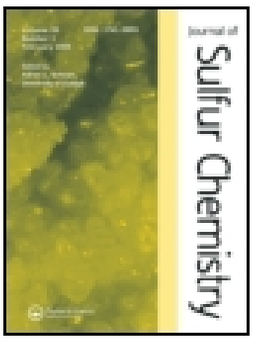

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Highly regioselective, base-catalyzed, biginelli-type reaction of aldehyde, phenylacetone and urea/thiourea kinetic vs. thermodynamic control

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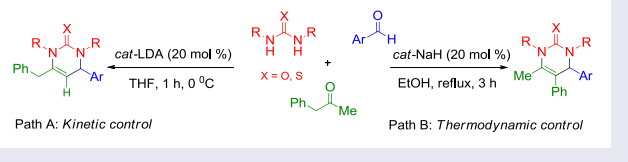
ABSTRACT

An efficient one-pot regioselective synthesis of various novel 3,4-dihydropyrimidin-2(1*H*)-one (DHPMs) via a three-component Biginelli-type condensation of aldehyde, phenylacetone and urea/thiourea under two different based-catalyzed conditions is described. In kinetic control path, lithium *N*, *N*-diisopropylamide (LDA-20 mol % generated *in situ* from *n*-BuLi and diisopropylamine) was used as the base, in tetrahydroforane (THF) as the solvent at 0°C. Thermodynamic control path was run with NaH as the base, in EtOH as the solvent under reflux status. The simple procedure, mild base-catalytic reaction conditions, no column chromatography and good to high yields are important features of this protocol.



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3,4-Dihydropyrimidin-2(1*H*)-one; lithium *N*,*N*-diisopropylamide; biginelli- type; phenylacetone; urea/thiourea; kinetic-thermodynamic

1. Introduction

Biginelli reaction is an acid(base)-catalyzed one-pot synthesis of 3,4-dihydropyrimidin-2(1*H*)-ones (DHPMs) using multicomponent condensation of easily-accessible starting materials, including (thio)urea, active methylene compound and aldehyde [1–5]. DHPMs are an interesting pharmacophore in the medicinal chemistry and fascinating target for combinatorial chemistry of biologically active heterocycles with novel properties in the past two decades [6–8]. Also, DHPM was applied as a key core in the synthesis of wide variety pharmaceutical compounds, significant biomolecules, diverse natural products and interesting alkaloids with special properties [9] and functional materials such as adhesive [10], polymers and fabric dyes [11]. Furthermore, some of the DHPMs show many attractive properties such as antiviral, antibacterial, antitumour, antimalarial, anti-inflammatory,

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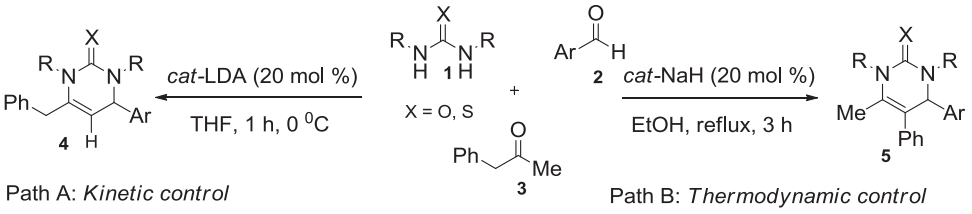


Scheme 1. Regioselective synthesis of novel 3,4-dihydropyrimidin-2(1*H*)-one (DHPMs) under two different conditions: kinetic and thermodynamic control.

antidiabetic, antitubercular, antileishmanial, anti-epileptic, antiproliferative activities, etc. [12–16]. A number of polysubstituted DHPMs have been found to be antihypertensive agents, potent calcium channel blockers [17], A_{2B} receptor antagonists [18] and mPGES-1 inhibitors [19]. Presently, the Biginelli reaction is exploited in solid-phase synthesis for heterocyclic compound [20] and asymmetric synthesis for bioactive chiral DHPMs [21]. Despite extensive studies on the Biginelli-type reactions, achieving to new approaches in synthesis of DHPMs with various substitutions in mild reaction conditions is a great deal of attention. The standard protocol for the Biginelli reaction generally involves the use of a Lewis or protic acid [22–25] and few methods are available under basic conditions. In addition, most reported Biginelli-type protocl led to formation of thermodynamic compunds.

Herein, we report a novel simple and efficient protocol for regioselective synthesis of various novel 3,4-dihydropyrimidin-2(1*H*)-one (DHPMs) via a three-component condensation of aldehyde, phenylacetone and urea/thiourea with good to high yields under two different conditions (Scheme 1). In the kinetic control reaction (Path A), the base LDA (*in situ* generated from *n*-BuLi and diisopropylamine) in tetrahydroforane (THF) at 0°C was used while the thermodynamic control pathway (Path B) [3,26–28] was run with NaH as the base in EtOH under the terms of reflux.

2. Results and discussion

At first, urea **1a**, benzaldehyde **2a** and phenylacetone **3** were selected as a model reaction and then the reaction was optimized under two different conditions separately. In Path A (kinetic control reaction), changing the solvent and amount of catalyst are checked out. It is proved that THF is the most optimal solvent compared to MeOH, EtOH, CH_2Cl_2, MeCN, DMF and acetone. Finally, the reaction was optimized by 20 mol% of LDA as the base-catalyst, 1.5 mmol of urea, 1.2 mmol of benzaldehyde and 1.5 mmol of phenylacetone in THF at 0°C (Table 1).

Using the optimized conditions described above, various 6-benzyl-4-phenyl-3,4-dihydropyrimidin-2(1*H*)-one were synthesized from urea, phenylacetone and benzaldehyde with various electron-withdrawing or electron-donating substituents on the aromatic rings (Table 2).

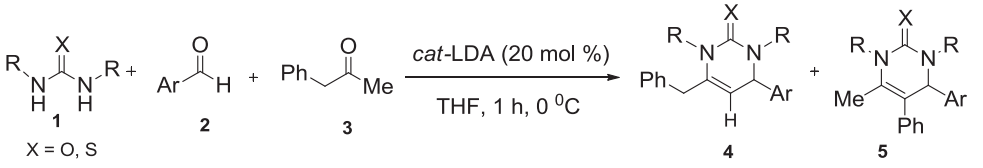
Structures of compounds **4a-m** were assigned by ^{1}H NMR, ^{13}C NMR, IR and mass spectral data (http://dx.doi.org/10.1080/17415993.2017.1402332). The ^{1}H NMR spectrum of **4a** exhibited two singlet for two NH group (δ = 6.04 and 8.61 ppm), three doublet in

Table 1. Formation of product **4a** under different reactions conditions.

