Synthesis of 2-Substituted 6-Fluoroalkylpyrimidin-4(3*H*)-ones and -pyrimidines

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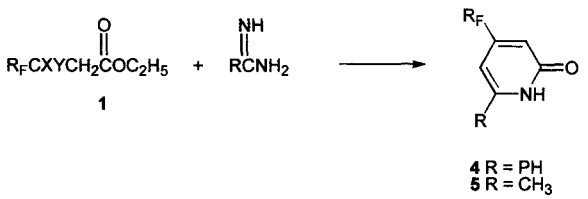
Treatment of ethyl α-fluoroalkylacetates **1** or ethyl 3-fluoroalkyl-2-iodoacrylates **2** under mild conditions with amidine affords 2-substituted 6-fluoroalkylpyrimidin-4(3*H*)-ones **4, 5, 6, 7** in excellent yields, while α-fluoroalkyl alkyl ketones or α-fluoroalkyl aldehyde **3** give polysubstituted 6-fluoroalkylpyrimidines **8, 9** under the same conditions.

Many pyrimidines and their derivatives are well-known therapeutic agents.[1] They are conventionally synthesized via a [3 + 3] fragment approach of amidines and substrates containing 1,3-dielectrophilic centers.[2] As a result, various amino,[3] hydroxyl,[4] halo[5] or nitro[6] substituted pyrimidines have been prepared by such a method. In recent years, fluorine-containing pyrimidines have proved to be more bioactive than their nonfluorine analogs,[7] which raises increasing interest in the development of new procedures for the synthesis of fluorinated or fluoroalkylated pyrimidines and pyrimidones. Till now, however, literature concerning the synthesis of such compounds is still limited and the majority of the methods reported are fluorination or fluoroalkylation of pyrimidines.[8] Since building block strategy is currently the subject of active investigation for introducing a fluoroalkyl group into molecules[9] and α-fluoroalkyl carbonyl compounds have proved to be versatile fluoroalkyl-containing intermediates,[10] we studied the synthesis of various 2-phenyl(or methyl)-6-fluoroalkylpyrimidines from amidine and certain carbonyl compounds containing the fluoroalkyl group. The results are reported herein.

In the presence of sodium carbonate, ethyl α-fluoroalkylacetates **1**[11] reacted with amidine to afford 2-substituted 6-fluoroalkylpyrimidones in high yields (Scheme 1). Generally, a mixture of **1** (5 mmol), benzamidine or acetamidine hydrochloride (6 mmol) and sodium carbonate (20 mmol) in 1,4-dioxane was stirred at 60 °C for about 10 hours. Usual workup gave product **4** or **5** in excellent yields. The results obtained are summarized in Table 1.



Solvents did not show a significant effect when benzamidine was used as a reagent. The reaction proceeded smoothly in 1,4-dioxane, tetrahydrofuran, ethanol or acetonitrile. However, when acetamidine was used, only 1,4-dioxane and tetrahydrofuran proved to be suitable solvents. Reaction temperature could be varied from r.t. to reflux in solvent with higher temperatures facilitating the reaction. Excess sodium carbonate was used in order to maintain basic conditions. The nature of the fluoralkyl group had little effect on the reaction. The fluorine (or halogen)-carrying carbon located at the β-position to the carbonyl group became part of the pyrimidine ring with elimination of the halogens on it.

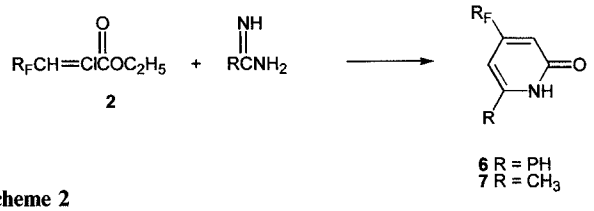
Table 1. Reaction of compounds **1** with amidine[a]

