Supporting Information

Identification of 2-(4-(phenylsulfonyl)piperazine-1-yl)pyrimidine analogues as Novel Inhibitors of Chikungunya Virus

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Cell lines and virus strain

Chikungunya virus, Indian Ocean strain 899, isolated in 2006 (Genbank FJ959103.1), was kindly provided by Prof. C. Drosten (Institute of Virology, University of Bonn, Germany). CHIKV was cultured on African green monkey kidney (Vero) cells (ATCC CCL-81) in minimum essential medium MEM Rega3 (Invitrogen, Belgium) supplemented with 10% Foetal Bovine Serum (FBS; Integro, The Netherlands), 1% L-glutamine and 1% sodium bicarbonate (Invitrogen). Antiviral assays were performed in MEM Rega-3 medium supplemented with 2% FBS.

Chikungunya virus-cell-based antiviral assay

Serial dilutions of compound were prepared in assay medium [MEM Rega3 (Cat. N°19993013; Invitrogen), 2% FCS (Integro), 5 ml 200 mM L-glutamine (25030024), and 5 ml 7.5% sodium bicarbonate (25080060)] that was added to empty wells of a 96-well microtiter plate (Falcon, BD). Subsequently, 50 µl of CHIKV dilution in assay medium was added (resulting in a MOI of 0.01), followed by 50 µl of Vero cell suspension (25 000 cells/50 µl). The assay plates were returned to the incubator for 5 days (37°C, 5% CO₂, 95-99% relative humidity), a time at which maximal virus-induced cell death or cytopathic effect (CPE) was observed in untreated, infected controls. Subsequently, the assay medium was aspirated, replaced with 75 µl of a 5% MTS (Promega) solution in phenol red-free medium and incubated for 1.5 hours. Absorbance was measured at a wavelength of 498 nm (Safire2, Tecan; optical densities (OD values) reached 0.6-0.8 for the untreated, uninfected controls). The EC₅₀ (50% effective concentration or concentration which is calculated to inhibit virus-induced cell death by 50%) and CC₅₀ (50% antimetabolic concentration or concentration which is calculated to inhibit the overall cell metabolism by 50%) values were derived from the dose-response curves. The 50% effective concentration (EC₅₀) and the 90%
effective concentration (EC₉₀) are the concentrations of compound that inhibit virus replication by 50% and 90%, respectively. The overall antimetabolic effect of the compounds is shown as Cytostatic/Cytotoxic Concentration (CC₅₀). The CC₅₀ is the calculated concentration of compound that causes a 50% adverse effect on non-infected host cells (incorporates cytotoxic, cytostatic, and antimetabolic effect). All assay conditions producing an antiviral effect exceeding 50% were checked microscopically for minor signs of CPE or adverse effects on the host cell (i.e. altered cell morphology). A compound was only considered to elicit a selective antiviral effect on virus replication when, following microscopic quality control, at least at one concentration of the compound, no CPE nor any adverse effect is observed (image resembling untreated, uninfected cells). Multiple, independent experiments were performed.
Instrumental and General Analytical Methods

All reagents and solvents (of analytical and HPLC grades) were purchased from Sigma-Aldrich or other commercial suppliers like Fluka and Alfa Aesar and were used without further purification. Reactions that were moisture-sensitive were performed using anhydrous solvents and under argon atmosphere. EtOH, THF and DCM were dried before use. Disposable needles and syringes (B| Braun Inject and B| Braun Sterican®) were applied to transfer the solvents into the reaction flask. The solvents were removed under reduced pressure using the Heildolph Laborota 4000 efficient evaporator. Analytical thin-layer chromatography (TLC) was carried out on Polygram® SIL G/UV254 plates, layer 0.2 mm silica gel with fluorescent indicator. The spots were visualised by UV light (254 and/or 366nm) with UV light Vilmer Lourmat VL-6L. A part of the syntheses was performed in Cem Discover to obtain microwave conditions. Compounds were purified, performing a flash chromatography on a glass column using Merck silica gel (40–60 mesh). The solvent mixtures for chromatography are always referred to as a vol/vol ratio, and the melting points were determined on Cambridge Instruments.