Entry	Solvent[a]	Time/h	Yield **4a** (%)
1	MeOH	6	32
2	EtOH	6	38
3	CH_2Cl_2	5	33
4[b]	**THF**	**1**	**81**
5	MeCN	4	52
6	DMF	5	59
7	Acetone	6	49

[a]Reactions were performed using **1a** (1.5 mmol), **2a** (1.2 mmol), **3** (1.5 mmol) and LDA as the base-catalyst (20 mol %) under different solvent (2 mL) at 0°C.
[b]10 mol% LDA as the base-catalyst, reaction time was 5 h.

Table 2. Synthesis of 3,4-dihydropyrimidin-2(1*H*)-one derivatives under kinetic control condition (Path A).

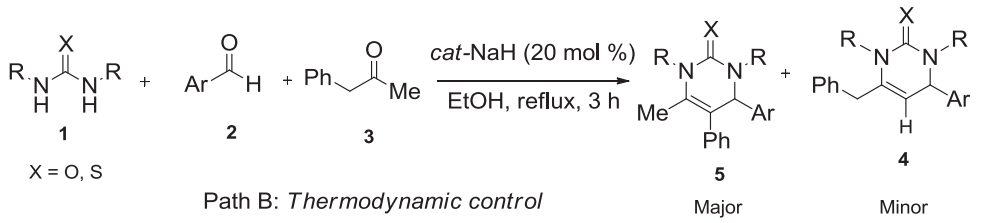


Path A: *Kinetic control*

Entry	1–4	X	R	Ar	Yield of **4** (%)
1	**a**	O	H	Ph	81
2	**b**	O	H	4-Cl-C_6H_4	83
3	**c**	O	H	2-Cl-C_6H_4	79
4	**d**	O	H	2-OH-C_6H_4	73
5	**e**	O	H	4-OMe-C_6H_4	77
6	**f**	O	H	4-NO_2-C_6H_4	88
7	**g**	S	H	Ph	85
8	**h**	S	H	4-Cl-C_6H_4	87
9	**i**	S	H	4-OMe-C_6H_4	79
10	**j**	S	H	4-NO_2-C_6H_4	91
11	**k**	S	Et	4-Br-C_6H_4	78
12	**l**	S	Me	4-Cl-C_6H_4	79
13	**m**	S	Me	4-NO_2-C_6H_4	83

aliphatic range for CH_2 benzyli group ($\delta = 3.62$ ppm, $J = 6.3$ Hz) protons and two CH group ($\delta = 5.26$ and 5.67 ppm, $J = 4.8$ Hz) protons together with multiplication characteristic aromatic protons. The ^{13}C NMR spectrum of **4a** exhibits 13 signals in agreement with the proposed structure. The mass spectrum of **4a** defined the molecular ion peak at $m/z = 264$. The NMR spectra of compounds **4b-m** are like that of **4a**, except for the substituents, which showed signals in the appropriate regions of the spectrum.

To extend our work of this field, we performed this reaction in the presence of sodium hydride as base in EtOH under the terms of reflux, thermodynamic control condition (Path B). These reactions led to 6-methyl-4,5-diphenyl-3,4-dihydropyrimidin-2(1*H*)-one **5a** in high yields (Scheme 2). Formation of this heterocyclic product can be attributable to the reaction has progressed from thermodynamic path. Structures of compounds **5a-k** were confirme by ^{1}H-NMR, ^{13}C-NMR, Mass and IR spectrum.



Scheme 2. Synthesis of 6-methyl-4,5-diphenyl-3,4-dihydropyrimidin-2(1*H*)-one derivatives under thermodynamic control condition (Path B).

Table 3. Optimization of reaction conditions for the formation of product **5a** from 1.5 mmol of urea, 1.2 mmol of benzaldehyde and 1.5 mmol of phenylacetone under the terms of reflux.

Base-catalyst[a]	Solvent	Yield (%)[b]	Base-catalyst[a]	Solvent	Yield (%)[b]
NaH[c]	**EtOH**	**88**	KOH	EtOH	34
NaH	MeOH	82	KOH	DMF	23
NaH	DMF	34	NaOH	EtOH	30
KO*t*-Bu	EtOH	80	NaOH	MeCN	21
KO*t*-Bu	DMF	30	NaOEt	EtOH	38
KO*t*-Bu	MeCN	26	NaOEt	MeCN	21
K_2CO_3	EtOH	47	LiOH	EtOH	–
K_2CO_3	DMF	28	LiOH	DMF	–
K_2CO_3	MeCN	22	*n*-BuLi	EtOH	–

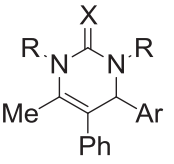
[a]20 mol% catalyst unless stated otherwise.
[b]Reaction time 3 h.
[c]10 mol% catalyst, reaction time was 7 h.

We optimize the reaction conditions by changing the solvent and base. Several base such as NaH, KO*t*-Bu, K_2CO_3, KOH, NaOH, NaOEt, LiOH and *n*-BuLi were tested. EtOH and NaH show the best results among various solvents and bases in this reaction. Eventually, this reaction was performed using 20 mol% of NaH as the base-catalyst, 1.5 mmol of urea, 1.2 mmol of benzaldehyde and 1.5 mmol of phenylacetone in EtOH under the terms of reflux (Table 3).

Various 6-methyl-4,5-diphenyl-3,4-dihydropyrimidin-2(1*H*)-one were synthesized from urea, phenylacetone and various benzaldehyde under the optimized conditions described above (Table 4). We have used aliphatic aldehyde instead of aromatic aldehyde under thermodynamic and kinetic control condition but we were unable to isolate the various dihydropyrimidin derivatives **4** and **5**.

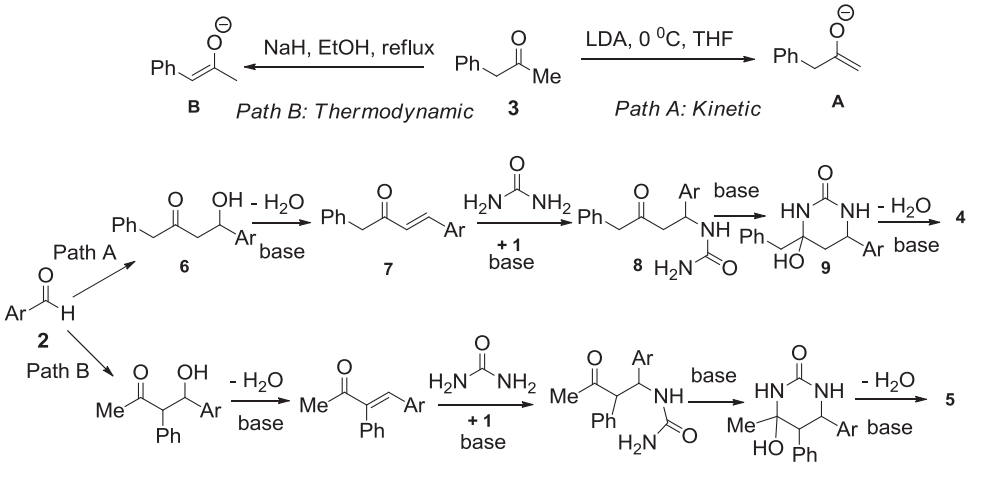
A possible reaction mechanism is shown in Scheme 3. It is proposed that phenylacetone **3**, an unsymmetrical dialkyl ketone, can form two *regioisomeric* enolates on deprotonation. The formation of an enolate mixture can be governed by kinetic or thermodynamic factors. Under two different conditions, LDA as the base, in THF as the solvent at 0°C, kinetic enol (A) is formed. When NaH was used as the base and EtOH as solvent, under the terms of reflux, thermodynamic enol (B) is formed. Aldol condensation of aldehyde **2** with enol (**A** or **B**), followed by elimination of the resulting hydroxyl group gives one **7**. Subsequent aza-Michael addition of urea **1** to enone **7** leads to the formation of Michael adduct **8**. Compunds **4** or **5** were formed from intermediate **8** undergo cyclization reaction and subsequent loss of water [29].

