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Straightforward Pyrimidine Ring Construction: A Versatile Tool for the Synthesis of Nucleobase and Nucleoside Analogues

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A general route to 1,2,4-trisubstituted pyrimidines is described in one to three steps from a common key precursor, diazadienium iodide **2**. An efficient preliminary [4+2] cyclocondensation reaction between the azabutadiene building block **2** and various iso(thio)cyanates constitutes an original construction of the pyrimidine skeleton. Subsequent structural modifications on the heterocycle allow the elaboration of a 1-substituted pyrimidine library that includes nucleoside analogues.

Introduction

The pyrimidine ring is encountered in numerous natural and synthetic compounds which exhibit a wide range of biological activities and which have been exploited for some time in the pharmaceutical field. As an example, the synthetic pyrimidines DABOs and their thio analogues *S*-DABOs represent an interesting class of non-nucleosidic inhibitors of HIV-1.[1] The well-known pyrimidine AZT is an example of a nucleosidic molecule with antiviral properties.[2] For many years, various synthetic routes to pyrimidine derivatives have been widely described.[3] In the course of our research on new methodologies for the synthesis of heterocycles, we now wish to report a straightforward route to the pyrimidine skeleton that allows further elaboration for a facile synthesis of a 1-substituted pyrimidine library, including nucleoside analogues. Our synthetic method introduces an alkylsulfanyl substituent α to the nitrogen, which can be easily substituted to afford numerous derivatives.

Results and Discussion

Pyrimidine Ring Construction

In a recent paper,[4] we described the use of α,β-unsaturated thioamide **1**, previously *N*-protected as thiabutadiene, for the synthesis of 2-aminothiopyrans and 2-aminothiophenes through a cycloaddition process. This synthon, which is easily prepared in 79% yield by sulfhydration of commercially available dimethylaminoacrylonitrile, is also, after *S*-protection, an azabutadiene building block: reaction of vinylthioamide **1** with methyl iodide afforded the corresponding *S*-methyl diazadienium iodide **2**, which proved to be a suitable, stable and versatile reactant for the preparation of heterocyclic rings.[5] Indeed, a cyclisation reaction takes place with diazadienium iodide **2** and isothiocyanates or isocyanates, in basic medium, that affords 4-methylsulfanylpyrimidin(e)-2(1*H*)-(thi)ones **3**–**9** (Scheme 1). In this reaction, the dimethylamine generated in situ reacts (faster than **2**) with iso(thio)cyanate to give (thio)ureas as side products. All attempts to circumvent this problem (yet never observed in preliminary studies[6]) failed, which led us to use two equivalents of iso(thio)cyanate for good conversions into pyrimidines. The latter (thio)urea compounds are easily removed from the pyrimidine products by flash chromatography on silica gel. Thus, this drawback did not hinder our work and pyrimidine(e)-2-(thi)ones **3**–**9** were simply isolated in one [4+2] cyclocondensation step in 60–90% yield (based on **2**) (Table 1).

This reaction was applied to a large range of isothiocyanates and aryl isocyanates but, when starting from alkyl isocyanates, a two-step sequence was required to afford pyrimidinones **10** and **11** (Scheme 2, Table 1). In these two cases, the experimental conditions used previously only led to a linear intermediate by a simple nucleophilic addition reaction. The corresponding pyrimidinones could be synthesised in a second independent step by intramolecular cyclisation mediated by the strong base sodium hydride. Interestingly, in this scenario, only one equivalent of alkyl isocyanate is needed as dimethylamine elimination occurs during the second step only.

Isothiocyanates and isocyanates are very useful reagents in organic chemistry.[7] However, the thioxo analogues are usually more accessible and less toxic than the oxo analogues. For instance, methyl isocyanate was taken off the market after a dramatic accident in Bhopal in 1984. On the

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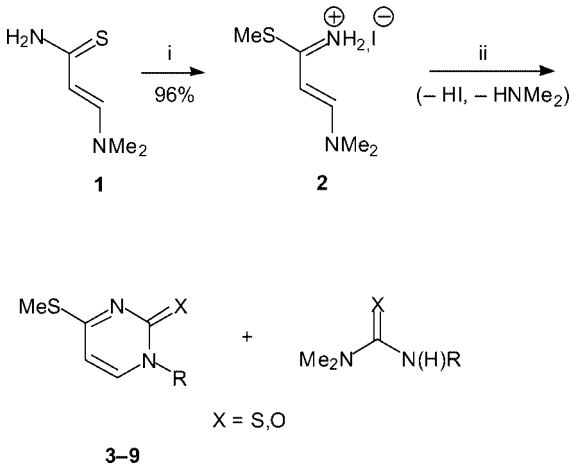
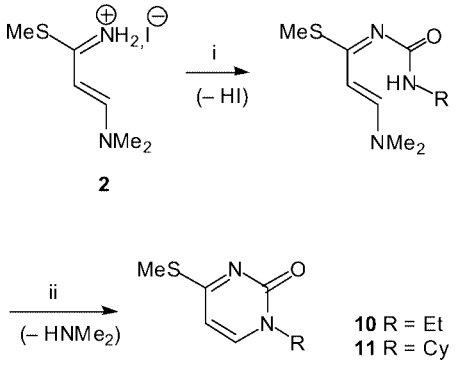


Scheme 1. Pyrimidine ring construction by heterocyclisation. Reagents and conditions: i) MeI, THF; ii) RNCX (2 equiv.), NEt_3, CH_2Cl_2.

Table 1. Synthesis of *N*-substituted pyrimidines **3**–**12** from diazadienium iodide **2** (Schemes 1–3).

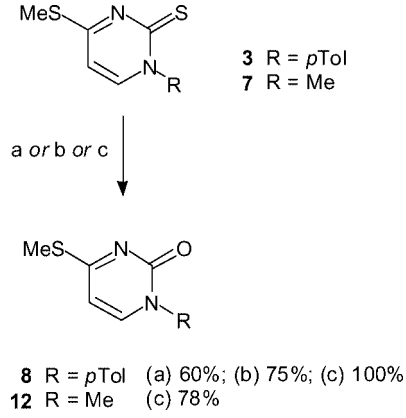
(X = S) R	Compd. [%][a]	(X = O) R	Compd. [%][b]
*p*Tol	**3** (91)	*p*Tol	**8** (80)
Ph	**4** (70)	Ph	**9** (75)
Bn	**5** (60)	Et	**10** (32)[c]
All	**6** (87)	Cy	**11** (66)[c]
Me	**7** (69)	Me	**12** (54)[d]

[a] Reagents and conditions: RNCS (2 equiv.), NEt_3, CH_2Cl_2. [b] RNCO (2 equiv.), NEt_3, CH_2Cl_2. [c] Over two steps: 1) RNCO (1 equiv.), NEt_3, CH_2Cl_2; 2) NaH, CH_3CN, reflux. [d] Over two steps: 1) MeNCS (2 equiv.), NEt_3, CH_2Cl_2; 2) Oxone®, wet Al_2O_3, CH_2Cl_2, reflux.



Scheme 2. Two-step ring construction from alkyl isocyanates. Reagents and conditions: i) RNCO (1 equiv.), NEt_3, CH_2Cl_2; ii) NaH, CH_3CN, reflux.

other hand, methyl isothiocyanate is commercially available. Synthesis of *N*-methylpyrimidinone (**12**) was thus achieved in two steps from *N*-methyl isothiocyanate, through a preliminary [4+2] cyclocondensation with diazadienium iodide **2** to give *N*-methylpyrimidinethione (**7**) and subsequent transformation of the thiocarbonyl into carbonyl. Different reaction conditions for this kind of C=S to C=O transformation of thioamides have been reported in the literature[8–10] and tolerate various functionalities on the ring. These conditions were first applied to the conversion of *N*-*p*-tolylpyrimidinethione (**3**) into *N*-*p*-tolylpyrimidinone (**8**): in so far as compound **8** had already been isolated in one step from **2** and *N*-*p*-tolyl isocyanate (Scheme 1, Table 1), comparison assignments were helpful. Oxone® proved to be the most efficient reagent and was therefore used for preparation of **12** from **7** in a 78% yield (Scheme 3, Table 1).



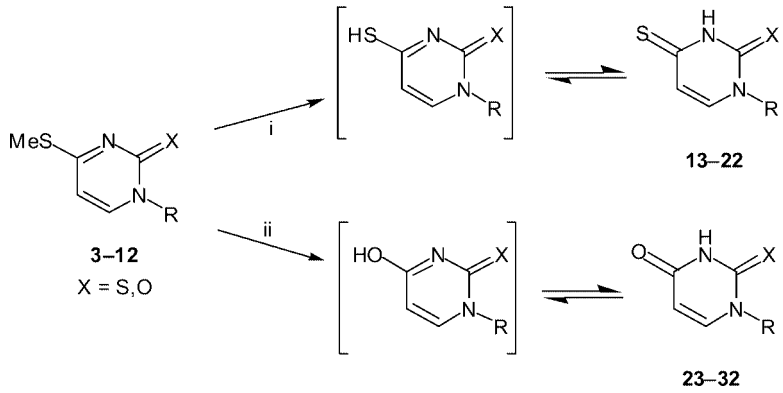
Scheme 3. Pyrimidinones from pyrimidinethiones. Reagents and conditions: a) $Bi(NO_3)_3 \cdot 5H_2O$, CH_3CN, reflux; b) $(CF_3CO)_2O$, CH_3CN, reflux; c) Oxone®, wet Al_2O_3, CH_2Cl_2.

Nucleophilic Substitutions

In our synthetic approach, pyrimidines **3**–**12** were synthesised with variation of the substituent on N-1. From these compounds, a change of the functional group on C-4 was also envisioned. Indeed, it is known that a sulfanyl substituent positioned on the carbon of an imine can act as a good leaving group,[11,12] and this prompted us to use this reaction to enlarge the number of pyrimidines accessible through our methodology. New functional groups were thus introduced on the previously constructed pyrimidines **3**–**12** by nucleophilic substitution of the methylsulfanyl group. Reactions with hydrogen sulfide in basic medium[13] or hydroxide potassium in alcoholic medium[14] gave, after prototropic equilibrium, 4-thioxopyrimidines **13**–**22** and 4-oxopyrimidines **23**–**32**, respectively (Scheme 4). These transformations were achieved with good yields (Table 2) and we note that substitution with thiohydroxide can be considered as an *S*-deprotection of thioamide **1**.