NMR spectra were recorded on a Bruker Avance 500 NMR spectrometer (UltraShield) using a 5 mm switchable probe (TCI Prodigy Kryo-probe head, 5 mm, triple resonance-inverse-detection probe head) with z-axis gradients and automatic tuning and matching accessory (Bruker BioSpin). The resonance frequency for $^1$H NMR was 500.13 MHz and for $^{13}$C NMR 125.75 MHz. All measurements were performed for a solution in fully deuterated dimethylsulfoxide at 298 K. Standard 1D and gradient-enhanced 2D experiments, like double quantum filtered (DQF) COSY, HSQC, and HMBC, were used as supplied by the manufacturer. Chemical shifts are referenced internally to the residual, non-deuterated solvent signal $^1$H (δ 2.50 ppm) and the carbon signal $^{13}$C (δ 39.50 ppm) of dimethylsulfoxide. $^{19}$F NMR spectra were recorded on a Bruker Avance III 400
NMR spectrometer (UltraShield) using a 5 mm switchable probe (BBFOPLUS, BB/19F – 1H/D) with z-axis gradients and automatic tuning and matching accessory (Bruker BioSpin). The resonance frequency for $^1$H NMR was 400.23 MHz and for $^{19}$F NMR 376.55 MHz. All measurements were performed for a solution in fully deuterated dimethylsulfoxide at 298 K. $^{19}$F NMR spectra (broadband decoupled for 1H) were measured as supplied by the manufacturer using absolute referencing via $\Xi$ ratio. Chemical shifts are given in ppm and are reported relative to TMS and referenced to the residual proton signal of d6-DMSO (2.49 ppm). d6-DMSO with 0.03% TMS (V/V), purchased at Euriso-top®, was used as a solvent for the samples. The specified abbreviations were used to characterize the signals: s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sext = sextet, m = multiplet, and br = broad signal. The spectra were analysed by a computer using the software MestReNova 6 (Mestrelab research, 1994).

HRESIMS spectra were obtained on a maXis HD ESI-Qq-TOF mass spectrometer (Bruker Daltonics, Bremen, Germany). Samples were dissolved to 20 µg/mL in MeOH and directly infused into the ESI source at a flow rate of 3 µL/min with a syringe pump. The ESI ion source was operated as follows: capillary voltage: 0.9 to 4.0 kV (individually optimised), nebulizer: 0.4 bar (N₂), dry gas flow: 4 L/min (N₂), and dry temperature: 200 °C. Mass spectra were recorded in the range of \( m/z \) 50 – 1550 in the positive-ion mode. The sum formulas were determined using Bruker Compass DataAnalysis 4.2 based on the mass accuracy ($\Delta m/z \leq 2$ ppm) and isotopic pattern matching (SmartFormula algorithm).

The purity of the compounds was determined by HPLC on LC-2010A HT Liquid Chromatograph device (Shimadzu Corporation, Tokyo, Japan). The separation was carried out on an Acclaim 120 C18, 2.1 x 150 mm, 3 µm HPLC column (Thermo Fisher Scientific) using LC-MS-grade water with 0.1% FA and acetonitrile with 0.1% FA as mobile phase A and B,
respectively. The sample components were separated and eluted with a linear gradient from 5% to 95% B in 30 min, followed by an isocratic column cleaning and re-equilibration step. The flow rate was 0.1 mL/min, and the column oven temperature was set to 25 °C. The purity was determined from the UV chromatogram (254 nm) as the ratio of the peak area of the compound to the total peak area (i.e., the sum of the areas of all peaks that were not present in the solvent blank). Based on the HPLC data, all final compounds are ≥95% pure.

General Procedures

General Procedure A: Amine alkylation reaction for the synthesis of pyrimidine amines 2a-2j. A stirred solution of pyrimidine (1 equiv) in anhydrous ethanol under an inert atmosphere was cooled to 0 °C before amine (2 equiv) was added dropwise. The reaction mixture was brought to room temperature and then stirred for 48 hours. After evaporation of the solvent, the residue was dissolved in dichloromethane and washed twice with water and with brine. The organic layer was dried over sodium sulphate, and then evaporated to dryness. The crude product was purified by column chromatography (SiO₂, eluent: hexane/EtOAc or DCM/MeOH) to afford the desired pyrimidine amines.