Table 4. Synthesis of 6-methyl-4,5-diphenyl-3,4-dihydropyrimidin-2(1*H*)-one derivatives.



5

Entry	1–5	X	R	Ar	Yield of **5** (%)
1	**a**	O	H	Ph	88
2	**b**	O	H	4-NO_2-C_6H_4	92
3	**c**	O	H	4-Cl-C_6H_4	90
4	**d**	O	H	4-OMe-C_6H_4	79
5	**e**	S	H	4-NO_2-C_6H_4	93
6	**f**	S	H	4-OMe-C_6H_4	75
7	**g**	S	H	Ph	89
8	**h**	S	Me	Ph	85
9	**i**	S	Me	4-OMe-C_6H_4	77
10	**j**	S	Me	4-Br-C_6H_4	87
11	**k**	S	Et	4-Cl-C_6H_4	86



Scheme 3. A plausible mechanism the formation of compounds **4, 5**.

3. Conclusion

In conclusion, a novel protocol, one-pot regioselective synthesis of various 3,4-dihydropyrimidin-2(1*H*)-one (DHPMs) via a three-component Biginelli-type condensation of aldehyde, phenylacetone and urea/thiourea under two different conditions, kinetic control; LDA-20 mol % as the base in THF at 0°C and thermodynamic control; NaH as the base, in EtOH, under the terms of reflux, affording good to high yields was described. The generally available substrates, mild conditions, high yields and ease purification procedure make this reaction suitable for the synthesis of various 3,4-dihydropyrimidin-2(1*H*)-one.

4. Experimental

4.1. General

All chemicals were obtained commercially and used without further purification. IR Spectra: *Shimadzu-IR-460* spectrometer; bond positions in cm^{-1}. ^1H- and ^{13}C-NMR Spectra: *Bruker DRX-500 Avance* instrument using TMS as internal standard and $CDCl_3$ as applied solvent at 500.1 and 125.7 MHz, resp.; the abbreviations used for NMR signals: s = singlet, d = doublet, t = triplet, m = multiplet and δ in ppm, J in Hz. MS: *Finnigan-MAT-8430EI-MS* mass spectrometer; at 70 eV; in *m/z* (rel. %). mp: melting points (uncorrected) *Electrothermal-9100* apparatus. Elemental analyses: *Vario EL III CHNOS* elemental analyzer.

4.2. General procedure for preparation of compounds 4

A solution of *n*-BuLi (20 mol %) in THF (2 mL) was slowly added to diisopropylamine (20 mol%) and the mixture was stirred at at 0°C for 1 min. Then, a mixture of urea **1a** (1.5 mmol), benzaldehyde **2a** (1.2 mmol) and phenylacetone **3** (1.5 mmol) in THF (3 mL) was slowly added to the first solution and the mixture was stirred at 0°C for 1 h. After completion of the reaction [about 1 h; TLC (AcOEt/ hexane 1:4) monitoring], the resulting solid was isolated by filtration and washed with acetone.

4.2.1. 6-Benzyl-4-phenyl-3,4-dihydropyrimidin-2(1H)-one (4a)

White powder, mp: 223–225°C; yield: 0.21 g (81%). IR (KBr) (ν_{max}, cm^{-1}): 3114, 1620, 1237, 1178, 1090. ^1H-NMR (500 MHz, $CDCl_3$): δ_H = 3.62 (2 H, d, J = 6.3, CH_2), 5.26 (1 H, d, ^3J = 4.8, CH), 5.67 (1 H, d, ^3J = 4.8, CH), 6.04 (1 H, s, NH), 7.13 (2 H, d, ^3J = 7.5, Ar), 7.19 (1 H, t, ^3J = 7.5, Ar), 7.24 (2 H, t, ^3J = 7.5, Ar), 7.40 (2 H, d, ^3J = 7.7, Ar), 7.48 (1 H, t, ^3J = 7.7, Ar), 7.60 (2 H, t, ^3J = 7.7, Ar), 8.61 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.8 (CH_2), 56.3 (CH), 100.0 (CH), 125.9 (CH), 126.1 (2 CH), 127.7 (2 CH), 128.7 (2 CH), 129.9 (2 CH), 131.5 (C), 133.7 (CH), 135.4 (C), 143.4 (C), 153.3 (C=O). EI-MS: 264 (M^+, 8), 207 (15), 187 (86), 173 (34), 91 (100), 77 (19), 57 (23). Anal. Calc. for $C_{17}H_{16}N_2O$ (264.32): C, 77.25; H, 6.10; N, 10.60%. Found: C, 77.27; H, 6.13; N, 10.58%.

4.2.2. 6-Benzyl-4-(4-chlorophenyl)-3,4-dihydropyrimidin-2(1H)-one (4b)

White powder, mp: 260–262°C; yield: 0.25 g (83%). IR (KBr) (ν_{max}, cm^{-1}): 3122, 1658, 1241, 1182, 1095. ^1H-NMR (500 MHz, $CDCl_3$): δ_H = 3.73 (2 H, d, J = 6.5, CH_2), 5.10 (1 H, d, ^3J = 4.8, CH), 5.66 (1 H, d, ^3J = 4.8, CH), 6.02 (1 H, s, NH), 7.06 (2 H, d, ^3J = 7.4, Ar), 7.18 (1 H, t, ^3J = 7.4, Ar), 7.27 (2 H, t, ^3J = 7.4, Ar), 7.38 (2 H, d, ^3J = 7.9, Ar), 7.90 (2 H, d, ^3J = 7.9, Ar), 8.00 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 43.1 (CH_2), 57.6 (CH), 100.0 (CH), 126.6 (2 CH), 127.4 (2 CH), 128.7 (CH), 129.9 (2 CH), 130.6 (2 CH), 132.4 (C), 134.4 (C), 142.1 (C), 147.4 (C), 153.8 (C=O). EI-MS: 298 (M^+, 2), 240 (18), 207 (29), 111 (67), 91 (100), 77 (45), 58 (14). Anal. Calc. for $C_{17}H_{15}ClN_2O$ (298.77): C, 68.34; H, 5.06; N, 9.38%. Found: C, 68.38; H, 5.10; N, 9.33%.