In order to modulate the functionality at the 4-position of the pyrimidine, other nucleophiles were used. *N*-*p*-Tolylpyrimidinethione (**3**), which is easily accessible on a large scale, served as a starting material model for this purpose. In this way, 4-substituted pyrimidinethiones **33**–**37** and **38**–**42** were obtained in good yields upon treatment of **3** with amines and sodium alkoxides, respectively (Scheme 5, Table 3). The 4-aminopyrimidinethione **33** could be easily isolated using a commercially available methanolic solution of ammonia.

These structural modifications, associated with the efficiency of the preliminary [4+2] cyclocondensation reaction, describe a general access to 1,2,4-trisubstituted pyrimidines (Figure 1). In summary, pyrimidines **3**–**42** can be isolated

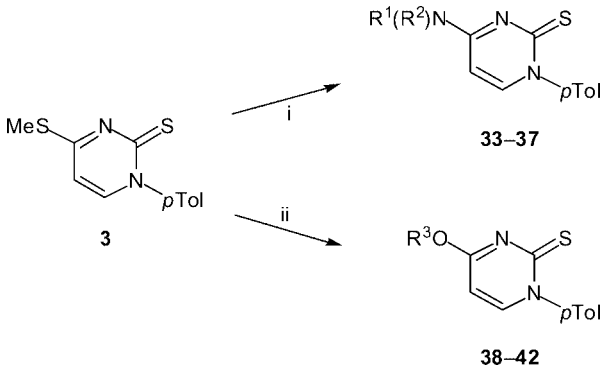


Scheme 4. Nucleophilic substitutions. Reagents and conditions: i) H_2S, Py, NEt_3; ii) aqueous KOH, EtOH, reflux.

Table 2. Synthesis of *N*-substituted pyrimidines **13**–**22** and **23**–**32** from **3**–**12** (Scheme 4).

X	R	Compd. [%][a]	Compd. [%][b]
S	*p*Tol	**13** (71)	**23** (65)
S	Ph	**14** (70)	**24** (76)
S	Bn	**15** (65)	**25** (71)
S	All	**16** (54)	**26** (68)
S	Me	**17** (75)	**27** (98)
O	*p*Tol	**18** (83)	**28** (98)
O	Ph	**19** (68)	**29** (70)
O	Et	**20** (70)	**30** (79)
O	Cy	**21** (53)	**31** (92)
O	Me	**22** (64)	**32** (74)

[a] Reagents and conditions: H_2S, Py, NEt_3. [b] Aqueous KOH, EtOH, reflux.



Scheme 5. Nucleophilic substitutions. Reagents and conditions: i) for **33** (R^1 = R^2 = H): NH_3, MeOH, 50 °C; for **34**–**37**: $R^1(R^2)$NH, CH_3CN, reflux; ii) for **38** (R^3 = Bn): BnONa, CH_2Cl_2; for **39**–**42**: R^3ONa, R^3OH.

Table 3. Synthesis of *N*-*p*-Tol-substituted pyrimidinethiones **33**–**37** and **38**–**42** from **3** (Scheme 5).

R^1	R^2	Compd. [%][a]	R^3	Compd. [%][c]
H	H	**33** (91)[b]	Bn	**38** (65)[d]
H	Bn	**34** (90)	Me	**39** (65)
H	Me	**35** (95)	*i*Pr	**40** (71)
Me	Me	**36** (80)	All	**41** (65)
	$(CH_2)_5$	**37** (97)	$(CH_2)_2OMe$	**42** (81)

[a] Reagents and conditions: $R^1(R^2)$NH, CH_3CN, reflux. [b] NH_3, MeOH, 50 °C. [c] R^3ONa, R^3OH. [d] BnONa, CH_2Cl_2.

after a one to three step synthesis from diazadienium iodide **2**. These molecules, and the associated synthetic route, constitute a potentially expansive library which may be useful for pharmacomodulation and biological tests. This pyrimidine series notably includes uracil analogues **13**–**32**. Our methodology therefore represents an interesting alternative to the usually non-regioselective *N*-alkylation reaction of the natural nucleobase uracil.[15–17] The other natural pyrimidine nucleobase cytosine is represented by analogues **33**–**37**.

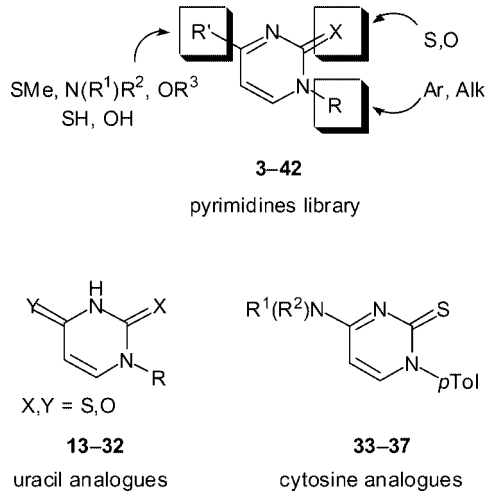
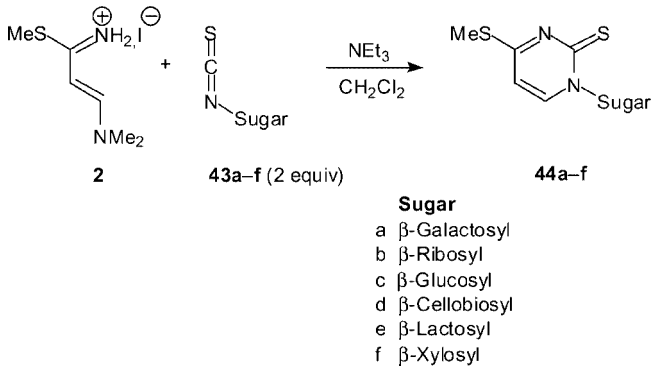


Figure 1. 1,2,4-Substituted pyrimidines.

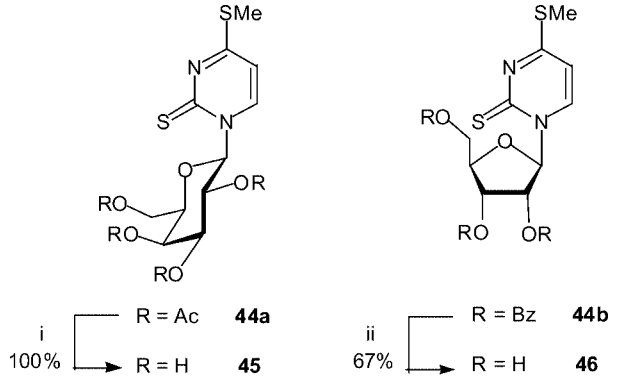
Nucleoside Analogue Synthesis

These results naturally led us to further apply our strategy to the synthesis of modified pyrimidine nucleosides. We recently reported[18] that the [4+2] cyclocondensation reaction between glycosyl isothiocyanates and diazadienium iodide **2** is very efficient in terms of chemical yield and diastereo- and regioselectivity for the synthesis of nucleosides **44a**–**f**. These compounds were synthesised in a range of 72 to 84% yield from preconstructed β-glycosyl isothiocyanates **43a**–**f** (Scheme 6).

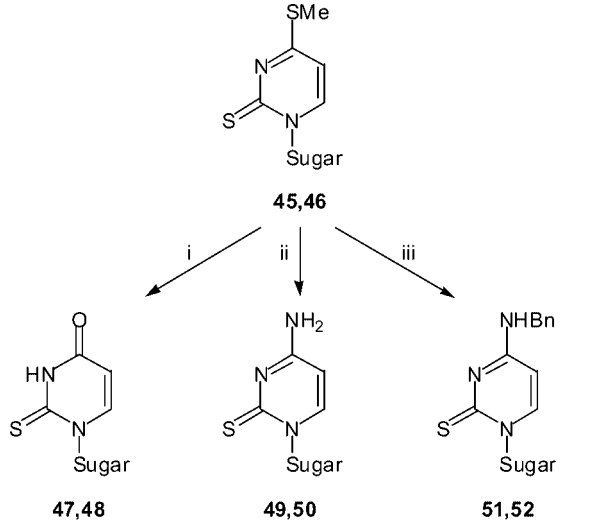


Scheme 6. Pyrimidine nucleoside analogues.

Studies for the substitution of the methylsulfanyl group were undertaken with compounds **44a** and **44b**, which contain a peracetylated galactosyl and a perbenzoylated ribosyl, respectively. In order to avoid side reactions on protected alcohol functions, sugar moiety deprotection was first examined (Scheme 7). Classical basic and nucleophilic conditions[19–21] could not be used as they would result in



Scheme 7. *O*-Deprotection of the sugar moiety. Reagents and conditions: i) MeOH, 0 °C; ii) K_2CO_3 (0.05 equiv.), MeOH, 0 °C.



Scheme 8. Modified nucleosides. Reagents and conditions: i) aqueous KOH, EtOH, reflux; ii) NH_3, MeOH, 50 °C; iii) for **51**: $BnNH_2$, CH_3CN, reflux; for **52**: $BnNH_2$, MeOH, reflux.

structural modifications on the pyrimidine moiety by methylsulfanyl substitution. Surprisingly, complete deacetylation of **44a** took place quantitatively in methanolic medium. We postulate that the pyrimidine moiety is basic enough to catalyse the reaction. Debenzoylation of **44b** required the addition of a catalytic amount of potassium carbonate as well as a longer reaction time.

Nucleophilic substitutions of the methylsulfanyl group on the pyrimidine moiety were then undertaken (Scheme 8). The previously described transformations were successfully applied to free OH-glycosyl compounds **45** and **46**, and modified nucleosides **47**–**52** were isolated in good yields (Table 4).

Table 4. Synthesis of pyrimidine nucleosides **47**–**52** from **45** and **46** (Scheme 8).

Sugar	Compd. [%][a]	Compd. [%][b]	Compd. [%]
Galactosyl	47 (70)	49 (100)	51 (81)[c]
Ribosyl	48 (64)	50 (56)	52 (100)[d]

[a] Reagents and conditions: aqueous KOH, EtOH, reflux. [b] NH_3, MeOH, 50 °C. [c] $BnNH_2$, CH_3CN, reflux. [d] $BnNH_2$, MeOH, reflux.