entry	**1** (R_F(CXY)	R	Time (h)	Product (R_F)[b]	Yield (%)[c]
1	**1a**[$Cl(CF_2)_3CF_2$]	C_6H_5	8	**4a**[$Cl(CF_2)_3$]	90
2			8	**4a**[d]	88
3			10	**4a**[e]	85
4			10	**4a**[f]	82
5		CH_3	10	**5a**	**76**
6	**1b**[$Cl(CF_2)_5CF_2$]	C_6H_5	10	**4b**[$Cl(CF_2)_5$]	88
7		CH_3	10	**5b**	80
8	**1c**(CF_3CF_2)	C_6H_5	9	**4c**(CF_3)	86
9		CH_3	8	**5c**	75
10	**1d**(CF_3CFBr)	C_6H_5	9	**4c**	83
11		CH_3	8	**5c**	77
12	**1e**(CF_3CCl_2)	C_6H_5	10	**4c**	82
13		CH_3	9	**5c**	72

[a] The reaction was carried out in 1,4-dioxane at about 60 °C unless otherwise indicated.
[b] All new compounds were characterized by ^{1}H NMR, ^{19}F NMR, IR, MS and elemental analyses.
[c] Isolated yield based on **1**.
[d] The reaction was carried out in THF.
[e] The reaction was carried out in MeCN.
[f] The reaction was carried out in EtOH.

Attempts to extend such a reaction by employing thiourea and urea as reagents in place of amidine failed even when potassium hydroxide or sodium hydride was used as base. In this case, only α,β-unsaturated carboxylates, through dehydrohalogenation were found. This was attributed to the low nucleophilicity of such reagents.

Furthermore, the reaction of 3-fluoroalkyl-2-iodoacrylates **2**[12] with benzamidine hydrochloride also proceeded well in ethanol (95%) at r.t. in the presence of excess sodium carbonate to give the corresponding 6-perfluoroalkyl-2-phenylpyrimidin-4(3*H*)ones **6** in high yields (Scheme 2). Solvent, temperature and the nature of fluoroalkyl chain had little effect on the reaction. Satisfactory results were obtained in tetrahydrofuran, 1,4-dioxane, acetonitrile as well as in ethanol. The fluoroalkyl group remained intact during the reaction. When acetamidine was used instead of benzamidine in tetrahydrofuran, the corresponding 6-fluoroalkyl-2-methylpyramidin-4(3*H*)-ones **7** were formed. The results are listed in Table 2.



Scheme 2

Table 2. Reaction of compounds **2** with amidine[a]

entry	2	R_F	Time (h)	Product[b]	Yield (%)[c]
1	**2a**	$F(CF_2)_2$	8	**6a**	80
2	**2b**	$F(CF_2)_4$	8	**6b**	86
3	**2c**	$F(CF_2)_6$	9	**6c**	83
4	**2d**	$F(CF_2)_8$	10	**6d**	85
5	**2e**	$Cl(CF_2)_2$	10	**6e**	82
6	**2f**	$Cl(CF_2)_4$	8	**6f**	83
7	**2g**	$Cl(CF_2)_6$	10	**6g**	87
8			10	**6g**[d]	83
9			10	**6g**[e]	81
10			10	**6g**[f]	77
11			12	**7**[g]	73
12	**2h**	$Cl(CF_2)_8$	10	**6h**	88

[a] The reaction was carried in EtOH at r.t. and the reagent used was benzamidine unless otherwise indicated.
[b] All new compounds were characterized by ^1H NMR, ^{19}F NMR, IR, MS and elemental analyses.
[c] Isolated yield, based on **2**.
[d] The reaction was carried out in 1,4-dioxane.
[e] The reaction was carried out in THF.
[f] The reaction was carried out in MeCN.
[g] Acetamidine was used as reagent.