4.2.3. 6-Benzyl-4-(2-chlorophenyl)-3,4-dihydropyrimidin-2(1H)-one (4c)

White powder, mp: 231–233°C; yield: 0.24 g (79%). IR (KBr) (ν_{max}, cm^{-1}): 3116, 1660, 1244, 1184, 1097. ^1H-NMR (500 MHz, $CDCl_3$): δ_H = 3.80 (2 H, d, J = 6.7, CH_2), 5.24 (1

H, d, $^3J = 4.7$, CH), 5.80 (1 H, d, $^3J = 4.7$, CH), 6.52 (1 H, s, NH), 7.19 (1 H, d, $^3J = 7.8$, Ar), 7.28 (1 H, t, $^3J = 7.8$, Ar), 7.31–7.36 (3 H, m, Ph), 7.59 (2 H, t, $^3J = 7.5$, Ar), 7.78 (1 H, t, $^3J = 7.8$, Ar), 7.98 (1 H, d, $^3J = 7.8$, Ar), 8.22 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 41.7$ (CH_2), 56.8 (CH), 104.5 (CH), 126.9 (CH), 127.4 (CH), 127.8 (C), 128.8 (2 CH), 129.9 (CH), 130.2 (2 CH), 130.9 (CH), 131.7 (CH), 132.9 (C), 135.8 (C), 144.7 (C), 153.0 (C=O). EI-MS: 298 (M^+, 4), 207 (77), 187 (84), 111 (85), 91 (100), 77 (79). Anal. Calc. for $C_{17}H_{15}ClN_2O$ (298.77): C, 68.34; H, 5.06; N, 9.38%. Found: C, 68.31; H, 5.11; N, 9.40%.

4.2.4. 6-Benzyl-4-(2-hydroxyphenyl)-3,4-dihydropyrimidin-2(1H)-one (4d)

White powder, mp: 253–255°C; yield: 0.20 g (73%). IR (KBr) (ν_{max}, cm^{-1}): 3446, 3332, 1626, 1240, 1151, 1094. ^{1}H-NMR (500 MHz, $CDCl_3$): $\delta_H = 3.76$ (2 H, d, $J = 6.8$, CH_2), 4.99 (1 H, d, $^3J = 4.8$, CH), 5.36 (1 H, d, $^3J = 4.8$, CH), 6.00 (1 H, s, OH), 6.24 (1 H, s, NH), 7.18 (2 H, d, $^3J = 7.4$, Ar), 7.22 (1 H, t, $^3J = 7.6$, Ar), 7.26–7.33 (3 H, m, Ph), 7.38 (1 H, t, $^3J = 7.6$, Ar), 7.46 (1 H, d, $^3J = 7.6$, Ar), 7.88 (1 H, d, $^3J = 7.6$, Ar), 8.18 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 42.0$ (CH_2), 55.6 (CH), 101.5 (CH), 120.0 (CH), 124.4 (CH), 125.8 (CH), 125.9 (CH), 128.7 (2 CH), 129.2 (2 CH), 130.6 (CH), 132.5 (C), 134.9 (C), 135.5 (C), 142.1 (C), 151.3 (C=O). EI-MS: 280 (M^+, 5), 222 (18), 189 (25), 91 (100), 58 (88). Anal. Calc. for $C_{17}H_{16}N_2O_2$ (280.32): C, 72.84; H, 5.75; N, 9.99%. Found: C, 72.80; H, 5.78; N, 10.02%.

4.2.5. 6-Benzyl-4-(4-methoxyphenyl)-3,4-dihydropyrimidin-2(1H)-one (4e)

Cream powder, mp: 239–241°C; yield: 0.23 g (77%). IR (KBr) (ν_{max}, cm^{-1}): 3455, 1680, 1242, 1153, 1095. ^{1}H-NMR (500 MHz, $CDCl_3$): $\delta_H = 3.54$ (2 H, d, $J = 6.7$, CH_2), 3.72 (3 H, s, OMe), 5.34 (1 H, d, $^3J = 4.8$, CH), 5.89 (1 H, d, $^3J = 4.8$, CH), 6.37 (1 H, s, NH), 7.23 (2 H, d, $^3J = 7.2$, Ar), 7.25-7.34 (5 H, m, Ph), 7.48 (2 H, d, $^3J = 7.2$, Ar), 8.13 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 42.5$ (CH_2), 52.2 (CH), 55.2 (OMe), 100.2 (CH), 120.0 (2 CH), 126.1 (2 CH), 127.8 (CH), 129.0 (2 CH), 131.4 (2 CH), 132.8 (C), 134.8 (C), 145.0 (C), 148.2 (C), 152.5 (C=O). EI-MS: 294 (M^+, 15), 236 (16), 203 (52), 187 (79), 107 (51), 91 (100), 77 (54). Anal. Calc. for $C_{18}H_{18}N_2O_2$ (294.35): C, 73.45; H, 6.16; N, 9.52%. Found: C, 73.47; H, 6.19; N, 9.48%.

4.2.6. 6-Benzyl-4-(4-nitrophenyl)-3,4-dihydropyrimidin-2(1H)-one (4f)

Pale yellow powder, mp: 269–271°C; yield: 0.27 g (88%). IR (KBr) (ν_{max}, cm^{-1}): 3291, 1622, 1554, 1360, 1095. ^{1}H-NMR (500 MHz, $CDCl_3$): $\delta_H = 3.61$ (2 H, d, $J = 6.7$, CH_2), 4.98 (1 H, d, $^3J = 4.8$, CH), 5.26 (1 H, d, $^3J = 4.8$, CH), 6.25 (1 H, s, NH), 7.30 (2 H, d, $^3J = 7.5$, Ar), 7.44 (2 H, d, $^3J = 8.0$, Ar), 7.59 (2 H, t, $^3J = 7.5$, Ar), 7.71 (1 H, t, $^3J = 7.5$, Ar), 8.01 (2 H, d, $^3J = 8.0$, Ar), 8.71 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 41.0$ (CH_2), 56.0 (CH), 103.3 (CH), 127.4 (2 CH), 128.7 (2 CH), 129.2 (2 CH), 130.2 (CH), 132.5 (2 CH), 135.7 (C), 136.0 (C), 144.8 (C), 148.9 (C), 152.1 (C=O). EI-MS: 309 (M^+, 15), 252 (31), 187 (35), 122 (18), 91 (100), 77 (15), 58 (24). Anal. Calc. for $C_{17}H_{15}N_3O_3$ (309.32): C, 66.01; H, 4.89; N, 13.58%. Found: C, 66.00; H, 4.90; N, 13.53%.