General Procedure B: Synthesis of compounds 3a-3l. The pyrimidine amine (2a-2j, 1 equiv) and the Boc-protected pyridine (2 equiv) were dissolved/suspended in 1.5 ml dry ethanol. The mixture was heated to 155 °C for 30 minutes under microwave irradiation (250 Watt, 12 bars). After the solvent was evaporated, the resulting crude product was dissolved in dichloromethane and washed twice with K₂CO₃ solution (10% in water) and with water. The organic layer was dried over sodium sulphate, filtered, and then evaporated to dryness. The crude was purified by column chromatography (SiO₂, eluent: 80% dichloromethane/20% methanol), to obtain the pure product.
**General Procedure C:** Boc-deprotection reaction of compounds 4a-4b and 4d-4m. Carboxylate (1 equiv) was dissolved in dry tetrahydrofurane and stirred at room temperature, then the hydrochloric acid solution (4.0 M in dioxane, 10 equiv) was added dropwise. The mixture was stirred for 24 hours and evaporated to dryness. The residuum was dissolved in dichloromethane, washed twice with an aqueous solution of potassium carbonate (10%) and with water. The organic phase was dried over sodium sulphate, and filtered to obtain the desired product.

**General Procedure D:** Sulfonacylation reaction of nitrogen heterocycles. The pyrimidine (1 equiv) was dissolved in DCM. Sulfonyl chloride (1 equiv) and triethylamine (1 equiv) as a base was added and stirred overnight at room temperature. The mixture was diluted in DCM and washed twice with H₂O and with brine. The organic layer was dried over Na₂SO₄, filtered and concentrated in vacuum. The crude product was purified by recrystallization (DIPE/EtOAc; DIPE/EtOH or Hexane/EtOAc) or by column chromatography (SiO₂, eluent: DCM/MeOH).
Characterization and Spectral Data of the Compounds
**N-ethyl-6-methyl-2-(4-(4-fluorophenylsulfonyl)piperazin-1-yl)pyrimidin-4-amine** (1).

Compound 1 was prepared following general procedure D using 4a (90 mg, 0.4 mmol), 4-fluorobenzenesulfonyl chloride (79 mg, 0.4 mmol) and TEA (42 mg, 0.42 mmol) in DCM. The crude product was purified by recrystallization (DIME/EtOAc), resulting in 50 mg of pure product (yield 33%). Mp 170.6–171.9 °C. Ret. time. 13.0 min, purity 96.9%. HRESIMS m/z 380.1555 [M+H]+ (calcd for C\textsubscript{17}H\textsubscript{23}FN\textsubscript{5}O\textsubscript{2}S\textsuperscript{+}, 380.1551, Δ = -1.0 ppm). ¹H NMR (500 MHz, d\textsubscript{6}DMSO) δ = 1.05 (t, 3H, CH\textsubscript{3}), 2.00 (s, 3H, pyr-CH\textsubscript{3}), 2.88 (m, 4H, pip-H3,5), 3.18 (br, 2H, NCH\textsubscript{2}), 3.74 (m, 4H, pip-H2,6) 5.58 (s, 1H, pyr - H), 6.83 (br, 1H, NH), 7.48 (t, 2H, Ph-H3,5), 7.81 (q, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d\textsubscript{6}DMSO) δ = 14.61 (CH\textsubscript{3}), 23.71 (pyr-CH\textsubscript{3}), 34.60 (NCH\textsubscript{2}), 42.43 (pip-C2,6), 45.78 (pip-C3,5), 116.68 (\textsuperscript{3}J\textsubscript{13C,19F} = 22.6 Hz, (Ph-C3,5), 129.66 (pyr-C5), 130.69 (\textsuperscript{3}J\textsubscript{13C,19F} = 9.7 Hz, Ph-C2,6), 131.11 (\textsuperscript{3}J\textsubscript{13C,19F} = 3.1 Hz, Ph-C1), 160.62 (pyr-C2), 162.94 (pyr-C6), 164.72 (\textsuperscript{3}J\textsubscript{13C,19F} = 253.9 Hz, Ph-C4), 174.42 (pyr-C4); ¹⁹F NMR (400 MHz, d\textsubscript{6}DMSO) δ = -105.57 (Ph-F).