Conclusions

In conclusion, we have described here an efficient strategy for the synthesis of pyrimidines substituted at N-1, including the preparation of modified nucleosides, by the original construction and further elaboration of the heterocycle ring. Although a large number of pyrimidines have already been isolated, investigations are still under way to extend this library, notably with the use of other nucleophiles. Such an easily accessible wide range of potentially biologically active compounds should be of great interest in many pharmaceutical fields.

Experimental Section

Pyrimidines 3–9: Isothiocyanate or isocyanate (2.2 mmol) was added to a solution of diazadienium iodide **2**[18] (272 mg, 1.0 mmol) in dichloromethane (10 mL). After 15 min, triethylamine (300 μL, 2.2 mmol) was added and the reaction mixture was stirred at room temperature over a period of 4–18 h (18 h for **3**, **5**, **8** and **9**; 6 h for **4** and **6**; 4 h for **7**). The organic mixture was then washed twice with water, dried with magnesium sulfate and concentrated under vacuum. The residue was purified by chromatography on silica gel [dichloromethane/petroleum ether/triethylamine (80:17:3) for **3**; dichloromethane/petroleum ether/triethylamine (50:47:3) for **4**,**7**,**9**; dichloromethane/petroleum ether/triethylamine (40:57:3) for **5**; dichloromethane/ethyl acetate (80:20) for **6**; dichloromethane/ethyl acetate (90:10) for **8**].

4-Methylsulfanyl-1-*p*-tolylpyrimidine-2(1*H*)-thione (3): Yellow solid (226 mg, 91%). M.p. 197–199 °C. IR (KBr): $\tilde{\nu}$ = 1597 (s), 1482 (s), 1405 (m), 1322 (s), 1174 (m) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.39 (s, 3 H, CH_3), 2.62 (s, 3 H, SCH_3), 6.61 (d, J = 6.9 Hz, 1 H, 5-C*H*), 7.17 (d, J = 8.4 Hz, 2 H, $2CH_{ar}$), 7.28 (d, J = 8.4 Hz, 2 H, $2CH_{ar}$), 7.47 (d, J = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 12.8 (SCH_3), 21.0 (CH_3), 107.5 (5-*C*H),

125.9 (2*C*H$_{ar}$), 130.1 (2*C*H$_{ar}$), 139.1 (*C*$_{ar}$), 141.1 (*C*$_{ar}$), 144.2 (6-*C*H), 172.9 (4-*C*), 181.6 (2-*C*) ppm. MS (CI$^+$, NH$_3$): *m*/*z* (%) = 249 (100) [M + H]$^+$.

4-Methylsulfanyl-1-phenylpyrimidine-2(1*H*)-thione (4): Yellow solid (164 mg, 70%). M.p. 173–175 °C. IR (KBr): $\tilde{\nu}$ = 1605 (s), 1589 (s), 1481 (s), 1405 (m), 1323 (s), 1175 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.66 (s, 3 H, C*H*$_3$), 6.60 (d, *J* = 7.0 Hz, 1 H, 5-C*H*), 7.40 (m, 5 H, 5C*H*$_{ar}$), 7.43 (d, *J* = 7.0 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.2 (*C*H$_3$), 107.7 (5-*C*H), 126.6 (2*C*H$_{ar}$), 129.3 (*C*H$_{ar}$), 129.9 (2*C*H$_{ar}$), 144.0 (*C*$_{ar}$ and 6-*C*H), 173.4 (4-*C*), 182.0 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 234 (100) [M]$^+$, 233 (100), 219 (46), 203 (22), 187 (21), 77 (13).

1-Benzyl-4-(methylsulfanyl)pyrimidine-2(1*H*)-thione (5): Yellow solid (149 mg, 60%). M.p. 109–111 °C. IR (KBr): $\tilde{\nu}$ = 1605 (s), 1495 (s), 1403 (m), 1349 (w), 1258 (w), 1146 (w) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.61 (s, 3 H, C*H*$_3$), 5.62 (s, 2 H, C*H*$_2$), 6.48 (d, *J* = 7.0 Hz, 1 H, 5-C*H*), 7.36 (m, 6 H, 5C*H*$_{ar}$ and 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.1 (*C*H$_3$), 59.1 (*C*H$_2$), 108.5 (5-*C*H), 128.6 (2*C*H$_{ar}$), 128.7 (*C*H$_{ar}$), 129.2 (2*C*H$_{ar}$), 134.5 (*C*$_{ar}$), 143.2 (6-*C*H), 172.0 (4-*C*), 181.7 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 248 (100) [M]$^+$, 233 (10), 215 (47), 200 (14), 91 (27).

1-Allyl-4-(methylsulfanyl)pyrimidine-2(1*H*)-thione (6): Yellow oil (172 mg, 87%). TLC (dichloromethane/petroleum ether, 1:1): R_f = 0.56. IR (film): $\tilde{\nu}$ = 3058 (m), 1608 (s), 1504 (s), 1404 (s), 1346 (s), 1268 (s), 1153 (s) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.61 (s, 3 H, C*H*$_3$), 5.04 (d, *J* = 6.0 Hz, 2 H, C*H*$_2$), 5.34 (m, 2 H, C*H*$_2$=), 6.03 (m, 1 H, C*H*=), 6.58 (d, *J* = 6.9 Hz, 1 H, 5-C*H*), 7.53 (d, *J* = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.0 (*C*H$_3$), 58.5 (*C*H$_2$), 108.5 (5-*C*H), 120.5 (*C*H$_2$=), 130.7 (*C*H=), 143,3 (6-*C*H), 172.2 (4-*C*), 181.1 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 198 (15) [M]$^+$, 183 (100), 165 (15), 150 (15), 125 (16), 111 (29), 39 (20).

1-Methyl-4-(methylsulfanyl)pyrimidine-2(1*H*)-thione (7): Yellow solid (119 mg, 69%). M.p. 149–151 °C. IR (KBr): $\tilde{\nu}$ = 1610 (m), 1501 (s), 1335 (w), 1169 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.61 (s, 3 H, SC*H*$_3$), 3.85 (s, 3 H, NC*H*$_3$), 6.55 (d, *J* = 6.9 Hz, 1 H, 5-C*H*), 7.56 (d, *J* = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.1 (S*C*H$_3$), 45.7 (N*C*H$_3$), 108.2 (5-*C*H), 144.5 (6-*C*H), 172.4 (4-*C*), 181.3 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 172 (100) [M]$^+$, 157 (92), 98 (30), 42 (47).

4-Methylsulfanyl-1-*p*-tolylpyrimidin-2(1*H*)-one (8): Yellow solid (186 mg, 80%). M.p. 155–157 °C. IR (KBr): $\tilde{\nu}$ = 1666 (s), 1611 (m), 1492 (m), 1297 (w), 1205 (w) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.39 (s, 3 H, C*H*$_3$), 2.59 (s, 3 H, SC*H*$_3$), 6.28 (d, *J* = 7.0 Hz, 1 H, 5-C*H*), 7.26 (s, 4 H, 4C*H*$_{ar}$), 7.37 (d, *J* = 7.0 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.0 (S*C*H$_3$), 21.2 (*C*H$_3$), 103.6 (5-*C*H), 125.9 (2*C*H$_{ar}$), 130.2 (2*C*H$_{ar}$), 137.8 (*C*$_{ar}$), 138.9 (*C*$_{ar}$), 144.1 (6-*C*H), 153.0 (2-*C*), 178.5 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 232 (24) [M]$^+$, 217 (50), 107 (31), 91 (97), 86 (30), 65 (100), 39 (33).

4-Methylsulfanyl-1-phenylpyrimidin-2(1*H*)-one (9): White solid (163 mg, 75%). M.p. 156–158 °C. IR (KBr): $\tilde{\nu}$ = 1664 (s), 1614 (m), 1493 (m), 1287 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.52 (s, 3 H, C*H*$_3$), 6.22 (d, *J* = 7.0 Hz, 1 H, 5-C*H*), 7.28 (m, 6 H, 5C*H*$_{ar}$ and 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.0 (*C*H$_3$), 103.7 (5-*C*H), 126.1 (2*C*H$_{ar}$), 128.7 (*C*H$_{ar}$), 129.5 (2*C*H$_{ar}$), 140.3 (*C*$_{ar}$), 144.0 (6-*C*H), 153.9 (2-*C*), 178.6 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 218 (59) [M]$^+$, 203 (100), 160 (11), 77 (83), 51 (38).

Pyrimidines 10 and 11: Isocyanate (1.2 mmol) was added to a solution of diazadienium iodide **2**[18] (272 mg, 1.0 mmol) in dichloromethane (10 mL). After 15 min, triethylamine (200 µL, 1.4 mmol) was added and the reaction mixture was stirred at room temperature for 18 h. Then, the organic mixture was washed twice with water, dried with magnesium sulfate and concentrated under vacuum. The resulting solid was washed with diethyl ether.

Intermediate for 10: White solid (120 mg, 56%). M.p. 91–93 °C. IR (KBr): $\tilde{\nu}$ = 1623 (s), 1506 (m), 1389 (m), 1234 (m), 1109 (w) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.18 (t, *J* = 7.2 Hz, 3 H, C*H*$_3$), 2.32 (s, 3 H, SC*H*$_3$), 2.89 [br. s, 6 H, N(C*H*$_3$)$_2$], 3.31 (quin, *J* = 7.2 Hz, 2 H, C*H*$_2$), 5.10 (br. s, 1 H, N*H*), 5.46 (d, *J* = 13.2 Hz, 1 H, C*H*=), 7.32 (d, *J* = 13.2 Hz, 1 H, NC*H*=) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.1 (S*C*H$_3$), 15.2 (*C*H$_3$), 35.2 (*C*H$_2$), 92.5 (*C*H=), 149.4 (N*C*H=), 163.7 (*C*=O), 171.0 (*C*=N) ppm; [N(*C*H$_3$)$_2$] not observed. MS (EI, 70 eV): *m*/*z* (%) = 215 (3) [M]$^+$, 168 (17), 97 (100), 56 (15), 42 (19), 29 (11).