4.2.7. 6-Benzyl-4-phenyl-3,4-dihydropyrimidine-2(1H)-thione (4g)

White powder, mp: 240–242°C; yield: 0.24 g (85%). IR (KBr) (ν_{max}, cm^{-1}): 3466, 1643, 1158, 1105. ^{1}H-NMR (500 MHz, $CDCl_3$): $\delta_H = 3.77$ (2 H, d, $J = 6.4$, CH_2), 5.25 (1 H, d,

^3J = 4.8, CH), 5.70 (1 H, d, ^3J = 4.8, CH), 6.34 (1 H, s, NH), 7.19 (2 H, d, ^3J = 7.5, Ar), 7.26 (1 H, t, ^3J = 7.5, Ar), 7.33 (2 H, t, ^3J = 7.5, Ar), 7.60 (2 H, t, ^3J = 7.7, Ar), 7.72 (1 H, t, ^3J = 7.7, Ar), 7.87 (2 H, d, ^3J = 7.7, Ar), 9.11 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 42.8 (CH_2), 58.0 (CH), 102.1 (CH), 126.1 (2 CH), 127.3 (2 CH), 127.8 (CH), 129.0 (2 CH), 130.0 (CH), 131.2 (2 CH), 131.9 (C), 135.8 (C), 141.9 (C), 175.0 (C=S). EI-MS: 280 (M^+, 10), 204 (29), 189 (38), 91 (100), 77 (49), 73 (10). Anal. Calc. for $C_{17}H_{16}N_2S$ (280.39): C,72.82; H, 5.75; N, 9.99%. Found: C, 72.80; H, 5.77; N, 9.95%.

4.2.8. 6-Benzyl-4-(4-chlorophenyl)-3,4-dihydropyrimidine-2(1H)-thione (4h)

White powder, mp: 255–257°C; yield: 0.27 g (87%). IR (KBr) (ν_{max}, cm^{-1}): 3366, 1679, 1162, 1117. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 3.40 (2 H, d, J = 6.8, CH_2), 5.38 (1 H, d, ^3J = 4.8, CH), 5.95 (1 H, d, ^3J = 4.8, CH), 6.45 (1 H, s, NH), 7.21 (2 H, d, ^3J = 7.6, Ar), 7.25 (1 H, t, ^3J = 7.6, Ar), 7.32 (2 H, t, ^3J = 7.6, Ar), 7.61 (2 H, d, ^3J = 7.9, Ar), 8.00 (2 H, d, ^3J = 7.9, Ar), 9.11 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.9 (CH_2), 58.4 (CH), 101.1 (CH), 125.3 (2 CH), 125.5 (2 CH), 127.5 (2 CH), 128.9 (CH), 130.0 (2 CH), 130.2 (C), 131.8 (C), 135.7 (C), 144.9 (C), 175.0 (C=S). EI-MS: 314 (M^+, 4), 240 (90), 203 (59), 111 (100), 91 (62), 73 (72). Anal. Calc. for $C_{17}H_{15}ClN_2O_2S$ (314.83): C, 64.85; H, 4.80; N, 8.90%. Found: C, 64.85; H, 4.76; N, 8.93%.

4.2.9. 6-Benzyl-4-(4-methoxyphenyl)-3,4-dihydropyrimidine-2(1H)-thione (4i)

Cream powder, mp: 244–246°C; yield: 0.24 g (79%). IR (KBr) (ν_{max}, cm^{-1}): 3368, 1638, 1252, 1106. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 3.55 (2 H, d, J = 6.8, CH_2), 3.67 (3 H, s, OMe), 5.05 (1 H, d, ^3J = 4.6, CH), 5.55 (1 H, d, ^3J = 4.6, CH), 6.25 (1 H, s, NH), 7.25 (2 H, d, ^3J = 7.4, Ar), 7.33 (1 H, t, ^3J = 7.4, Ar), 7.40–7.48 (4 H, m, Ph), 7.50 (2 H, d, ^3J = 7.6, Ar), 9.01 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.1 (CH_2), 58.6 (CH), 60.1 (OMe), 102.5 (CH), 118.6 (2 CH), 126.7 (2 CH), 127.9 (CH), 128.6 (2 CH), 129.4 (2 CH), 130.1 (C), 131.9 (C), 135.6 (C), 143.9 (C), 175.5 (C=S). EI-MS: 310 (M^+, 19), 237 (24), 219 (25), 107 (36), 91 (100). Anal. Calc. for $C_{18}H_{18}N_2OS$ (310.41): C, 69.65; H, 5.84; N, 9.02%. Found: C, 69.67; H, 5.90; N, 9.07%.

4.2.10. 6-Benzyl-4-(4-nitrophenyl)-3,4-dihydropyrimidine-2(1H)-thione (4j)

Pale yellow powder, mp: 275–277°C; yield: 0.30 g (91%). IR (KBr) (ν_{max}, cm^{-1}): 3363, 1682, 1551, 1345, 1160, 1109. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 3.68 (2 H, d, J = 6.8, CH_2), 4.73 (1 H, d, ^3J = 4.8, CH), 5.59 (1 H, d, ^3J = 4.8, CH), 6.15 (1 H, s, NH), 7.09 (2 H, d, ^3J = 7.4, Ar), 7.28-7.33 (3 H, m, Ph), 7.49 (2 H, d, ^3J = 7.9, Ar), 7.89 (2 H, d, ^3J = 7.9, Ar), 9.05 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.2 (CH_2), 60.7 (CH), 102.1 (CH), 126.8 (CH), 126.9 (2 CH), 127.5 (2 CH), 128.7 (2 CH), 129.9 (2 CH), 130.1 (C), 131.6 (C), 135.8 (C), 142.9 (C), 174.4 (C=S). EI-MS: 325 (M^+, 15), 251 (44), 234 (48), 203 (40), 122 (66), 91 (60), 77 (100). Anal. Calc. for $C_{17}H_{15}N_3O_2S$ (325.38): C, 62.75; H, 4.65; N, 12.91%. Found: C, 62.77; H, 4.62; N, 12.95%.