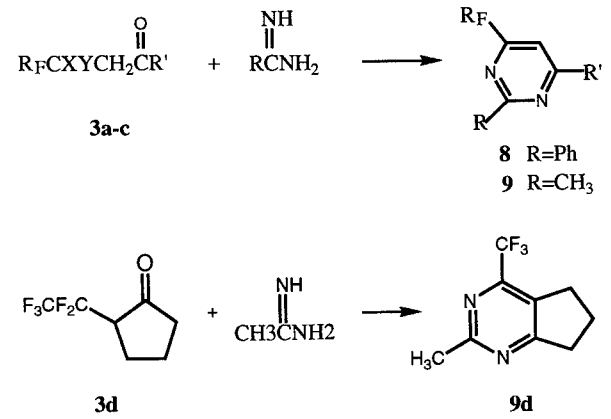
It was obvious that similar products, 2-substituted 6-fluoroalkylpyrimidin-4(3*H*)-ones **4**, **5** and **6**, **7**, could be prepared respectively from substrates **1** and **2**. The only difference is that the fluoroalkyl groups in **4** and **5** (derived from **1**) have one carbon less than those of the starting materials **1** while the fluoroalkyl groups in **6** and **7** remained the same as those of **2**.

In addition, α-fluoroalkyl alkyl ketones **3a**, **3b**, **3d**[13] or α-fluoroalkyl aldehyde **3c**[11] could be used as substrates in place of **1** and **2**. They reacted with benzamidine or acetamidine under similar conditions to give 2(and 4)-substituted 6-fluoroalkylpyrimidines **8** and **9** in high yields (Scheme 3). The results obtained are summarized in Table 3.

Table 3. Reaction of compounds **3** with amidine[a]

entry	3	R	Time (h)	Product[b]	Yield (%)[c]
1	**3a**	C_6H_5	9	**8a**	89
2		CH_3	9	**9a**	80
3	**3b**	C_6H_5	9	**8b**	85
4		CH_3	10	**9b**	78
5	**3c**	C_6H_5	10	**8c**	82
6		CH_3	10	**9c**	77
7	**3d**	CH_3	10	**9d**	80

[a] The reaction was carried out in 1,4-dioxane at 60 °C.
[b] All new products were fully characterized by ^1H NMR, ^{19}F NMR, IR, MS and elemental analyses.
[c] Isolated yield based on **3**.



	R_FCXY :	R'
3a	CF_3CFBr	$C(CH_3)_3$
3b	$Cl(CF_2)_3CF_2$	$C(CH_3)_3$
3c	$Cl(CF_2)_3CF_2$	H

Scheme 3

In summary, a wide range of 2-substituted-6-fluoroalkyl pyrimidine derivatives **4**, **5**, **6**, **7**, **8** and **9** were synthesized readily from **1**, **2** and **3** using a simple experimental procedure and in high yields.

Mps are uncorrected. IR spectra were recorded as film for liquid samples and KCl plate for solid samples on a Shimadzu IR-440 Spectrometer. ^1H NMR spectra were measured using $CDCl_3$ as solvent and internal TMS as standard on a Varian EM-360A spectrometer. ^{19}F NMR spectra were obtained with external CF_3COOH as standard with upfield shifts positive on a Varian EM-360L spectrometer at 56.4 MHz. Mass spectra were recorded on a HP5989A mass spectrometer. All chemicals and reagents were of analytical grade and were used without further purification. Light petroleum refers to the fraction boiling in the range 60–90 °C.

General Procedure:
A mixture of substrates **1**, **2** or **3** (5 mmol), amidine hydrochloride (6 mmol) and Na_2CO_3 (20 mmol) in solvent (10 mL) was well-stirred at the indicated temperature for about 10 h. After the reaction was complete (monitored by TLC and ^{19}F NMR) the mixture was poured into H_2O (50 mL) and extracted with Et_2O (3 × 20 mL). The combined extracts were washed thoroughly with brine and dried (Na_2SO). The residue which remained after evaporation was purified by recrystallization (for solid samples) in mixed solvent (light petroleum/CH_2Cl_2, 5:1) or by flash chromatography on silica gel using light petroleum/EtOAc (20:1–10:1) as eluent to give pure products.