Intermediate for 11: White solid (196 mg, 73%). M.p. 133–135 °C. IR (KBr): $\tilde{\nu}$ = 1623 (s), 1506 (m), 1401 (m), 1226 (m), 1107 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.13–2.02 (m, 10 H, 5C*H*$_2$), 2.33 (s, 3 H, SC*H*$_3$), 2.90 [br. s, 6 H, N(C*H*$_3$)$_2$], 3.67 (m, 1 H, C*H*), 5.04 (d, *J* = 8.1 Hz, 1 H, N*H*), 5.42 (d, *J* = 12.9 Hz, 1 H, C*H*=), 7.31 (d, *J* = 12.9 Hz, 1 H, NC*H*=) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.1 (S*C*H$_3$), 24.9 (2*C*H$_2$), 25.6 (*C*H$_2$), 33.5 (2*C*H$_2$), 48.9 (*C*H), 92.4 (*C*H=), 149.3 (N*C*H=), 163.1 (*C*=O), 170.6 (*C*=N) ppm; [N(*C*H$_3$)$_2$] not observed. MS (EI, 70 eV): *m*/*z* (%) = 222 (22) [M – SMe]$^+$, 143 (23), 97 (100), 67 (23), 56 (24), 42 (27).

Sodium hydride (60% dispersion, 90 mg, 2.2 mmol) was added to a solution of the intermediate (2.0 mmol) in acetonitrile (10 mL) and the reaction mixture was refluxed for 5 h. Then, acetonitrile was removed and the residue was dissolved in dichloromethane (25 mL), washed twice with water, dried with magnesium sulfate and concentrated under vacuum. The residue was purified by chromatography on silica gel (dichloromethane/ethyl acetate (7:3) for **10**; dichloromethane/ethyl acetate (8:2) for **11**).

1-Ethyl-4-(methylsulfanyl)pyrimidin-2(1*H*)-one (10): Colourless oil (196 mg, 58%). TLC (dichloromethane/ethyl acetate, 6:4): R_f = 0.32. IR (film): $\tilde{\nu}$ = 1653 (s), 1614 (s), 1507 (m), 1422 (w), 1265 (w), 1215 (w) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.29 (t, *J* = 7.2 Hz, 3 H, C*H*$_3$), 2.48 (s, 3 H, SC*H*$_3$), 3.83 (q, *J* = 7.2 Hz, 2 H, C*H*$_2$), 6.15 (d, *J* = 6.9 Hz, 1 H, 5-C*H*), 7.24 (d, *J* = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 12.8 (S*C*H$_3$), 14.3 (*C*H$_3$), 45.9 (*C*H$_2$), 103.6 (5-*C*H), 143.3 (6-*C*H), 154.7 (2-*C*), 177.4 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 170 (100) [M]$^+$, 155 (55), 127 (52), 94 (36), 45 (25), 29 (43).

1-Cyclohexyl-4-(methylsulfanyl)pyrimidin-2(1*H*)-one (11): Yellow oil (404 mg, 90%). TLC (dichloromethane/ethyl acetate, 7:3): R_f = 0.43. IR (film): $\tilde{\nu}$ = 2928 (s), 2855 (m), 1651 (s), 1610 (s), 1504 (m), 1435 (w), 1271 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.16–2.01 (m, 10 H, 5C*H*$_2$), 2.52 (s, 3 H, C*H*$_3$), 4.61 (m, 1 H, C*H*), 6.20 (d, *J* = 6.9 Hz, 1 H, 5-C*H*), 7.32 (d, *J* = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 12.7 (*C*H$_3$), 25.3 (*C*H$_2$), 25.6 (2*C*H$_2$), 32.3 (2*C*H$_2$), 55.5 (*C*H); 103.4 (5-*C*H), 139.9 (6-*C*H), 154.6 (2-*C*), 176.3 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 224 (16) [M]$^+$, 143 (100), 127 (22), 55 (33), 41 (42).

1-Methyl-4-(methylsulfanyl)pyrimidin-2(1*H*)-one (12): Oxone® (1.23 g, 2.0 mmol) and wet alumina (1.0 g) were added to a solution of pyrimidine **7** (172 mg, 1.0 mmol) in dichloromethane (15 mL). The reaction mixture was stirred at room temperature for 48 h. Then, the inorganic salts were removed by filtration and the filtrate was concentrated under vacuum. The residue was purified by chromatography on silica gel (dichloromethane/petroleum ether/triethylamine, 90:7:3). Yellow solid (121 mg, 78%). M.p. 116–118 °C. IR (KBr): $\tilde{\nu}$ = 1652 (s), 1616 (s), 1506 (s), 1329 (w), 1228 (w) cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.56 (s, 3 H, SCH_3), 3.49 (s, 3 H, NCH_3), 6.20 (d, ^3J = 6.9 Hz, 1 H, 5-C*H*), 7.29 (d, ^3J = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.0 (S*C*H$_3$), 38.6 (N*C*H$_3$), 103.6 (5-*C*H), 144.5 (6-*C*H), 155.5 (2-*C*), 177.9 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 156 (96) $[M]^+$, 123 (19), 141 (100), 100 (24), 42 (73).

Pyrimidines 13–22: Hydrogen sulfide was passed for 2 h through a solution of pyrimidine **3**–**12** (1.0 mmol) in triethylamine (10 mL) and pyridine (10 mL). Then, the solvents were removed and the residue was dissolved in dichloromethane (20 mL), washed twice with water, dried with magnesium sulfate and concentrated under vacuum. The resulting solid was either washed with diethyl ether (for **13**, **15**, **18**, **19** and **22**) or dichloromethane (**17**), or was purified by chromatography on silica gel (dichloromethane/petroleum ether (6:4) for **16**; dichloromethane for **14** and **21**; dichloromethane/ethyl acetate (7:3) for **20**).

1-*p*-Tolylpyrimidine-2,4(1*H*,3*H*)-dithione (13): Yellow solid (166 mg, 71%). M.p. 122–124 °C. IR (KBr): $\tilde{\nu}$ = 1612 (m), 1507 (m), 1445 (m), 1293 (s), 1198 (s), 1143 (s) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.42 (s, 3 H, CH_3), 6.64 (d, J = 7.5 Hz, 1 H, 5-C*H*), 7.08 (d, J = 7.5 Hz, 1 H, 6-C*H*), 7.20 (d, J = 8.3 Hz, 2 H, 2CH_{ar}), 7.32 (d, J = 8.3 Hz, 2 H, 2CH_{ar}), 10.56 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.4 (*C*H$_3$), 117.2 (5-*C*H), 126.5 (2*C*H$_{ar}$), 130.6 (2*C*H$_{ar}$), 138.7 (6-*C*H), 139.4 (C_{ar}), 140.3 (C_{ar}), 173.9 (2-*C*), 186.2 (4-*C*) ppm. MS (CI^+, NH_3): *m*/*z* (%) = 235 (100) $[M + H]^+$.

1-Phenylpyrimidine-2,4(1*H*,3*H*)-dithione (14): Yellow solid (154 mg, 70%). M.p. 222–224 °C. IR (KBr): $\tilde{\nu}$ = 1623 (s), 1592 (m), 1492 (s), 1445 (s), 1285 (m), 1232 (m), 1194 (m), 1070 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.66 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.10 (d, J = 7.2 Hz, 1 H, 6-C*H*), 7.34 (m, 2 H, 2CH_{ar}), 7.55 (m, 3 H, 3CH_{ar}), 10.81 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 117.1 (5-*C*H), 126.8 and 130.0 (5*C*H$_{ar}$), 138.3 (6-*C*H), 141.8 (C_{ar}), 173.7 (2-*C*), 186.1 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 220 (100) $[M]^+$, 219 (59), 187 (16), 162 (25), 104 (19), 77 (57), 51 (27).

1-Benzylpyrimidine-2,4(1*H*,3*H*)-dithione (15): White solid (152 mg, 65%). M.p. 168–170 °C. IR (KBr): $\tilde{\nu}$ = 1611 (s), 1507 (m), 1465 (m), 1134 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 5.40 (s, 2 H, CH_2), 6.55 (d, J = 7.2 Hz, 1 H, 5-C*H*), 6.98 (d, J = 7.2 Hz, 1 H, 6-C*H*), 7.39 (m, 5 H, 5CH_{ar}), 10.77 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 57.3 (*C*H$_2$), 118.0 (5-*C*H), 128.2 (2*C*H$_{ar}$), 129.0 (*C*H$_{ar}$), 129.3 (2*C*H$_{ar}$), 133.7 (C_{ar}), 137.2 (6-*C*H), 173.6 (2-*C*), 185.5 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 234 (55) $[M]^+$, 201 (19), 91 (100), 65 (19).

1-Allylpyrimidine-2,4(1*H*,3*H*)-dithione (16): Yellow solid (100 mg, 54%). M.p. 109–111 °C. IR (KBr): $\tilde{\nu}$ = 1609 (s), 1507 (m), 1464 (m), 1256 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 4.80 (d, J = 6.0 Hz, 2 H, CH_2), 5.35 (m, 2 H, CH_2=), 5.91 (m, 1 H, C*H*=), 6.60 (dd, J = 7.8, 1.2 Hz, 1 H, 5-C*H*), 7.03 (d, J = 7.8 Hz, 1 H, 6-C*H*), 11.08 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.6 (*C*H$_2$), 118.0 (5-*C*H), 121.0 (*C*H$_2$=), 129.9 (*C*H=), 137.4 (6-*C*H), 173.1 (2-*C*), 185.6 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 184 (28) $[M]^+$, 169 (100), 124 (10), 84 (10), 69 (11), 41 (25).

1-Methylpyrimidine-2,4(1*H*,3*H*)-dithione (17): Yellow solid (118 mg, 75%). M.p. 245–247 °C. IR (KBr): $\tilde{\nu}$ = 1614 (m), 1601 (s), 1537 (s), 1350 (m), 1218 (m), 1108 (s) cm^{-1}. ^{1}H NMR (300 MHz, [D$_6$]DMSO): δ = 3.57 (s, 3 H, CH_3), 6.58 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.68 (d, J = 7.2 Hz, 1 H, 6-C*H*), 12.60 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 42.9 (*C*H$_3$), 117.3 (5-*C*H), 140.9 (6-*C*H), 173.4 (2-*C*), 186.4 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 158 (100) $[M]^+$, 100 (18), 72 (11), 42 (30).