4.2.11. 6-Benzyl-4-(4-bromophenyl)-1,3-diethyl-3,4-dihydropyrimidine-2(1H)-thione (4k)

White powder, mp: 250–252°C; yield: 0.26 g (78%). IR (KBr) (ν_{max}, cm^{-1}): 1675, 1160, 1107. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 0.99 (3 H, t, J = 6.8, Me), 1.19 (3 H, t, J = 6.8, Me), 3.22 (2 H, q, J = 6.8, NCH_2), 3.35 (2 H, q, J = 6.8, NCH_2), 3.54 (2 H, d, J = 6.8,

CH_2), 5.29 (1 H, d, ^3J = 4.8, CH), 5.98 (1 H, d, ^3J = 4.8, CH), 7.63 (2 H, t, ^3J = 7.6, Ar), 7.68 (1 H, t, ^3J = 7.6, Ar), 8.05 (2 H, d, ^3J = 7.6, Ar), 8.09 (2 H, d, ^3J = 7.9, Ar), 8.40 (2 H, d, ^3J = 7.9, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 16.9 (Me), 18.6 (Me), 40.9 (CH_2), 41.3 (NCH_2), 43.4 (NCH_2), 60.0 (CH), 100.1 (CH), 126.9 (2 CH), 127.2 (2 CH), 128.1 (C), 130.3 (4 CH), 131.7 (CH), 132.5 (C), 135.9 (C), 147.8 (C), 177.7 (C=S). EI-MS: 415 (M^+, 5), 385 (24), 259 (44), 154 (100), 91 (61), 77 (70). Anal. Calc. for $C_{21}H_{23}BrN_2S$ (415.39): C, 60.72; H, 5.58; N, 6.74%. Found: C, 60.70; H, 5.60; N, 6.77%.

4.2.12. 6-Benzyl-4-(4-chlorophenyl)-1,3-dimethyl-3,4-dihydropyrimidine-2(1H)-thione (4l)

Cream powder, mp: 264–266°C; yield: 0.27 g (79%). IR (KBr) (ν_{max}, cm^{-1}): 1630, 1251, 1100. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.95 (3 H, s, NMe), 3.10 (3 H, s, NMe), 3.63 (2 H, d, J = 6.3, CH_2), 5.27 (1 H, d, ^3J = 4.6, CH), 5.68 (1 H, d, ^3J = 4.6, CH), 7.05 (1 H, t, ^3J = 7.6, Ar), 7.38–7.43 (4 H, m, Ph), 7.76 (2 H, d, ^3J = 7.9, Ar), 7.92 (2 H, d, ^3J = 7.9, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.4 (CH_2), 42.3 (NMe), 42.9 (NMe), 56.4 (CH), 102.0 (CH), 127.8 (2 CH), 128.2 (C), 129.3 (2 CH), 129.8 (CH), 130.1 (C), 130.7 (2 CH), 131.9 (2 CH), 140.1 (C), 147.2 (C), 173.2 (C=S). EI-MS: 344 (M+2, 14), 342 (7), 327 (20), 265 (33), 251 (31), 91 (100), 77 (77). Anal. Calc. for $C_{19}H_{19}ClN_2S$ (342.89): C, 66.55; H, 5.59; N, 8.17%. Found: C, 66.57; H, 5.61; N, 8.21%.

4.2.13. 6-Benzyl-1,3-dimethyl-4-(4-nitrophenyl)-3,4-dihydropyrimidine-2(1H)-thione (4m)

Pale yellow powder, mp: 289–291°C; yield: 0.29 g (83%). IR (KBr) (ν_{max}, cm^{-1}): 1689, 1557, 1342, 1155, 1100. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.92 (3 H, s, NMe), 3.01 (3 H, s, NMe), 3.88 (2 H, d, J = 6.8, CH_2), 5.26 (1 H, d, ^3J = 4.6, CH), 5.64 (1 H, d, ^3J = 4.6, CH), 7.27 (1 H, t, ^3J = 7.6, Ar), 7.30-7.35 (4 H, m, Ph), 7.50 (2 H, d, ^3J = 7.9, Ar), 8.04 (2 H, d, ^3J = 7.9, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 41.1 (CH_2), 42.0 (NMe), 42.7 (NMe), 57.1 (CH), 100.5 (CH), 126.2 (2 CH), 127.4 (2 CH), 127.8 (CH), 128.7 (2 C), 129.2 (2 CH), 132.5 (2 CH), 135.7 (C), 144.9 (C), 175.1 (C=S). EI-MS: 353 (M^+, 7), 338 (25), 234 (28), 231 (32), 122 (82), 91 (64), 77 (100). Anal. Calc. for $C_{19}H_{19}N_3O_2S$ (353.44): C, 64.57; H, 5.42; N, 11.89%. Found: C, 64.50; H, 5.40; N, 11.88%.

4.3. General procedure for preparation of compounds 5

Amixture of urea **1a** (1.5 mmol), benzaldehyde **2** (1.2 mmol) and phenylacetone **3** (1.5 mmol) in EtOH (3 mL) was slowly added to NaH (20 mol %) and the mixture was stirred at 75°C for 3 h. After completion of the reaction [about 3 h; TLC (AcOEt/hexane 1:3) monitoring], the resulting solid was isolated by filtration and washed with diethyl ether.

4.3.1. 6-Methyl-4,5-diphenyl-3,4-dihydropyrimidin-2(1H)-one (5a)

White powder, mp: 220–222°C; yield: 0.23 g (88%). IR (KBr) (ν_{max}, cm^{-1}): 3209, 1636, 1397, 1103. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.61 (3 H, s, Me), 5.28 (1 H, s, CH), 6.25 (1 H, s, NH), 7.26–7.30 (3 H, m, Ph), 7.44 (2 H, d, ^3J = 7.3, Ar), 7.60 (2 H, t, ^3J = 7.7, Ar), 7.71 (1 H, t, ^3J = 7.7, Ar), 7.87 (2 H, d, ^3J = 7.7, Ar), 8.06 (1 H, s,NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.8 (Me), 57.6 (CH), 112.4 (C), 123.5 (2 CH), 127.4 (2 CH), 128.8 (CH), 129.3 (2 CH), 130.2 (2 CH), 132.5 (CH), 133.1 (C), 135.7 (C), 144.7 (C), 152.0

(C = O). EI-MS: 264 (M^+, 11), 250 (21), 206 (26), 187 (84), 110 (80), 77 (100), 58 (31). Anal. Calc. for $C_{17}H_{16}N_2O$ (264.32): C, 77.25; H, 6.10; N, 10.60%. Found: C, 77.21; H, 6.08; N, 10.56%.

4.3.2. 6-Methyl-4-(4-nitrophenyl)-5-phenyl-3,4-dihydropyrimidin-2(1H)-one (5b)

Pale yellow powder, mp: 266–268°C; yield: 0.28 g (92%). IR (KBr) (ν_{max}, cm^{-1}): 3192, 1636, 1527, 1350, 1256, 1102, 1049. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.45 (3 H, s, Me), 5.63 (1 H, s, CH), 6.33 (1 H, s, NH), 7.29–7.35 (3 H, m, Ph), 7.40 (2 H, d, ^3J = 7.5, Ar), 7.50 (2 H, d, ^3J = 7.9, Ar), 7.91 (2 H, d, ^3J = 7.9, Ar), 8.86 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.2 (Me), 57.2 (CH), 113.4 (C), 122.6 (C), 127.5 (2 CH), 128.8 (2 CH), 129.2 (CH), 130.7 (2 CH), 132.6 (2 CH), 142.1 (C), 144.5 (C), 147.3 (C), 152.2 (C = O). EI-MS: 309 (M^+, 15), 251 (23), 232 (31), 187 (57), 122 (48), 110 (42), 77 (100), 58 (27). Anal. Calc. for $C_{17}H_{15}N_3O_3$ (309.32): C, 66.01; H, 4.89; N, 13.58%. Found: C, 66.09; H, 4.91; N, 13.55%.

