.2 Hz, 1H, C_3-H), 7.48 (t, 1H, thienyl), 8.12 (d, *J* = 3.0 Hz, 1H, thienyl), 8.40 (d, *J* = 4.5 Hz, 1H, thienyl), 10.31 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_9H_7N_3O_3S$: C, 45.56; H, 2.95; N, 17.72; Found: C, 45.64; H, 2.91; N, 17.76.

7-Hydrazino-5-phenylpyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7a). mp160-162°; ir: 3462, 3391, 3223, 1732, 1669, 1598 cm^{-1}; ^1H nmr: δ 7.27 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.63-7.66 (t, 3H, Ar-H), 7.98 (s, 1H, NH), 10.31 (s, 1H, NH), 11.28 (s, 1H, NH). *Anal*. Calcd. for $C_{12}H_{10}N_6O_2$: C, 44.44; H, 3.70; N, 31.11; Found: C, 44.37; H, 3.62; N, 31.19.

7-Hydrazino-5-(4-methoxyphenyl)pyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7b). mp 154-156°; ir: 3460, 3384, 3223, 1738, 1699, 1595 cm^{-1}; ^1H nmr: δ 3.8 (s, 3H, OCH_3), 7.24-7.36 (m, 4H, Ar-H), 7.96 (s, 1H, NH), 10.29 (s, 1H, NH), 11.28 (s, 1H, NH). *Anal*. Calcd. for $C_{13}H_{12}N_6O_3$: C, 52.00; H, 4.00; N, 28.00; Found: C, 51.94; H, 4.06; N, 28.13.

5-(1,3-Benzodioxol-5yl)-7-hydrazinopyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7c). mp 180-182°; ir: 3452, 3394, 3220, 1740, 1701, 1599 cm^{-1}; ^1H nmr: δ 5.86 (s, 2H, OCH_2O), 6.68 (d, 1H, *J* = 8.0, Ar-H), 6.86 (d, 1H, *J* = 8.0, Ar-H), 7.04 (s, 1H, Ar-H), 7.87 (s, 1H, NH), 10.30 (s, 1H, NH), 11.31 (s, 1H, NH). *Anal*. Calcd. for $C_{13}H_{10}N_6O_4$: C, 49.68; H, 3.18; N, 26.75; Found: C, 49.52; H, 3.21; N, 26.78.

5-(2-Chloroquinolinyl)-7-hydrazinopyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7d). mp 176-178°; ir: 3459, 3391, 3228, 1727, 1698, 1595 cm^{-1}; ^1H nmr: δ 7.76-7.82 (m, 5H, Ar-H), 7.89 (s, 1H, NH), 10.28 (s, 1H, NH), 11.30 (s, 1H, NH). *Anal*. Calcd. for $C_{15}H_{10}N_7O_2Cl$: C, 50.63; H, 2.81; N, 27.56; Found: C, 50.56; H, 2.79; N, 27.60.

5-(4-Chlorophenyl)-7-hydrazinopyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7e). mp 180-182°; ir: 3462, 3390, 3212, 1730, 1682, 1598 cm^{-1}; ^1H nmr: δ 7.47 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.59-7.61 (d, *J* = 8.0 Hz, 2H, Ar-H), 7.96 (s, 1H, NH), 10.31 (s, 1H, NH), 11.28 (s, 1H, NH). *Anal*. Calcd. for $C_{12}H_9N_6O_2Cl$: C, 47.29; H, 2.95; N, 27.58; Found: C, 47.33; H, 2.98; N, 27.51.

7-Hydrazino-5-(2-thienyl)pyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione (7f). mp 224-226°; ir: 3460, 3384, 3218, 1738, 1699, 1590 cm^{-1}; ^1H nmr: δ 7.47-7.49 (t, 1H, thienyl), 7.92 (s, 1H, NH), 8.01 (d, *J* = 3.0 Hz, 1H, thienyl), 8.36 (d, *J* = 4.8 Hz, 1H, thienyl) 10.31 (s, 1H, NH), 11.27 (s, 1H, NH). *Anal*. Calcd. for $C_{10}H_8N_6O_2S$: C, 43.47; H, 2.89; N, 30.43; Found: C, 43.39; H, 2.82; N, 30.45.

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