4-Thioxo-1-*p*-tolylpyrimidin-2(1*H*,3*H*)-one (18): Yellow solid (180 mg, 83%). M.p. 155–157 °C. IR (KBr): $\tilde{\nu}$ = 1700 (s), 1685 (s), 1617 (m), 1507 (m), 1437 (m), 1153 (m) cm^{-1}. ^{1}H NMR (300 MHz, [D$_6$]DMSO): δ = 2.33 (s, 3 H, CH_3), 6.30 (d, J = 6.7 Hz, 1 H, 5-C*H*), 7.29 (s, 4 H, 4CH_{ar}), 7.55 (d, J = 6.7 Hz, 1 H, 6-C*H*), 12.71 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 20.7 (*C*H$_3$), 112.5 (5-*C*H), 126.3 (2*C*H$_{ar}$), 129.6 (2*C*H$_{ar}$), 136.2 (C_{ar}), 138.2 (C_{ar}), 144.2 (6-*C*H), 148.0 (2-*C*), 190.7 (4-*C*) ppm. MS (CI^+, NH_3): *m*/*z* (%) = 236 (12) $[M + NH_4]^+$, 219 (100) $[M + H]^+$.

1-Phenyl-4-thioxopyrimidin-2(1*H*,3*H*)-one (19): Yellow solid (138 mg, 68%). M.p. 196–198 °C. IR (KBr): $\tilde{\nu}$ = 1712 (m), 1684 (m), 1619 (s), 1591 (s), 1280 (m), 1144 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.49 (d, J = 7.5 Hz, 1 H, 5-C*H*), 7.17 (d, J = 7.5 Hz, 1 H, 6-C*H*), 7.42 (m, 5 H, 5CH_{ar}), 10.03 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 113.4 (5-*C*H), 125.9 (2*C*H$_{ar}$), 129.3 (*C*H$_{ar}$), 129.8 (2*C*H$_{ar}$), 138.1 (C_{ar}), 139.2 (6-*C*H), 147.5 (2-*C*), 190.0 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 204 (100) $[M]^+$, 161 (22), 117 (29), 104 (24), 77 (45), 51 (16).

1-Ethyl-4-thioxopyrimidin-2(1*H*,3*H*)-one (20): Yellow solid (109 mg, 70%). M.p. 154–156 °C. IR (KBr): $\tilde{\nu}$ = 1694 (s), 1685 (s), 1615 (s), 1459 (m), 1263 (m), 1105 (m) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.34 (t, J = 7.2 Hz, 3 H, CH_3), 3.80 (q, J = 7.2 Hz, 2 H, CH_2), 6.39 (dd, J = 7.2, 1.8 Hz, 1 H, 5-C*H*), 7.00 (d, J = 7.2 Hz, 1 H, 6-C*H*), 10.11 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 14.2 (*C*H$_3$), 44.7 (*C*H$_2$), 113.4 (5-*C*H), 139.0 (6-*C*H), 148.2 (2-*C*), 189.9 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 156 (100) $[M]^+$, 128 (28), 86 (12).

1-Cyclohexyl-4-thioxopyrimidin-2(1*H*,3*H*)-one (21): Yellow solid (112 mg, 53%). M.p. 196–198 °C. IR (KBr): $\tilde{\nu}$ = 2932 (m), 1692 (s), 1684 (s), 1611 (m), 1271 (m), 1244 (w) cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.14–1.91 (m, 10 H, 5CH_2), 4.43 (m, 1 H, C*H*), 6.40 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.07 (d, J = 7.8 Hz, 1 H, 6-C*H*), 10.13 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.1 (*C*H$_2$), 25.5 (2*C*H$_2$), 31.8 (2*C*H$_2$), 55.5 (*C*H), 113.2 (5-*C*H), 135.8 (6-*C*H), 148.4 (2-*C*), 189.0 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 210 (65) $[M]^+$, 128 (100), 86 (12), 55 (30), 41 (24).

1-Methyl-4-thioxopyrimidin-2(1*H*,3*H*)-one (22): Yellow solid (91 mg, 64%). M.p. 193–196 °C. IR (KBr): $\tilde{\nu}$ = 1742 (m), 1734 (s), 1719 (m), 1630 (s), 1325 (w), 1109 (m) cm^{-1}. ^{1}H NMR (300 MHz, [D$_6$]DMSO): δ = 3.25 (s, 3 H, CH_3), 6.22 (d, J = 6.8 Hz, 1 H, 5-C*H*), 7.53 (d, J = 6.8 Hz, 1 H, 6-C*H*), 12.65 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 36.0 (*C*H$_3$), 111.7 (5-*C*H), 142.4 (6-*C*H), 148.8 (2-*C*), 190.1 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 142 (100) $[M]^+$, 113 (14), 42 (81).

Pyrimidines 23–32: Pyrimidine **3**–**12** (1.0 mmol) was dissolved in ethanol (5 mL) and aqueous potassium hydroxide (2 M, 5 mL). The reaction mixture was refluxed for 4 h. Then, after cooling to 0 °C, the reaction mixture was acidified to pH 4 with aqueous hydrochloric acid (6 M). For **23** and **27**–**29** the precipitate was filtered, washed with water and dried in vacuo. For **24**–**26** and **30**–**32** the solvents were removed and the residue was dissolved in dichloromethane (15 mL), washed twice with water, dried with magnesium sulfate and concentrated under vacuum. The resulting solid was either washed with diethyl ether (for **24**–**26**, **31** and **32**), or was purified by chromatography on silica gel (ethyl acetate for **30**).

2-Thioxo-1-*p*-tolylpyrimidin-4(1*H*,3*H*)-one (23): Yellow solid (142 mg, 65%). M.p. 146–148 °C. IR (KBr): $\tilde{\nu}$ = 1676 (s), 1507 (m), 1278 (m), 1251 (w) cm^{-1}. ^{1}H NMR (300 MHz, [D$_6$]DMSO): δ = 2.36 (s, 3 H, CH_3), 5.97 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.28 (s, 4 H, 4CH_{ar}), 7.73 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.68 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 20,7 (*C*H$_3$), 105.9 (5-*C*H), 127.3 (2*C*H$_{ar}$), 129.8 (2*C*H$_{ar}$), 138.4 (C_{ar}), 140.1 (C_{ar}), 146.3 (6-*C*H), 160.5 (4-*C*), 177.3 (2-*C*) ppm. MS (CI^+, NH_3): *m*/*z* (%) = 219 (100) $[M + H]^+$.

1-Phenyl-2-thioxopyrimidin-4(1*H*,3*H*)-one (24): Yellow solid (155 mg, 76%). M.p. 222–224 °C. IR (KBr): $\tilde{\nu}$ = 1687 (s), 1641 (m), 1594 (m), 1493 (s), 1280 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 6.07 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.34 (m, 2 H, 2CH_{ar}), 7.36 (d, J = 7.8 Hz, 1 H, 6-C*H*), 7.53 (m, 3 H, 3CH_{ar}), 10.03 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 106.5 (5-*C*H), 127.2 (2*C*H_{ar}), 129.7 (*C*H_{ar}), 129.9 (2*C*H_{ar}), 142.0 (C_{ar}), 145.2 (6-*C*H), 160.0 (4-*C*), 177.1 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 204 (100) $[M]^+$, 203 (96), 145 (17), 117 (44), 95 (22), 77 (38), 51 (19).

1-Benzyl-2-thioxopyrimidin-4(1*H*,3*H*)-one (25): White solid (155 mg, 71%). M.p. 153–155 °C. IR (KBr): $\tilde{\nu}$ = 1720 (s), 1494 (m), 1440 (s), 1144 (m) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 5.44 (s, 2 H, CH_2), 5.99 (dd, J = 7.8, 1.8 Hz, 1 H, 5-C*H*), 7.33 (m, 5 H, 5CH_{ar}), 7.92 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.69 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 55.3 (*C*H$_2$), 106.8 (5-*C*H), 127.3 (2*C*H_{ar}), 127.7 (*C*H_{ar}), 128.6 (2*C*H_{ar}), 135.9 (C_{ar}), 145.9 (6-*C*H), 160.1 (4-*C*), 176.7 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 218 (54) $[M]^+$, 185 (21), 91 (100), 65 (22).

1-Allyl-2-thioxopyrimidin-4(1*H*,3*H*)-one (26): White solid (114 mg, 68%). M.p. 184–186 °C. IR (KBr): $\tilde{\nu}$ = 1669 (s), 1640 (m), 1487 (s), 1247 (m), 1157 (m) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 4.81 (d, J = 3.2 Hz, 2 H, CH_2), 5.20 (m, 2 H, CH_2=), 5.90 (m, 1 H, C*H*=), 5.97 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.76 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.62 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]-DMSO): δ = 54.7 (*C*H$_2$), 106.6 (5-*C*H), 118.2 (*C*H$_2$=), 131.8 (*C*H=), 145.6 (6-*C*H), 160.1 (4-*C*), 176.2 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 168 (45) $[M]^+$, 153 (100), 80 (27), 68 (24), 39 (33).

1-Methyl-2-thioxopyrimidin-4(1*H*,3*H*)-one (27): White solid (140 mg, 98%). M.p. > 300 °C. IR (KBr): $\tilde{\nu}$ = 1737 (s), 1701 (m), 1503 (s), 1440 (m), 1314 (s), 1125 (s) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 3.56 (s, 3 H, CH_3), 5.92 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.83 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.65 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 42.0 (*C*H$_3$), 106.0 (5-*C*H), 146.7 (6-*C*H), 160.5 (4-*C*), 176.4 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 142 (100) $[M]^+$, 84 (19), 82 (18), 55 (34), 42 (56).

1-*p*-Tolylpyrimidine-2,4(1*H*,3*H*)-dione (28): White solid (198 mg, 98%). M.p. 134–136 °C. IR (KBr): $\tilde{\nu}$ = 1740 (m), 1701 (m), 1691 (s), 1384 (m) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 2.34 (s, 3 H, CH_3), 5.65 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.28 (s, 4 H, 4CH_{ar}), 7.65 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.69 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 20.7 (*C*H$_3$), 101.5 (5-*C*H), 126.6 (2*C*H_{ar}), 129.6 (2*C*H_{ar}), 136.4 (C_{ar}), 137.8 (C_{ar}), 145.7 (6-*C*H), 150.5 (2-*C*), 163.8 (4-*C*) ppm. MS (CI$^+$, NH_3): *m*/*z* (%) = 220 (46) $[M + NH_4]^+$, 203 (100) $[M + H]^+$.