2-chloro-N-ethyl-6-methylpyrimidin-4-amine (2a). 2a was prepared following the general procedure A using 2,4-dichloro-6-methylpyrimidine (2.00 g, 12.27 mmol) and ethylamine (2.0 M in methanol, 12.27 ml, 24.54 mmol). The crude product was purified by column chromatography (SiO\textsubscript{2}, eluent: either using a mixture of 50% hexane/50% ethyl acetate or 97.5% dichloromethane/2.5% methanol), resulting in 0.949 g of pure 2-chloro-N-ethyl-6-methylpyrimidin-4-amine (yield 45%).

[As a side product, 0.358 g of pure 4-chloro-N-ethyl-6-methylpyrimidin-2-amine 2f (yield 17%) was obtained.]

2-chloro-N-isopropyl-6-methylpyrimidin-4-amine (2b). 2b was prepared following the general procedure A using 2,4-dichloro-6-methylpyrimidine (1.00 g, 6.13 mmol) and propan-2-amine
(1.00 ml, 12.27 mmol, diluted in 5 ml ethanol). The crude product was purified by column chromatography (SiO$_2$, eluent: 50% hexane/50% ethyl acetate), resulting in 0.608 g of pure 2-chloro-N-isopropyl-6-methylpyrimidin-4-amine (yield 53%).

[As a side product 0.239 g of pure 4-chloro-N-isopropyl-6-methylpyrimidin-2-amine 2j (yield 21%) was obtained.]

**N-(tert-butyl)-2-chloro-6-methylpyrimidin-4-amine (2c).** 2c was prepared following the general procedure A using 2,4-dichloro-6-methylpyrimidine (1.00 g, 6.13 mmol) and 2-methylpropan-2-amine (1.29 ml, 12.34 mmol, diluted in 5 ml ethanol). The crude product was purified by column chromatography (SiO$_2$, eluent: 50% hexane/50% ethyl acetate), resulting in 0.200 g of pure N-(tert-butyl)-2-chloro-6-methylpyrimidin-4-amine (yield 16%).

**2-chloro-4-ethoxy-6-methylpyrimidin (2d).** 2d was prepared following the general procedure A using 2,4-dichloro-6-methylpyrimidine (1.00 g, 6.13 mmol) and sodium ethoxide solution (21% w/w in ethanol, 6.13 ml). The crude product was purified by column chromatography (SiO$_2$, eluent: dichloromethane) resulting in 0.353g of pure 2-chloro-4-ethoxy-6-methylpyrimidin (yield 33%).

**2-chloro-4-methyl-6-(pyrrolidin-1-yl)pyrimidine (2e).** 2e was prepared following the general procedure A using 2,4-dichloro-6-methylpyrimidine (0.50 g, 3.67 mmol) and pyrrolidine (0.435g, 6.12 mmol, diluted in 5 ml of dry ethanol). The crude product was purified by column chromatography (SiO$_2$, eluent: 50% hexane/50% ethyl acetate), resulting in 0.282 g of pure 2-chloro-4-methyl-6-(pyrrolidin-1-yl)pyrimidine (yield 39%).

[As a side product 0.109g of pure 4-chloro-6-methyl-2-(pyrrolidin-1-yl)pyrimidine (yield 15%) was obtained.]
4-chloro-N-ethyl-6-methylpyrimidin-2-amine (2f). 2f was obtained as a side product from synthesis 2a (yield 17%).

6-chloro-N-ethyl-2-methylpyrimidin-4-amine (2g). 2g was prepared following the general procedure A using 4,6-dichloro-2-methylpyrimidine (1.00 g, 6.13 mmol) and ethylamine (2.0 M in methanol, 6.12 ml, 12.4 mmol). The crude product (0.95 g, 90% yield) was used without purification.