6-(ω-Chlorohexafluoropropyl)-2-phenylpyrimidin-4(3H)-one (**4a**):
Mp: 166.0–168.0 °C.
IR: ν = 3450, 1680, 1600, 1540, 1180 cm^{-1}.
^1H NMR: δ = 8.17 (2H, m), 7.53 (3H, m), 6.67 (1H, s).
^{19}F NMR: δ = −10.2 (2F, s, CF_2Cl), 38.0 (2F, s, CF_2–C), 42.3 (2F, s).
MS: *m/e* = 356 (M^+, 58.12), 321 (M^+ − Cl, 6.18), 278 (M^+ − Ph, 4.22), 256, 193, 221 [M−$Cl(CF_2)_2$, 5.50], 104 (PhC=NH, 100).
Anal. calc. for $C_{13}H_7ClF_6N_2O$: C, 43.76; H, 1.96; N, 7.85; F, 31.98. found: C, 43.75; H, 1.90; N, 7.86, F, 31.23.

6-(ω-Chlorohexafluoropropyl)-2-methylpyrimidin-4(3H)-one **(5a)**:
Mp: 99.0–101.0 °C.
IR: ν = 3400, 2750, 1680, 1610, 1190, 1120 cm^{-1}.
^{1}HNMR: δ = 6.71 (1 H, s), 2.60 (3 H, s).
^{19}F NMR: δ = −8.14 (2 F, s), 38.2 (2 F, s), 42.1 (2 F, s).
MS: *m/e* = 294 (M^+, 100), 259 (M^+ − Cl, 7.46), 218 (11.10), 159 [M^+ − $Cl(CF_2)_2$, 39.26], 131 (159 − CO, 41.14), 42 (79.31), 68.
Anal. calc. for $C_8H_5ClF_6NO$: C, 32.60; H, 1.69; N, 9.51; F, 38.77; found: C, 32.60; H, 1.44; N, 9.62; F, 38.99.

6-(ω-Chlorodecafluoropentyl)-2-phenylpyrimidin-4(3H)-one **(4b)**:
Mp: 176.0–179.0 °C.
IR: ν = 3000, 1680, 1600, 1540, 1180 cm^{-1}.
^{1}H NMR: δ = 8.33 (2 H, m), 7.67 (3 H, m), 6.93 (1 H, s).
^{19}F NMR: δ = −8.9 (2 F, s), 38.1 (2 F, s), 43.5 (4 F, m), 44.4 (2 F, s).
MS: *m/e* = 456 (M^+, 32.88), 421 (M^+ − Cl, 6.68), 378 (M^+ − Ph, 2.01), 256 (8.76), 221 (8.68), 193 [M − $Cl(CF_2)_2$ − CO, 44.29], 221 (5.50), 104 (100).
HRMS: calc. for $C_{15}H_7ClF_{10}N_2O$: 456.0088; found: 456.0087.

6-(ω-Chlorodecafluoropentyl-2-methyl)pyrimidin-4(3H)-one **(5b)**:
Mp: 105.0–106.0 °C.
IR; ν = 3400, 2800, 1680, 1600, 1200, 1130 cm^{-1}.
^{1}H NMR: δ = 6.73 (1 H, s), 2.51 (3 H, s).
^{19}F NMR: δ = −10.6 (2 F, s), 38.3 (2 F, s), 42.1, 43.0 (6 F, m).
MS: *m/e* = 394 (M^+, 74.9), 359 (M^+ − Cl, 23.46), 318 (17.90), 159 [M^+ − $Cl(CF_2)_4$, 100], 131 (159 − CO, 71.88), 42 (73.79), 68.
HRMS: calc. for $C_{10}H_5ClF_{10}N_2O$: 393.9981; found: 393.9970.