1-Phenylpyrimidine-2,4(1*H*,3*H*)-dione (29): White solid (132 mg, 70%). M.p. 236–238 °C. IR (KBr): $\tilde{\nu}$ = 3053 (w), 1745 (s), 1692 (s), 1629 (w), 1384 (s), 1298 (w) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]-DMSO): δ = 5.67 (dd, J = 7.8, 2.1 Hz, 1 H, 5-C*H*), 7.46 (m, 5 H, 5CH_{ar}), 7.71 (d, J = 7.8 Hz, 1 H, 6-C*H*), 12.71 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 101.6 (5-*C*H), 126.9 (2*C*H_{ar}), 128.3 (*C*H_{ar}), 129.2 (2*C*H_{ar}), 138.9 (C_{ar}), 145.6 (6-*C*H), 150.4 (2-*C*), 163.7 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 188 (100) $[M]^+$, 145 (88), 117 (90), 104 (27), 90 (24), 77 (56), 51 (27).

1-Ethylpyrimidine-2,4(1*H*,3*H*)-dione (30): White solid (110 mg, 79%). M.p. 144–146 °C. IR (KBr): $\tilde{\nu}$ = 1676 (s), 1452 (w), 1268 (m) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 1.30 (t, J = 7.2 Hz, 3 H, CH_3), 3.78 (q, J = 7.2 Hz, 2 H, CH_2), 5.71 (d, J = 7.5 Hz, 1 H, 5-C*H*), 7.17 (d, J = 7.5 Hz, 1 H, 6-C*H*), 9.72 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 14.5 (*C*H$_3$), 44.0 (*C*H$_2$), 102.5 (5-*C*H), 144.1 (6-*C*H), 151.0 (2-*C*), 164.2 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 140 (68) $[M]^+$, 112 (39), 82 (100), 69 (26).

1-Cyclohexylpyrimidine-2,4(1*H*,3*H*)-dione (31): Yellow solid (178 mg, 92%). M.p. 210–215 °C. IR (KBr): $\tilde{\nu}$ = 2931 (m), 1685 (s), 1379 (m), 1269 (m), 1244 (m) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 1.03–1.84 (m, 10 H, 5CH_2), 4.41 (m, 1 H, C*H*), 5.67 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.19 (d, J = 7.8 Hz, 1 H, 6-C*H*), 9.69 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.1 (*C*H$_2$), 25.5 (2*C*H$_2$), 31.9 (2*C*H$_2$), 54.6 (*C*H), 102.1 (5-*C*H), 140.7 (6-*C*H), 151.1 (2-*C*), 163.5 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 194 (18) $[M]^+$, 113 (100), 82 (20), 67 (22), 55 (30).

1-Methylpyrimidine-2,4(1*H*,3*H*)-dione (32): White solid (93 mg, 74%). M.p. 229–234 °C. IR (KBr): $\tilde{\nu}$ = 1695 (s), 1623 (m), 1423 (s), 1379 (s), 1331 (s) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 3.21 (s, 3 H, CH_3), 5.51 (d, J = 8.0 Hz, 1 H, 5-C*H*), 7.60 (d, J = 8.0 Hz, 1 H, 6-C*H*), 12.66 (br. s, 1 H, N*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]-DMSO): δ = 34.4 (*C*H$_3$), 99.7 (5-*C*H), 145.6 (6-*C*H), 150.5 (2-*C*), 163.1 (4-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 126 (96) $[M]^+$, 83 (45), 55 (35), 42 (100), 28 (23).

4-Amino-1-*p*-tolylpyrimidine-2(1*H*)-thione (33): A solution of pyrimidine **3** (248 mg, 1.0 mmol) in methanolic ammonia (7 M, 15 mL) was stirred at 50 °C in a sealed tube for 18 h. After concentration under vacuum, the resulting solid was washed with a minimum of methanol. White solid (198 mg, 91%). M.p. 267–269 °C. IR (KBr): $\tilde{\nu}$ = 1642 (s), 1476 (m), 1365 (m), 1350 (s) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 2.34 (s, 3 H, CH_3), 6.07 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.15 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.25 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.65 (br. s, 1 H, NH_2), 7.69 (d, J = 7.2 Hz, 1 H, 6-C*H*), 7.91 (br. s, 1 H, NH_2) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 20.6 (*C*H$_3$), 97.2 (5-*C*H), 127.2 (2*C*H_{ar}), 129.4 (2*C*H_{ar}), 137.3 (C_{ar}), 142.1 (6-*C*H), 146.5 (C_{ar}), 161.1 (4-*C*), 181.2 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 217 (10) $[M]^+$, 216 (18), 158 (100), 100 (21), 64 (21), 42 (41).

Pyrimidines 34–37: Amine N(R^1)R^2 (1.0 mmol for **34**; 10.0 mmol for **35** and **36**; 5 mmol for **37**) was added to a solution of pyrimidine **3** (248 mg, 1.0 mmol) in acetonitrile (20 mL). The reaction mixture was refluxed for 18 h. The solvent was then removed and the resulting solid was either purified by chromatography on silica gel [dichloromethane/petroleum ether/triethylamine (80:17:3) for **34**; dichloromethane/petroleum ether/triethylamine (50:47:3) for **37**] or washed with diethyl ether (**35** and **36**).

4-*N*-Benzylamino-1-*p*-tolylpyrimidine-2(1*H*)-thione (34): White solid (276 mg, 90%). M.p. 196–198 °C. IR (KBr): $\tilde{\nu}$ = 1634 (s), 1509 (m), 1495 (m), 1454 (m), 1351 (s), 1152 (m), 1085 (m) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 2.38 (s, 3 H, CH_3), 4.63 (s, 2 H, CH_2), 6.20 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.34 (m, 9 H, 9CH_{ar}), 7.66 (d, J = 7.2 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): 21.3 (*C*H$_3$), 45.4 (*C*H$_2$), 100.2 (5-*C*H), 128.1 (2*C*H_{ar}), 128.5 (*C*H_{ar}), 129.2, 129.7 and 130.9 (6*C*H_{ar}), 139.5 (C_{ar}), 140.0 (C_{ar}), 143.5 (C_{ar}), 146.7 (6-*C*H), 160.5 (4-*C*), 183.5 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 307 (53) $[M]^+$, 306 (85), 91 (100), 65 (25).

4-*N*-Methylamino-1-*p*-tolylpyrimidine-2(1*H*)-thione (35): White solid (2.195 g, 95%). M.p. 221–223 °C. IR (KBr): $\tilde{\nu}$ = 1637 (s), 1510 (m), 1385 (m), 1353 (s), 1149 (m) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 2.41 (s, 3 H, CH_3), 3.01 (s, 3 H, NCH_3), 6.17 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.18 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.30 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.55 (d, J = 7.2 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 21.2 (*C*H$_3$), 28.0 (N*C*H$_3$), 100.2 (5-*C*H), 128.1 (2*C*H_{ar}), 130.9 (2*C*H_{ar}), 139.9 (C_{ar}), 143.5 (C_{ar}), 146.2 (6-*C*H), 161.2 (4-*C*), 183.7 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 231 (63) $[M]^+$, 230 (100), 173 (24), 158 (18), 91 (14).

4-*N*,*N*-Dimethylamino-1-*p*-tolylpyrimidine-2(1*H*)-thione (36): Yellow solid (1.960 g, 80%). M.p. 107–109 °C. IR (KBr): $\tilde{\nu}$ = 1628 (s),

1507 (m), 1481 (m), 1358 (s), 1086 (m) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.40 (s, 3 H, CH_3), 3.13 [s, 3 H, N(CH_3)$_2$], 3.33 [s, 3 H, N(CH_3)$_2$], 6.11 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.25 (m, 4 H, 4CH_{ar}), 7.43 (d, J = 7.8 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.2 (*C*H$_3$), 37.8 [N(*C*H$_3$)$_2$], 38.0 [N(*C*H$_3$)$_2$], 94.7 (5-*C*H), 126.9 (2*C*H$_{ar}$), 130.0 (2*C*H$_{ar}$), 138.7 (C_{ar}), 141.9 (C_{ar}), 146.4 (6-*C*H), 158.7 (4-*C*), 181.5 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 245 (49) $[M]^+$, 244 (100), 201 (12), 139 (15), 91 (19).

4-Piperidino-1-*p*-tolylpyrimidine-2(1*H*)-thione (37): White solid (1.380 g, 97%). M.p. 229–231 °C. IR (KBr): $\tilde{\nu}$ = 2937 (w), 1629 (s), 1547 (m), 1509 (m), 1445 (m), 1386 (m), 1358 (s), 1347 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 1.68 (m, 6 H, 3CH_2), 2.39 (s, 3 H, CH_3), 3.49 (br. s, 2 H, CH_2), 4.06 (br. s, 2 H, CH_2), 6.16 (d, J = 7.8 Hz, 1 H, 5-C*H*), 7.24 (m, 4 H, 4CH_{ar}), 7.40 (d, J = 7.8 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.2 (*C*H$_3$), 24.3 (*C*H$_2$), 25.7 (*C*H$_2$), 25.9 (*C*H$_2$), 44.9 (*C*H$_2$), 46.8 (*C*H$_2$), 94.5 (5-*C*H), 126.9 (2*C*H$_{ar}$), 130.0 (2*C*H$_{ar}$), 138.7 (C_{ar}), 141.9 (C_{ar}), 145.5 (6-*C*H), 157.2 (4-*C*), 181.6 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 285 (62) $[M]^+$, 284 (100), 201 (15), 179 (17), 121 (15), 91 (12).

Pyrimidines 38–42: Sodium alkoxide R^3ONa (1.5 mmol) was added to a solution of pyrimidine **3** (248 mg, 1.0 mmol) in alcohol R^3OH (15 mL) or in dichloromethane (15 mL) for **38**. The reaction mixture was stirred at room temperature for 90 min. The solvent was then removed and the residue was dissolved in dichloromethane (20 mL), washed five times with water, dried with magnesium sulfate and concentrated under vacuum. The residue was purified by chromatography on silica gel (dichloromethane/petroleum ether/triethylamine, 40:57:3) or was washed with diethyl ether (**39**).