2-chloro-N-ethylpyrimidin-4-amine (2h). 2h was prepared following the general procedure A using 2,4-dichloropyrimidine (3.50 g, 23.5 mmol) and ethylamine (2.0 M in methanol, 23.5 ml, 47 mmol). The crude product was purified by column chromatography (SiO₂, eluent: 50% hexane/50% ethyl acetate), resulting in 1.871 g of pure 2-chloro-N-ethylpyrimidin-4-amine (yield 51%).
[As a side product 0.700 g of pure 4-chloro-N-ethylpyrimidin-2-amine 2i (yield 19%) was obtained.]

4-chloro-N-ethylpyrimidin-2-amine (2i). 2i was obtained in the first step of the synthesis of 2h (yield 19%).

4-chloro-N-isopropyl-6-methylpyrimidin-2-amine (2j). 2j was obtained in the first step of the synthesis of 2b (yield 21%).

tert-butyl 4-(4-(ethylamino)-6-methylpyrimidin-2-yl)piperazine-1-carboxylate (3a). 3a was prepared following the general procedure B using 2a (0.86 g, 5.01 mmol) and tert-butyl piperazine-1-carboxylate (1.826 g, 9.8 mmol), to yield 1,365 g of pure product (yield 85%).

tert-butyl 4-(4-(ethylamino)-6-methylpyrimidin-2-yl)-1,4-diazepane-1-carboxylate (3b). 3b was prepared following the general procedure B using 2a (0.2 g, 1.17 mmol) and tert-butyl 1,4-diazepane-1-carboxylate (0.467 g, 2.3 mmol), to yield 0.333 g of pure product (yield 85%).
tert-butyl 4-(4-(isopropylamino)-6-methylpyrimidin-2-yl)piperazine-1-carboxylate (3c). 3c was prepared following the general procedure B using 2b (185 mg, 0.99 mmol) and tert-butyl piperazine-1-carboxylate (363 mg, 1.95 mmol), to yield 0.292 g of product (yield 87%).

tert-butyl 4-(4-(tert-butylamino)-6-methylpyrimidin-2-yl)piperazine-1-carboxylate (3d). 3d was prepared following the general procedure B using 2c (170 mg, 0.85 mmol) and tert-butyl piperazine-1-carboxylate (310 mg, 1.66 mmol), to yield 0.169 g of product (yield 57%).

tert-butyl 4-(4-ethoxy-6-methylpyrimidin-2-yl)piperazine-1-carboxylate (3e). 3e was prepared following the general procedure B using 2d (150 mg, 0.87 mmol) and tert-butyl piperazine-1-carboxylate (310 mg, 1.66 mmol), to yield 0.170 g of product (yield 61%).

tert-butyl 4-(4-methyl-6-(pyrrolidin-1-yl)pyrimidin-2-yl)piperazine-1-carboxylate (3f). 3f was prepared following the general procedure B using 2e (231 mg, 1.17 mmol) and tert-butyl piperazine-1-carboxylate (425 mg, 2.28 mmol), to yield 0.305 g of product (yield 75%).

tert-butyl 4-(2-(ethylamino)-6-methylpyrimidin-4-yl)piperazine-1-carboxylate (3g). 3g was prepared following the general procedure B using 2f (304 mg, 1.78 mmol) and tert-butyl piperazine-1-carboxylate (646 mg, 3.47 mmol), to yield 0.542 g of product (yield 95%).

tert-butyl 4-(6-(ethylamino)2-methylpyrimidin-4-yl)piperazine-1-carboxylate (3h). 3h was prepared following the general procedure B using 2g (196 mg, 1.14 mmol) and tert-butyl piperazine-1-carboxylate (414 mg, 2.22 mmol), to yield 0.203 g of product (yield 55%).