2-Phenyl-6-(trifluoromethyl)pyrimidin-4-(3H)-one **(4c)**:
Mp: 219.0–221.0 °C.
IR: ν = 3300 (NH), 1670 (C=O), 1600, 1540 (C=C, C=N), 1150 cm^{-1}.
^{1}H NMR: δ = 8.27 (2 H, m), 7.66 (3 H, m), 6.80 (1 H, s).
^{19}F NMR: δ = −7.67 (3 F, s).
MS: *m/e* = 240 (M^+, 100), 221 (M^+ − F, 7.80), 212 (M^+ − CO, 16.22), 193, 165, 104 (PhC=NH, 98.86).
Anal. calc. for $C_{11}H_7F_3N_2O$: C, 55.00; H, 2.90; N, 11.67; F, 23.75. found: C, 54.26; H, 2.58; N, 11.67; F, 23.20.

2-Methyl-6-(trifluoromethyl)pyrimidin-4(3H)-one **(5c)**:
Mp: 128.0–131.0 °C.
IR: ν = 3300, 2800, 1620, 1580, 1120 cm^{-1}.
^{1}H NMR: δ = 6.70 (1 H, s), 2.57 (3 H, s).
^{19}F NMR: δ = −6.67 (3 F, s).
MS: *m/e* = 179 (M^+ + 1, 17.17), 178 (M^+, 100), 159 (M^+ − F, 10.96), 150 (M^+ − CO, 38.11), 69 (CF_3, 13.09), 42 (CH_3C=NH, 98.86).
Anal. calc. for $C_6H_5F_3N_2O$: C, 40.44; H, 2.81; N, 15.73; F, 32.02. found: C, 39.89; H, 2.71; N, 15.77; F, 31.92.

6-(Pentafluoroethyl)-2-phenylpyrimidin-4(3H)-one **(6a)**:
Mp: 196.0–198.0 °C.
IR: ν = 3310 (NH), 1680 (C=O), 1600, 1530 (C=C, C=N), 1200 (C−O, C−C) cm^{-1}.
^{1}H NMR: δ = 8.10 (2 H, m), 7.60 (3 H, m), 6.82 (1 H, s).
^{19}F NMR: δ = 5.70 (3 F, s), 41.8 (2 F, s).
MS: *m/e* = 290 (M^+, 26.36), 271 (M^+ − F, 2.00), 262 (M^+ − CO, 2.50), 193 (M^+ − F − Ph, 16.53), 104 (PhC=NH, 100), 77 (Ph^+, 32.23).
Anal. calc. for $C_{12}H_7F_5N_2O$: C, 49.66; H, 2.41; N, 9.66; F, 32.76. found: C, 49.11; H, 2.26; N, 9.26; F, 32.07.

6-(Nonafluorobutyl)-2-phenylpyrimidin-4(3H)-one **(6b)**:
Mp: 175.0–178.0 °C.
IR: ν = 3380, 1680, 1610, 1540, 1190 cm^{-1}.
^{1}H NMR: δ = 8.10 (2 H, m), 7.55 (3 H, m), 6.80 (1 H, s).
^{19}F NMR: δ = 3.70 (3 F, s), 38.5 (2 F, s), 45.0, 48.0 (4 F, m).
MS: *m/e* = 390 (M^+, 79.83), 371 (3.05), 363 (25.04), 193 (39.30), 104 (100), 77.
Anal. calc. for $C_{14}H_7F_9N_2O$: C, 43.08; H, 1.79; N, 7.18; F, 43.85. found: C, 43.05; H, 1.60; N, 7.09; F, 43.67.

2-Phenyl-6-(tridecafluorohexyl)pyrimidin-4(3H)-one **(6c)**:
Mp: 169.0–118.0 °C.
IR: ν = 3400, 1680, 1610, 1540, 1200 cm^{-1}.
^{1}H NMR: δ = 8.10 (2 H, m), 7.60 (3 H, m), 6.82 (1 H, s).
^{19}F NMR: δ = 2.40 (3 F, s), 37.9 (2 F, s), 43.3 (6 F, m), 47.8 (2 F, s).
MS: *m/e* = 490 (M^+, 51.83), 471 (2.83), 463 (1.01), 193 (44.14), 104 (100), 77.
Anal. calc. for $C_{16}H_7F_{13}N_2O$: C, 39.18; H, 1.43; N, 5.71; F, 50.41. found: C, 39.29; H, 1.43; N, 5.48; F, 50.31.