4-Benzoxy-1-*p*-tolylpyrimidine-2(1*H*)-thione (38): Yellow oil (200 mg, 65%). TLC (petroleum ether/dichloromethane, 8:2): R_f = 0.73. IR (film): $\tilde{\nu}$ = 1655 (s), 1508 (w), 1471 (s), 1347 (m) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.42 (s, 3 H, CH_3), 5.56 (s, 2 H, CH_2), 6.27 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.34 (m, 9 H, 9CH_{ar}), 7.61 (d, J = 7.2 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.3 (*C*H$_3$), 69.8 (*C*H$_2$), 100.0 (5-*C*H), 126.5,128.7 and 130.4 (9*C*H$_{ar}$), 135.2 (C_{ar}), 139.5 (C_{ar}), 141.5 (C_{ar}), 148.3 (6-*C*H), 165.9 (4-*C*), 184.4 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 308 (31) $[M]^+$, 181 (50), 159 (21), 130 (27), 91 (100), 65 (28).

4-Methoxy-1-*p*-tolylpyrimidine-2(1*H*)-thione (39): Yellow solid (150 mg, 65%). M.p. 153–155 °C. IR (KBr): $\tilde{\nu}$ = 1633 (s), 1526 (s), 1509 (m), 1477 (s), 1343 (s), 1313 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.40 (s, 3 H, CH_3), 4.07 (s, 3 H, OCH_3), 6.23 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.18 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.29 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.58 (d, J = 7.2 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.3 (*C*H$_3$), 55.2 (O*C*H$_3$), 99.9 (5-*C*H), 126.5 (2*C*H$_{ar}$), 130.4 (2*C*H$_{ar}$), 139.4 (C_{ar}), 141.4 (C_{ar}), 148.2 (6-*C*H), 166.5 (4-*C*), 184.5 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 232 (37) $[M]^+$, 231 (100), 91 (12).

4-Isopropoxy-1-*p*-tolylpyrimidine(1*H*)-2-thione (40): Yellow oil (185 mg, 71%). TLC (petroleum ether/dichloromethane, 6:4): R_f = 0.82. IR (film): $\tilde{\nu}$ = 1621 (m), 1518 (m), 1509 (m), 1448 (s), 1339 (m), 1301 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 1.38 [d, J = 6.3 Hz, 6 H, CH(CH_3)$_2$], 2.41 (s, 3 H, CH_3), 5.70 [hept, J = 6.3 Hz, 1 H, C*H*(CH$_3$)$_2$], 6.17 (d, J = 7.2 Hz, 1 H, 5-C*H*), 7.21 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.30 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.57 (d, J = 7.2 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.3 (*C*H$_3$), 21.8 [CH(*C*H$_3$)$_2$], 71.2 [*C*H(CH$_3$)$_2$], 100.5 (5-*C*H), 126.5 (2*C*H$_{ar}$), 130.3 (2*C*H$_{ar}$), 139.3 (C_{ar}), 141.6 (C_{ar}), 147.9 (6-*C*H), 165.8 (4-*C*), 184.4 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 260 (59) $[M]^+$, 217 (100), 160 (92), 130 (31), 91 (26).

4-Allyloxy-1-*p*-tolylpyrimidine-2(1*H*)-thione (41): Yellow oil (168 mg, 65%). TLC (petroleum ether/dichloromethane, 6:4): R_f = 0.70. IR (film): $\tilde{\nu}$ = 1620 (s), 1520 (s), 1508 (m), 1466 (m), 1340 (s), 1304 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.42 (s, 3 H, CH_3), 5.03 (d, J = 6.0 Hz, 2 H, CH_2), 5.37 (m, 2 H, CH_2=), 6.04 (m, 1 H, C*H*=), 6.26 (d, J = 6.9 Hz, 1 H, 5-C*H*), 7.21 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.31 (d, J = 8.4 Hz, 2 H, 2CH_{ar}), 7.61 (d, J = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.3 (*C*H$_3$), 68.6 (*C*H$_2$), 99.9 (5-*C*H), 119.3 (*C*H$_2$=), 126.5 (2*C*H$_{ar}$), 130.4 (2*C*H$_{ar}$), 131.6 (*C*H=), 139.4 (C_{ar}), 141.4 (C_{ar}), 148.3 (6-*C*H), 165.8 (4-*C*), 184.4 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 258 (16) $[M]^+$, 243 (100), 160 (11), 130 (12), 91 (13).

4-(2-Methoxy)ethoxy-1-*p*-tolylpyrimidine-2(1*H*)-thione (42): Yellow oil (224 mg, 81%). TLC (petroleum ether/dichloromethane, 6:4): R_f = 0.68. IR (film): $\tilde{\nu}$ = 1621 (m), 1522 (m), 1510 (m), 1466 (m), 1342 (s), 1305 (s) cm^{-1}. ^1H NMR (300 MHz, $CDCl_3$): δ = 2.41 (s, 3 H, CH_3), 3.43 (s, 3 H, OCH_3), 3.74 (m, 2 H, CH_2), 4.68 (m, 2 H, CH_2), 6.31 (d, J = 6.9 Hz, 1 H, 5-C*H*), 7.20 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.30 (d, J = 8.1 Hz, 2 H, 2CH_{ar}), 7.62 (d, J = 6.9 Hz, 1 H, 6-C*H*) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.3 (*C*H$_3$), 59.0 (O*C*H$_3$), 66.9 (*C*H$_2$), 70.2 (*C*H$_2$), 100.1 (5-*C*H), 126.4 (2*C*H$_{ar}$), 130.4 (2*C*H$_{ar}$), 139.4 (C_{ar}), 141.4 (C_{ar}), 148.3 (6-*C*H), 166.1 (4-*C*), 184.3 (2-*C*) ppm. MS (EI, 70 eV): *m*/*z* (%) = 276 (91) $[M]^+$, 245 (53), 217 (100), 160 (41), 159 (99), 130 (35), 91 (34).

4-Methylsulfanyl-1-(2,3,4,6-tetrahydroxy-β-D-galactopyranosyl)pyrimidine-2(1*H*)-thione (45): A solution of peracetylated carbohydrate **44a**[18] (244 mg, 0.5 mmol) in methanol (15 mL) was stirred at 0 °C for 3 h. Then, dichloromethane (50 mL) was added to the reaction mixture and the mixture was concentrated under reduced pressure without heating. The resulting solid was washed with diethyl ether. Yellow solid (160 mg, 100%). M.p. 136–138 °C. IR (KBr): $\tilde{\nu}$ = 3381 (s), 1608 (s), 1495 (m), 1408 (m), 1312 (m), 1088 (s) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 2.52 (s, 3 H, CH_3), 3.43–3.63 (m, 4 H, gal 6a-*H*, 6b-*H*, 5-*H* and 3-*H*), 3.73 (m, 2 H, gal 2-*H* and 4-*H*), 4.71, 5.06 and 5.22 (3 br. s, 4 H, 4O*H*), 6.60 (d, J = 9.0 Hz, 1 H, gal 1-*H*), 6.93 (d, J = 7.2 Hz, 1 H, pyr 5-C*H*), 7.98 (d, J = 7.2 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 12.4 (*C*H$_3$), 60.3 (gal, 6-*C*), 68.4 (gal, 4-*C*), 69.9 (gal, 2-*C*), 73.6 (gal, 3-*C*), 79.0 (gal, 5-*C*), 89.2 (gal, 1-*C*), 108.0 (pyr, 5-*C*H), 142.6 (pyr, 6-*C*H), 171.7 (pyr, 4-*C*), 181.0 (pyr, 2-*C*) ppm. HRMS (ESI$^+$): calcd. for $C_{11}H_{16}N_2O_5S_2Na$ $[M + Na]^+$ 343.0398; found 343.0406.

4-Methylsulfanyl-1-(2,3,5-trihydroxy-β-D-ribofuranosyl)pyrimidine-2(1*H*)-thione (46): A solution of perbenzoylated carbohydrate **44b**[18] (301 mg, 0.5 mmol), first dissolved in dichloromethane (5 mL), and potassium carbonate (3.5 mg, 0.025 mmol) in methanol (15 mL) was stirred at 0 °C for 7 h. Then, dichloromethane (50 mL) was added to the reaction mixture and the mixture was concentrated under reduced pressure without heating. The residue was purified by chromatography on silica gel (dichloromethane/methanol, 95:5). White solid (98 mg, 67%). M.p. 146–148 °C. IR (KBr): $\tilde{\nu}$ = 3446 (s), 1653 (m), 1436 (m) cm^{-1}. ^1H NMR (300 MHz, [D$_6$]DMSO): δ = 2.52 (s, 3 H, CH_3), 3.64 (dd, J = 4.5, 12.6 Hz, 1 H, rib 5a-*H*), 3.83 (dd, J = 4.5, 12.6 Hz, 1 H, rib 5b-*H*), 3.97 (m, 2 H, rib 3-*H* and 4-*H*), 4.05 (m, 1 H, rib 2-*H*), 5.04 (d, J = 4.4 Hz, 1 H, O*H*), 5.35 (t, J = 4.5 Hz, 1 H, CH$_2$O*H*), 5.56 (d, J = 4.8 Hz, 1 H, O*H*), 6.37 (s, 1 H, rib 1-*H*), 6.94 (d, J = 7.2 Hz, 1 H, pyr 5-C*H*), 8.63 (d, J = 7.2 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, [D$_6$]DMSO): δ = 12.4 (*C*H$_3$), 58.6 (rib, 5-*C*), 67.3 (rib, 3-*C*), 74.8 (rib, 2-*C*), 83.9 (rib, 4-*C*), 94.7 (rib, 1-*C*), 107.4 (pyr, 5-*C*H), 141.3 (pyr, 6-*C*H), 171.7 (pyr, 4-*C*), 178.5 (pyr, 2-*C*) ppm. HRMS (ESI$^+$): calcd. for $C_{10}H_{14}N_2O_4S_2Na$ $[M + Na]^+$ 313.0293; found 313.0290.