tert-butyl 4-(4-(ethylamino)pyrimidin-2-yl)piperazine-1-carboxylate (3i). 3i was prepared following the general procedure B using 2h (180 mg, 1.14 mmol) and tert-butyl piperazine-1-carboxylate (440 mg, 2.36 mmol), to yield 0.256 g of product (yield 73%).
tert-butyl 4-(2-(ethylamino)pyrimidin-4-yl)piperazine-1-carboxylate (3j). 3j was prepared following the general procedure B using 2i (350 mg, 2.22 mmol) and tert-butyl piperazine-1-carboxylate (809 mg, 4.34 mmol), to yield 0.471 g of product (yield 69%).

tert-butyl 4-(4-(cyclopropylamino)pyrimidin-2-yl)piperazine-1-carboxylate (3k). 3k was prepared following the general procedure B using 2-chloro-N-cyclopropylpyrimidin-4-amine (200 mg, 1.18 mmol) and tert-butyl piperazine-1-carboxylate (430 mg, 2.31 mmol), to yield 0.193 g of product (yield 52%).

tert-butyl 4-(2-(isopropylamino)-6-methylpyrimidin-4-yl)piperazine-1-carboxylate (3l). 3l was prepared following the general procedure B using 2j (250 mg, 1.34 mmol) and tert-butyl piperazine-1-carboxylate (491 mg, 2.63 mmol), to yield 0.256 g of product (yield 57%).

N-ethyl-6-methyl-2-(piperazin-1-yl)pyrimidin-4-amine (4a). 4a was prepared following the general procedure C using 3a (870 mg, 2.70 mmol), to yield 0.311 g of product (yield 52%).

2-(1,4-diazepan-1-yl)-N-ethyl-6-methylpyrimidin-2-amine (4b). 4b was prepared following the general procedure C using 3b (311 mg, 0.93 mmol), to yield 0.182 g of product (yield 83%).

2-(3,4-dihydroquinoxaline-1(2H)-yl)-N-ethyl-6-methylpyrimidin-4-amine (4c). 2a (0.311 g, 1.81 mmol) and 1,2,3,4-tetrahydroquinoxaline (0.488 g, 3.64 mmol) were suspended in 1.5 ml dry ethanol. The mixture was heated to 155 °C for 30 minutes under microwave irradiation (250 Watt, 12 bars). After the solvent was evaporated, the resulting crude was dissolved in DCM and extracted twice with K₂CO₃ solution (10% in water). The organic layer was washed with water, dried with sodium sulphate, filtered, and then evaporated to dryness. The crude product was purified by column chromatography (SiO₂, eluent: 80% dichloromethane/20% methanol), to obtain 0.379 g of product (yield 78%).
**N-isopropyl-6-methyl-2-(piperazin-1-yl)pyrimidin-4-amine (4d).** 4d was prepared following the general procedure C using 3e (278 mg, 0.83 mmol), to yield 190 mg of product (yield 97%).

**N-(tert-butyl)-6-methyl-2-(piperazin-1-yl)pyrimidin-4-amine (4e).** 4e was prepared following the general procedure C using 3d (162 mg, 0.79 mmol), to yield 115 mg of product (yield 99%).

**4-ethoxy-6-methyl-2-(piperazin-1-yl)pyrimidin-4-amine (4f).** 4f was prepared following the general procedure C using 3e (162 mg, 0.5 mmol), to yield 107 mg of product (yield 96%).

**4-methyl-2-(piperazin-1-yl)-6-(pyrrolidin-1-yl)pyrimidine (4g).** 4g was prepared following the general procedure C using 3f (305 mg, 0.88 mmol), to yield 107 mg of product (yield 49%).

**N-ethyl-4-methyl-6-(piperazin-1-yl)pyrimidin-2-amine (4h).** 4h was prepared following the general procedure C using 3g (300 mg, 0.93 mmol), to yield 200 mg of product (yield 97%).

**N-ethyl-2-methyl-6-(piperazin-1-yl)pyrimidin-4-amine (4i).** 4i was prepared following the general procedure C using 3h (188 mg, 0.58 mmol), to yield 90 mg of product (yield 70%).