4.3.3. 4-(4-Chlorophenyl)-6-methyl-5-phenyl-3,4-dihydropyrimidin-2(1H)-one (5c)

White powder, mp: 233–235°C; yield: 0.27 g (90%). IR (KBr) (ν_{max}, cm^{-1}): 3193, 1637, 1257, 1141, 1036. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.46 (3 H, s, Me), 5.50 (1 H, s, CH), 6.29 (1 H, s, NH), 7.30-7.36 (3 H, m, Ph), 7.41 (2 H, d, ^3J = 7.4, Ar), 7.48 (2 H, d, ^3J = 8.0, Ar), 7.93 (2 H, d, ^3J = 8.0, Ar), 8.11 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 17.7 (Me), 58.6 (CH), 112.9 (C), 126.7 (2 CH), 127.3 (2 CH), 128.7 (CH), 129.7 (2 CH), 130.7 (2 CH), 132.5 (C), 136.7 (C), 140.0 (C), 142.4 (C), 152.7 (C = O). EI-MS: 298 (M^+, 7), 240 (51), 221 (100), 187 (65), 111 (89), 77 (89). Anal. Calc. for $C_{17}H_{15}ClN_2O$ (298.77): C, 68.34; H, 5.06; N, 9.38%. Found: C, 68.30; H, 5.10; N, 9.40%.

4.3.4. 4-(4-Methoxyphenyl)-6-methyl-5-phenyl-3,4-dihydropyrimidin-2(1H)-one (5d)

Cream powder, mp: 243–245°C; yield: 0.23 g (79%). IR (KBr) (ν_{max}, cm^{-1}): 3377, 1689, 1168, 1109. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.67 (3 H, s, Me), 3.76 (3 H, s, OMe), 5.47 (1 H, s, CH), 6.05 (1 H, s, NH), 7.28–7.33 (4 H, m, Ph), 7.44 (2 H, d, ^3J = 7.5, Ar), 7.47 (1 H, t, ^3J = 7.3, Ar), 7.89 (2 H, d, ^3J = 7.5, Ar), 8.31 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.9 (Me), 56.2 (CH), 60.6 (OMe), 112.5 (C), 120.0 (2 CH), 128.7 (2 CH), 129.3 (CH), 129.7 (2 CH), 130.0 (2 CH), 130.7 (C), 132.7 (C), 132.9 (C), 141.9 (C), 153.6 (C = O). EI-MS: 294 (M^+, 16), 236 (48), 217 (40), 187 (100), 110 (89), 77 (78). Anal. Calc. for $C_{18}H_{18}N_2O_2$ (294.35): C, 73.45; H, 6.16; N, 9.52%. Found: C, 73.49; H, 6.18; N, 9.55%.

4.3.5. 6-Methyl-4-(4-nitrophenyl)-5-phenyl-3,4-dihydropyrimidine-2(1H)-thione (5e)

Pale yellow powder, mp: 259–261°C; yield: 0.30 g (93%). IR (KBr) (ν_{max}, cm^{-1}): 3190, 1643, 1531, 1350, 1259, 1178. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.66 (3 H, s, Me), 5.57 (1 H, s, CH), 6.15 (1 H, s, NH), 7.22 (2 H, d, ^3J = 7.3, Ar), 7.28 (1 H, t, ^3J = 7.3, Ar), 7.36 (2 H, t, ^3J = 7.3, Ar), 7.41 (2 H, d, ^3J = 7.9, Ar), 7.92 (2 H, d, ^3J = 7.9, Ar), 10.05 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.8 (Me), 61.7 (CH), 116.3 (C), 126.2 (2 CH), 127.5 (CH), 127.7 (2 CH), 130.0 (2 CH), 130.6 (2 CH), 138.8 (C), 140.7 (C), 142.1 (C), 143.4 (C), 171.2 (C = S). EI-MS: 325 (M^+, 8), 251 (39), 248 (32), 203 (35), 122 (77), 77 (80), 73 (100). Anal. Calc. For $C_{17}H_{15}N_3O_2S$ (325.38): C, 62.75; H, 4.65; N, 12.91%. Found: C, 62.77; H, 4.67; N, 12.90%.

4.3.6. 4-(4-Methoxyphenyl)-6-methyl-5-phenyl-3,4-dihydropyrimidine-2(1H)-thione (5f)

Cream powder, mp: 251–253°C; yield: 0.23 g (75%). IR (KBr) (ν_{max}, cm^{-1}): 3201, 1652, 1264, 1117, 1040. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.47 (3 H, s, Me), 3.84 (3 H, s, OMe), 5.48 (1 H, s, CH), 6.18 (1 H, s, NH), 7.29–7.35 (3 H, m, Ph), 7.48 (2 H, d, ^3J = 7.3, Ar), 7.84 (2 H, d, ^3J = 7.5, Ar), 7.92 (2 H, d, ^3J = 7.5, Ar), 10.11 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 17.7 (Me), 56.3 (OMe), 63.6 (CH), 113.6 (C), 120.6 (2 CH), 127.4 (2 CH), 128.7 (2 CH), 129.2 (2 CH), 130.1 (CH), 132.6 (C), 135.7 (C), 144.8 (C), 151.5 (C), 171.6 (C=S). EI-MS: 310 (M^+, 12), 236 (50), 203 (49), 107 (68), 77 (100), 73 (41). Anal. Calc. for $C_{18}H_{18}N_2OS$ (310.41): C, 69.65; H, 5.84; N, 9.02%. Found: C, 69.68; H, 5.88; N, 9.10%.

4.3.7. 6-Methyl-4,5-diphenyl-3,4-dihydropyrimidine-2(1H)-thione (5g)

White powder, mp: 229–231°C; yield: 0.25 g (89%). IR (KBr) (ν_{max}, cm^{-1}): 3173, 1650, 1264, 1117, 1005. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.41 (3 H, s, Me), 5.45 (1 H, s, CH), 6.21 (1 H, s, NH), 7.30-7.36 (3 H, m, Ph), 7.47 (2 H, d, ^3J = 7.3, Ar), 7.62 (2 H, t, ^3J = 7.7, Ar), 7.74 (1 H, t, ^3J = 7.7, Ar), 8.05 (2 H, d, ^3J = 7.7, Ar), 10.01 (1 H, s, NH). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.0 (Me), 60.2 (CH), 112.5 (C), 127.5 (CH), 128.8 (2 CH), 129.0 (2 CH), 129.2 (2 CH), 130.2 (2 CH), 132.5 (C), 135.7 (CH), 140.0 (C), 144.8 (C), 170.2 (C=S). EI-MS: 280 (M^+, 12), 206 (49), 126 (52), 77 (100). Anal. Calc. for $C_{17}H_{16}N_2S$ (280.39): C, 72.82; H, 5.75; N, 9.99%. Found: C, 72.85; H, 5.77; N, 10.03%.