6-(Heptadecafluorooctyl)-2-phenylpyrimidin-4(3H)-one **(6d)**:
Mp: 184.0–186.5 °C.
IR: ν = 3400, 1680, 1600, 1530, 1190 cm^{-1}.
^{1}H NMR: δ = 8.00 (2 H, m), 7.45 (3 H, m), 6.68 (1 H, s).
^{19}F NMR: δ = 3.0 (3 F, s), 38.0 (2 F, s), 44.5 (10 F, m), 48.3 (2 F, s, CF_2CF_3).
MS: *m/e* = 590 (M^+, 57.72), 571 (4.79), 193 (3.82), 104 (100), 77.
Anal. calc. for $C_{18}H_7F_{17}N_2O$: C, 36.61; H, 1.19; N, 4.75; F, 54.75. found: C, 36.36; H, 1.18; N, 4.30; F, 55.05.

6-(ω-Chlorotetrafluoroethyl)-2-phenylpyrimidin-4(3H)-one **(6e)**:
Mp: 194.5–197.0 °C.
IR: ν = 3400, 1680, 1600, 1540, 1200 cm^{-1}.
^{1}H NMR: δ = 8.10 (2 H, m), 7.60 (3 H, m), 6.82 (1 H, s).
^{19}F NMR: δ = −9.0 (2 F, s, CF_2Cl), 37.2 (2 F, s).
MS: *m/e* = 306 (M^+, 32.50), 271 (M^+ − Cl, 4.13), 193 (M^+ − PhH − Cl, 26.45), 104 (PhC=NH, 100).
Anal. calc. for $C_{12}H_7ClF_4N_2O$: C, 47.05; H, 2.28; N, 9.12; F, 24.80. found: C, 46.67; H, 2.16; N, 8.61; F, 25.54.

6-(ω-Chlorooctafluorobutyl)-2-phenylpyrimidin-4(3H)-one **(6f)**:
Mp: 196.0–198.0 °C.
IR: ν = 3400, 1680, 1600, 1540, 1200 cm^{-1}.
^{1}H NMR: δ = 8.20 (2 H, m), 7.65 (3 H, m), 6.88 (1 H, s).
^{19}F NMR: δ = −9.40 (2 F, s, CF_2Cl), 38.0 (2 F, s, CF_2−C), 42.5 (4 F, m).
MS: *m/e* = 406 (M^+, 34.13), 371 (2.09), 193 (23.55), 104 (100), 77 (23.97).
Anal. calc. for $C_{14}H_7ClF_8N_2O$: C, 41.38; H, 1.72; N, 6.89; F, 37.39. found: C, 41.30; H, 1.68; N, 6.79; F, 37.45.

6-(ω-Chlorododecafluorohexyl)pyrimidin-4(3H)-one **(6g)**:
Mp: 175.0–178.0 °C.
IR: ν = 3400, 1680, 1610, 1540, 1200 cm^{-1}.
^{1}H NMR: δ = 8.10 (2 H, m), 7.60 (3 H, m), 6.78 (1 H, s).
^{19}F NMR: δ = −9.60 (2 F, s), 38.0 (2 F, s), 43.0 (8 F, m).
MS: *m/e* = 506 (M^+, 9.09), 471 (2.00), 193 (21.94), 104 (100), 77 (23.97).
Anal. calc. for $C_{16}H_7ClF_{12}N_2O$: C, 37.91; H, 1.38; N, 5.53; F, 45.01. found: C, 37.40; H, 1.37; N, 5.16; F, 44.83.

6-(ω-Chlorohexadecafluorooctyl)-2-phenylpyrimidin-4(3H)-one **(6h)**:
Mp: 186.0–188.0 °C.
IR: ν = 3400, 1670, 1600, 1540, 1190 cm^{-1}.