Nucleosides Analogues 47 and 48: A solution of pyrimidine **45** (320 mg, 1.0 mmol) or **46** (290 mg, 1.0 mmol) in ethanol (5 mL) and aqueous potassium hydroxide (2 M, 5 mL) was refluxed for 4 h.

After cooling to 0 °C, the reaction mixture was acidified to pH 4 with aqueous hydrochloric acid (6 M) and concentrated under reduced pressure. The residue was filtered, using a minimum of methanol for washing. The filtrate was concentrated and purified by chromatography on silica gel [dichloromethane/methanol (8:2) for **47**; dichloromethane/methanol (9:1) for **48**].

1-(2,3,4,6-Tetrahydroxy-β-D-galactopyranosyl)-2-thioxopyrimidin-4(1*H*,3*H*)-one (47): White solid (203 mg, 70%). M.p. > 300 °C. IR (KBr): $\tilde{\nu}$ = 3404 (s), 1684 (s), 1490 (m), 1289 (m), 1080 (m) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 3.66–3.97 (m, 6 H, gal 6a-*H*, 6b-*H*, 5-*H*, 4-*H*, 3-*H* and 2-*H*), 6.01 (d, *J* = 8.1 Hz, 1 H, pyr 5-C*H*), 6.59 (d, *J* = 9.0 Hz, 1 H, gal 1-*H*), 7.87 (d, *J* = 8.1 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 62.5 (gal, 6-*C*), 70.6 (gal, 4-*C*), 71.3 (gal, 2-*C*), 75.3 (gal, 3-*C*), 79.8 (gal, 5-*C*), 88.8 (gal, 1-*C*), 107.4 (pyr, 5-*C*H), 134.6 (pyr, 6-*C*H), 162.5 (pyr, 4-*C*), 179.8 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_{10}H_{14}N_2O_6SNa$ $[M + Na]^+$ 313.0470; found 313.0472.

1-(2,3,5-Trihydroxy-β-D-ribofuranosyl)-2-thioxopyrimidin-4(1*H*,3*H*)-one (48): Yellow solid (166 mg, 64%). M.p. 211–213 °C. IR (KBr): $\tilde{\nu}$ = 3403 (s), 1685 (s), 1496 (m), 1442 (m), 1274 (s) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 3.78 (dd, *J* = 2.1, 12.6 Hz, 1 H, rib 5a-*H*), 3.93 (dd, *J* = 1.8, 12.6 Hz, 1 H, rib 5b-*H*), 4.05 (m, 1 H, rib 4-*H*), 4.13 (m, 1 H, rib 3-*H*), 4.21 (m, 1 H, rib 2-*H*), 5.94 (d, *J* = 8.1 Hz, 1 H, pyr 5-C*H*), 6.58 (d, *J* = 2.4 Hz, 1 H, rib 1-*H*), 8.34 (d, *J* = 8.1 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 61.0 (rib, 5-*C*), 70.0 (rib, 3-*C*), 76.6 (rib, 2-*C*), 85.9 (rib, 4-*C*), 94.9 (rib, 1-*C*), 106.6 (pyr, 5-*C*H), 142.8 (pyr, 6-*C*H), 162.7 (pyr, 4-*C*), 177.8 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_9H_{12}N_2O_5SNa$ $[M + Na]^+$ 283.0365; found 283.0366.

Nucleosides Analogues 49 and 50: A solution of pyrimidine **45** (320 mg, 1.0 mmol) or **46** (290 mg, 1.0 mmol) in methanolic ammonia (7 M, 20 mL) was stirred at 50 °C in a sealed tube for 24 h. The reaction mixture was then concentrated under reduced pressure. The resulting solid **49** was washed with dichloromethane, or the residue **50** was purified by chromatography on silica gel (dichloromethane/methanol, 8:2).

4-Amino-1-(2,3,4,6-tetrahydroxy-β-D-galactopyranosyl)pyrimidine-2(1*H*)-thione (49): White solid (288 mg, 100%). M.p. 136–138 °C. IR (KBr): $\tilde{\nu}$ = 3375 (s), 1663 (s), 1363 (m), 1086 (s) cm^{-1}. ^1H NMR (300 MHz, $[D_6]$DMSO): δ = 3.41–3.58 (m, 4 H, gal 6a-*H*, 6b-*H*, 5-*H* and 3-*H*), 3.62–3.73 (m, 2 H, gal 2-*H* and 4-*H*), 4.60, 4.67, 4.98 and 5.07 (4 br. s, 4 H, 4O*H*), 6.09 (d, *J* = 7.2 Hz, 1 H, pyr 5-C*H*), 6.65 (d, *J* = 9.0 Hz, 1 H, gal 1-*H*), 7.63 (br. s, 1 H, NH_2), 7.70 (d, *J* = 7.2 Hz, 1 H, pyr 6-C*H*), 7.79 (br. s, 1 H, NH_2) ppm. ^{13}C NMR (75 MHz, $[D_6]$DMSO): δ = 60.2 (gal, 6-*C*), 68.3 (gal, 4-*C*), 69.3 (gal, 2-*C*), 73.9 (gal, 3-*C*), 78.4 (gal, 5-*C*), 88.1 (gal, 1-*C*), 98.2 (pyr, 5-*C*H), 142.6 (pyr, 6-*C*H), 159.8 (pyr, 4-*C*), 181.9 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_{10}H_{15}N_3O_5SNa$ $[M + Na]^+$ 312.0630; found 312.0625.

4-Amino-1-(2,3,5-trihydroxy-β-D-ribofuranosyl)pyrimidine-2(1*H*)-thione (50): White solid (145 mg, 56%). M.p. 195–197 °C. IR (KBr): $\tilde{\nu}$ = 3397 (m), 1633 (s), 1483 (m), 1370 (m), 1094 (m) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 3.78 (dd, *J* = 2.1, 12.3 Hz, 1 H, rib 5a-*H*), 3.96 (dd, *J* = 1.8, 12.3 Hz, 1 H, rib 5b-*H*), 4.04–4.11 (m, 2 H, rib 3-*H* and 4-*H*), 4.18 (m, 1 H, rib 2-*H*), 6.12 (d, *J* = 7.5 Hz, 1 H, pyr 5-C*H*), 6.60 (s, 1 H, rib 1-*H*), 8.43 (d, *J* = 7.5 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 60.7 (rib, 5-*C*), 69.4 (rib, 3-*C*), 77.0 (rib, 2-*C*), 85.4 (rib, 4-*C*), 96.0 (pyr, 5-*C*H), 99.0 (rib, 1-*C*), 143.0 (pyr, 6-*C*H), 162.3 (pyr, 4-*C*), 181.6 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_9H_{13}N_3O_4SNa$ $[M + Na]^+$: 282.0525; found 282.0524.

Nucleosides Analogues 51 and 52: Benzylamine (550 μL, 5.0 mmol) was added to a solution of pyrimidine **45** (320 mg, 1.0 mmol) in acetonitrile (20 mL) or **46** (290 mg, 1.0 mmol) in methanol (20 mL) and the reaction mixture was refluxed for 18 or 72 h. The solvent was then removed and crystallisation from dichloromethane afforded the products.

4-Benzylamino-1-(2,3,4,6-tetrahydroxy-β-D-galactopyranosyl)pyrimidine-2(1*H*)-thione (51): White solid (306 mg, 81%). M.p. 123–125 °C. IR (KBr): $\tilde{\nu}$ = 3384 (m), 1636 (s), 1356 (m), 1087 (m) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 3.54–3.94 (m, 6 H, gal 6a-*H*, 6b-*H*, 5-*H*, 4-*H*, 3-*H* and 2-*H*), 4.66 (s, 2 H, CH_2), 6.16 (d, *J* = 7.5 Hz, 1 H, pyr 5-C*H*), 6.84 (d, *J* = 9.3 Hz, 1 H, gal 1-*H*), 7.27 (m, 5 H, 5H_{ar}), 7.80 (d, *J* = 7.5 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 45.4 (*C*H_2), 62.5 (gal, 6-*C*), 70.5 (gal, 4-*C*), 71.8 (gal, 2-*C*), 75.6 (gal, 3-*C*), 80.0 (gal, 5-*C*), 90.1 (gal, 1-*C*), 101.2 (pyr, 5-*C*H), 128.5, 129.2, 129.6 and 129.9 (5*C*H_{ar}), 142.5 (*C*$_{ar}$), 145.0 (pyr, 6-*C*H), 159.2 (pyr, 4-*C*), 184.1 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_{17}H_{21}N_3O_5SNa$ $[M + Na]^+$ 402.1100; found 402.1103.

4-Benzylamino-1-(2,3,5-trihydroxy-β-D-ribofuranosyl)pyrimidine-2(1*H*)-thione (52): White solid (314 mg, 90%). M.p. 204–206 °C. IR (KBr): $\tilde{\nu}$ = 3241 (s), 1636 (s), 1101 (m), 1065 (w) cm^{-1}. ^1H NMR (300 MHz, CD_3OD): δ = 3.80 (d, *J* = 12.3 Hz, 1 H, rib 5a-*H*), 4.01 (d, *J* = 12.3 Hz, 1 H, rib 5b-*H*), 4.09–4.15 (m, 3 H, rib 2-*H*, 3-*H* and 4-*H*), 4.49 and 4.74 (2s, 2 H, CH_2), 6.16 (d, *J* = 7.8 Hz, 1 H, pyr 5-C*H*), 6.67 (s, 1 H, rib 1-*H*), 7.30 (m, 5 H, 5CH_{ar}), 8.36 (d, *J* = 7.8 Hz, 1 H, pyr 6-C*H*) ppm. ^{13}C NMR (75 MHz, CD_3OD): δ = 45.4 (*C*H_2), 60.9 (rib, 5-*C*), 69.6 (rib, 3-*C*), 77.1 (rib, 2-*C*), 85.5 (rib, 4-*C*), 95.9 (rib, 1-*C*), 100.1 (pyr, 5-*C*H), 128.2, 128.4, 129.1 and 129.6 (5*C*H_{ar}), 139.5 (*C*$_{ar}$), 141.7 (pyr, 6-*C*H), 159.8 (pyr, 4-*C*), 181.8 (pyr, 2-*C*) ppm. HRMS (ESI^+): calcd. for $C_{16}H_{19}N_3O_4SNa$ $[M + Na]^+$ 372.0994; found 372.0995.

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