4.3.8. 1,3,6-Trimethyl-4,5-diphenyl-3,4-dihydropyrimidine-2(1H)-thione (5h)

White powder, mp: 225–227°C; yield: 0.26 g (85%). IR (KBr) (ν_{max}, cm^{-1}): 1632, 1390, 1121. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.47 (3 H, s, Me), 2.91 (3 H, s, NMe), 3.01 (3 H, s, NMe), 5.66 (1 H, s, CH), 7.47-7.59 (5 H, m, Ph), 7.61 (1 H, t, ^3J = 7.6, Ar), 7.92 (2 H, d, ^3J = 7.6, Ar), 7.98 (2 H, d, ^3J = 7.8, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 18.4 (Me), 40.2 (NMe), 44.4 (NMe), 56.6 (CH), 111.9 (C), 127.4 (2 CH), 128.7 (2 CH), 129.0 (CH), 129.3 (CH), 130.7 (2 CH), 131.6 (2 CH), 132.3 (C), 134.4 (C), 145.4 (C), 172.7 (C=S). EI-MS: 308 (M^+, 10), 293 (20), 231 (29), 154 (66), 77 (100). Anal. Calc. for $C_{19}H_{20}N_2S$ (308.44): C, 73.99; H, 6.54; N, 9.08%. Found: C, 73.90; H, 6.57; N, 9.00%.

4.3.9. 4-(4-Methoxyphenyl)-1,3,6-trimethyl-5-phenyl-3,4-dihydropyrimidine-2(1H)-thione (5i)

Pale yellow powder, mp: 275–277°C; yield: 0.26 g (77%). IR (KBr) (ν_{max}, cm^{-1}): 1622, 1251, 1100, 1041. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.45 (3 H, s, Me), 2.92 (3 H, s, NMe), 3.02 (3 H, s, NMe), 4.02 (3 H, s, OMe), 5.89 (1 H, s, CH), 7.31-7.36 (3 H, m, Ph), 7.41 (2 H, d, ^3J = 7.8, Ar), 7.78 (2 H, d, ^3J = 7.6, Ar), 7.93 (2 H, d, ^3J = 7.8, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): δ_C = 19.9 (Me), 40.5 (NMe), 44.5 (NMe), 52.2 (CH), 56.0 (OMe), 111.4 (C), 122.6 (2 CH), 127.4 (2 CH), 128.7 (2 CH), 129.2 (2 CH), 130.1 (C), 132.5 (C), 134.6 (CH), 142.1 (C), 145.0 (C), 176.0 (C=S). EI-MS: 338 (M^+, 12), 323 (23), 231 (24), 261 (51), 107 (25), 77 (100). Anal. Calc. for $C_{20}H_{22}N_2OS$ (338.47): C, 70.97; H, 6.55; N, 8.28%. Found: C, 70.93; H, 6.50; N, 8.30%.

4.3.10. 4-(4-Bromophenyl)-1,3,6-trimethyl-5-phenyl-3,4-dihydropyrimidine-2(1H)-thione (5j)

White powder, mp: 288–290°C; yield: 0.34 g (87%). IR (KBr) (ν_{max}, cm^{-1}): 1621, 1252, 1140, 1032. ^{1}H-NMR (500 MHz, $CDCl_3$): δ_H = 2.66 (3 H, s, Me), 2.98 (3 H, s, NMe), 3.03

(3 H, s, NMe), 5.60 (1 H, s, CH), 6.92 (1 H, t, $^3J = 7.5$, Ar), 7.14 (2 H, d, $^3J = 7.5$, Ar), 7.21 (2 H, d, $^3J = 7.8$, Ar), 7.31 (2 H, t, $^3J = 7.5$, Ar), 7.57 (2 H, d, $^3J = 7.8$, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 18.6$ (Me), 40.0 (NMe), 42.3 (NMe), 57.7 (CH), 114.4 (C), 126.7 (C), 129.8 (2 CH), 130.1 (2 CH), 133.1 (CH), 134.0 (2 CH), 138.3 (C), 138.9 (2 CH), 142.9 (C), 145.3 (C), 176.0 (C=S). EI-MS: 387 (M^+, 7), 371 (50), 309 (24), 231 (33), 154 (100), 77 (81). Anal. Calc. for $C_{19}H_{19}BrN_2S$ (387.34): C, 58.92; H, 4.94; N, 7.23%. Found: C, 58.90; H, 4.96; N, 7.28%.

4.3.11. 4-(4-Chlorophenyl)-1,3-diethyl-6-methyl-5-phenyl-3,4-dihydropyrimidine-2(1H)-thione (5k)

Cream powder, mp: 279–281°C; yield: 0.32 g (86%). IR (KBr) (ν_{max}, cm^{-1}): 1655, 1161, 1021. ^{1}H-NMR (500 MHz, $CDCl_3$): $\delta_H = 0.95$ (3 H, t, $J = 6.8$, Me), 1.14 (3 H, t, $J = 6.8$, Me), 2.55 (3 H, s, Me), 3.09 (2 H, q, $J = 6.8$, NCH_2), 3.22 (2 H, q, $J = 6.8$, NCH_2), 5.62 (1 H, s, CH), 7.29–7.33 (4 H, m, Ph), 7.49 (2 H, d, $^3J = 7.9$, Ar), 7.73 (1 H, t, $^3J = 7.6$, Ar), 8.04 (2 H, d, $^3J = 7.9$, Ar). ^{13}C-NMR (125.7 MHz, $CDCl_3$): $\delta_C = 14.5$ (Me), 15.6 (Me), 17.9 (Me), 41.9 (NCH_2), 47.5 (NCH_2), 57.6 (CH), 114.9 (C), 127.4 (2 CH), 128.7 (2 CH), 129.2 (CH), 130.1 (C), 132.5 (2 CH), 135.7 (2 CH), 136.9 (C), 144.8 (C), 145.9 (C), 176.8 (C=S). EI-MS: 370 (M^+, 11), 355 (49), 341 (48), 259 (54), 111 (100), 77 (78). Anal. Calc. for $C_{21}H_{23}ClN_2S$ (370.94): C, 68.00; H, 6.25; N, 7.55%. Found: C, 68.09; H, 6.19; N, 7.58%.

Disclosure statement

No potential conflict of interest was reported by the authors.

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