^{1}H NMR: δ = 8.12 (2H, m), 7.60 (3H, m), 6.82 (1H, s).

^{19}F NMR: δ = −8.70 (2F, s), 38.5 (2F, s), 44.0 (12F, m).

MS: *m/e* = 606 (M^+, 33.03), 571 (4.28), 193 (34.27), 104 (100), 85 (CF_2Cl, 6.42) 77 (23.97).

Anal. calc. for $C_{18}H_7ClF_{16}N_2O$: C, 35.61; H, 1.15; N, 4.62; F, 50.12. found: C, 35.72; H, 1.21; N, 4.29; F, 50.11.

6-(ω-Chlorodecafluoropentyl-2-methylpyrimidin-4(3H)-one **(7)**:

Mp: 101.0–103.0 °C.

IR: ν = 3400, 2800, 1680, 1610, 1580 cm^{-1}.

^{1}H NMR: δ = 6.65 (1H, s), 2.30 (3H, s).

^{19}F NMR: δ = −8.80 (2F, s), 38.7 (2F, s), 43.0 (8F, m).

MS: *m/e* = 444 (M^+, 36.07), 409 ($M^+ - Cl$, 9.21), 159 [$M^+ - Cl(CF_2)_4$, 100], 131 (159 − CO, 67.95), 42 ($CH_3C{=}NH$, 82.96).

Anal. calc. for $C_{11}H_5ClF_{12}N_2O$: C, 29.73; H, 1.12; N, 6.30; F, 51.29. found: C, 29.78; H, 1.10; N, 6.10; F, 51.20.

4-tert-Butyl-2-phenyl-6-(trifluoromethyl)pyrimidine **(8a)**:

IR: ν = 2980 (C−H), 1600, 1580, 1560, 1380, 1260, 1150 cm^{-1}.

^{1}H NMR: δ = 8.27 (2H, m), 7.53 (4H, m), 1.50 (9H, s).

^{19}F NMR: δ = −8.56 (3F, s).

MS: *m/e* = 280 (M^+, 16.10), 279 ($M^+ - H$, 11.67), 266, 265 ($M^+ - CH_3$, 100), 238 [$M^+ - C(CH_3)_2$, 59.33], 155 [$M^+ - C(CH_3)_3 - CH_3$, 32.18], 104 ($PhC{=}NH$, 48.30).

Anal. calc. for $C_{15}H_{15}F_3N_2$: C, 64.29; H, 5.35; N, 10.00; F, 20.36. found: C, 64.35; H, 4.91; N, 9.95; F, 21.05.

4-tert-Butyl-2-methyl-6-(trifluoromethyl)pyrimidine **(9a)**:

IR: ν = 2950, 1600, 1580, 1558, 1390, 1160 cm^{-1}.

^{1}H NMR: δ = 7.05 (1H, s), 2.28 (3H, s), 0.90 (9H, s).

^{19}F NMR: δ = −8.67 (3F, s).

MS: *m/e* = 219 ($M^+ + 1$, 69.77), 218 (M^+, 10.36), 203 ($M^+ - CH_3$, 100), 176 [$M^+ - C(CH_3)_2$, 19.33], 161 (4.16), 69 (5.94), 42 ($CH_3C{=}NH$, 9.56).

Anal. calc. for $C_{10}H_{13}F_3N_2$: C, 55.04; H, 5.96, N, 12.84; F, 26.14. found: C, 55.33; H, 5.88; N, 12.98; F, 26.11.

4-tert-Butyl-6-(ω-chlorohexafluoropropyl)-2-phenylpyrimidine **(8b)**:

IR: ν = 3010 (Ar−H), 2950, 1590, 1570, 1550, 1380, 1270, 1120 cm^{-1}.

^{1}H NMR: δ = 8.41 (2H, m), 7.41 (4H, m), 1.34 (9H, s).

^{19}F NMR: δ = −8.10 (2F, s, CF_2Cl), 38.0 (2F, s, CF_2-C), 42.3 (2F, s).

MS: *m/e* = 397 ($M^+ + 1$, 56.19), 381 ($M^+ - CH_3$, 100), 354 [$M^+ - C(CH_2)_2$, 56.27], 246 [$M+ -(CF_2)_2Cl-CH_3$, 26.07], 15.50], 104 (24.63).

HRMS: calc. for $C_{17}H_{15}ClF_6N_2$: 398.0799; found: 398.0805.

4-tert-Butyl-6-(ω-chlorohexafluoropropyl)-2-methylpyrimidine **(9b)**:

IR: ν = 2960 (C−H), 1710, 1600, 1560, 1400, 1180 cm^{-1}.

^{1}H NMR: δ = 7.50 (1H, s), 2.85 (3H, s), 1.42 (9H, s).

^{19}F NMR: δ = −8.10 (3F, s), 38.0 (2F, s), 42.0 (2F, s).

MS: *m/e* = 334 (M^+, 9.43), 333 ($M^+ - 1$, 63.56), 319 ($M^+ - CH_3$, 23.91), 292 [$M^+ - C(CH_3)_2$, 13.24], 198 [$M^+ - H - Cl(CF_2)_2$, 100], 184 [$M^+ - CH_3 - Cl(CF_2)_2$, 16.45], 42 ($CH_3C{=}NH$, 31.11).

Anal. calc. for $C_{12}H_{13}ClF_6N_2$: C, 43.11; H, 3.89; N, 8.38; F, 34.13. found: C, 43.11; H, 3.94; N, 8.34; F, 34.48.

6-(ω-Chlorohexafluoropropyl-2-phenylpyrimidine **(8c)**:

IR: ν = 1570, 1430, 1390 (C=C, C=N), 1180 cm^{-1}.

^{1}H NMR: δ = 9.00 (1H, d), 8.50 (2H, m), 7.50 (4H, m).

^{19}F NMR: δ = −8.10 (2F, s), 38.0 (2F, s), 42.3 (2F, s).

MS: *m/e* = 340 (M^+, 97.47), 321 ($M^+ - F$, 3.36), 305 ($M^+ - Cl$, 12.76), 205 (4.83), 155 ($M - Cl(CF_2)$, 100], 104 (11.32).

Anal. calc. for $C_{13}H_7ClF_6N_2$: C, 45.88; H, 2.05; N, 8.23; F, 33.53. found: C, 45.89; H, 1.79; N, 8.09; F, 33.36.

6-(ω-Chlorohexafluoropropyl)-2-methylpyrimidine **(9c)**:

IR: ν = 1580, 1438, 1400, 1180, 1100 cm^{-1}.

^{1}H NMR: δ = 8.91 (1H, s), 7.50 (1H, s), 2.90 (3H, s).

^{19}F NMR: δ = −10.16 (2F, s), 37.0 (2F, s), 41.9 (2F, s).

MS: *m/e* = 278 (M^+, 21.25), 259 (2.27), 243 (10.89), 149 (100), 143 (9.01), 93 [$M^+ - Cl(CF_2)_3$, 28.24], 77 (17.42), 42 (5.91).

HRMS: calc. for $C_8H_5ClF_6N_2$: 278.0046; found: 278.0064.

2-Methyl-5,6-propylene-4-(trifluoromethyl)pyrimidine **(9d)**:

IR: ν = 2940, 1600, 1560, 1380, 1150 cm^{-1}.

^{1}H NMR: δ = 3.10 (4H, m), 2.80 (3H, s), 2.30 (2H, m).

^{19}F NMR: δ = −10.0 (3F, s).

MS: *m/e* = 202 (M^+, 100), 183 ($M^+ - F$, 6.88), 174 (11.56), 162 (6.69), 133 ($M^+ - CF_3$, 63.97).

Anal. calc. for $C_9H_9F_3N_2$: C, 53.47; H, 4.46; N, 13.84; F, 28.22. found: C, 52.89; H, 4.39; N, 13.5; F, 28.44.

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