**N-ethyl-2-(piperazin-1-yl)pyrimidin-4-amine (4j).** 4j was prepared following the general procedure C using 3i (244 mg, 0.79 mmol), to yield 110 mg of product (yield 67%).

**N-ethyl-4-(piperazin-1-yl)pyrimidin-2-amine (4k).** 4k was prepared following the general procedure C using 3j (876 mg, 2.85 mmol), to yield 396 mg of product (yield 67%).

**N-cyclopropyl-2-(piperazin-1-yl)pyrimidin-4-amine (4l).** 4l was prepared following the general procedure C using 3k (235 mg, 0.74 mmol), to yield 152 mg of product (yield 94%).

**N-isopropyl-4-methyl-6-(piperazin-1-yl)pyrimidin-2-amine (4m).** 4m was prepared following the general procedure C using 3l (257 mg, 0.76 mmol), to yield 152 mg of product (yield 93%).

**N-ethyl-6-methyl-2-(4-(phenylsulfonyl)piperazin-1-yl)pyrimidin-4-amine (5a).** Compound 5a was prepared following general procedure D using 4a (100 mg, 0.45 mmol), benzenesulfonyl chloride (80 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was
purified by recrystallization (DIPE/EtOAc), resulting in 87 mg of pure product (yield 53%). Mp 120.3–124.4 °C. Ret. Time 13.80 min, purity 99.2%. HRESIMS m/z 362.1655 [M+H]^+ (calcd for C_{17}H_{24}N_{5}O_{2}S^+, 362.1654, Δ = -2.8 ppm). \(^1^H\) NMR (500 MHz, d6DMSO) δ = 1.05 (t, 3H, CH₃), 2.00 (s, 3H, pyr-CH₃), 2.87 (m, 4H, pip-H3,5), 3.18 (br, 2H, NCH₂), 3.73 (m, 4H, pip-H2,6), 5.58 (s, 1H, pyr-H), 6.83 (br, 1H, NH), 7.64 (t, 2H, Ph-H3,5), 7.72 (m, 1H, Ph -H4), 7.74 (m, 2H, Ph-H2,6); \(^1^C\) NMR (125 MHz, d6DMSO) δ = 14.61 (CH₃), 23.71 (pyr-CH₃), 34.79 (NCH₂), 42.48 (pip-C2,6), 45.81 (pip-C3,5), 127.60 (Ph -C2,6), 129.46 (Ph -C3,5), 129.46 (pyr-C5), 133.35 (Ph -C4), 134.63 (Ph -C1), 160.65 (pyr-C2), 162.93 (pyr-C6), 174.29 (pyr-C4).

\(2-(4-((4-chlorophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine\) (5b).

Compound 5b was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-chlorobenzenesulfonyl chloride (95 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (Hexane/EtOAc), resulting in 58 mg of pure product (yield 33%). Mp 132.0–133.6 °C. Ret. Time 15.28 min, purity 99.2%. HRESIMS m/z 396.1267 [M+H]^+ (calcd for C_{17}H_{23}ClN_{5}O_{2}S^+, 396.1256, Δ = -2.8 ppm). \(^1^H\) NMR (500 MHz, d6DMSO) δ = 1.05 (t, 3H, CH₃), 2.00 (s, 3H, pyr-CH₃), 2.90 (m, 4H, pip-H3,5), 3.18 (br, 2H, NCH₂), 3.74 (m, 4H, pip-H2,6), 5.59 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.71 (m, 2H, Ph-H2,6), 7.75 (m, 2H, Ph-H3,5); \(^1^C\) NMR (125 MHz, d6DMSO) δ = 14.61 (CH₃), 23.70 (pyr-CH₃), 34.53 (NCH₂), 42.43 (pip-C2,6), 45.75 (pip-C3,5), 129.50 (Ph-C3,5), 129.61 (Ph-C2,6), 129.61 (pyr-C5), 133.67 (Ph-C4), 138.30 (Ph-C1), 160.62 (pyr-C2), 162.93 (pyr-C6), 174.83 (pyr-C4).

\(2-(4-((4-bromophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine\) (5c).

Compound 5c was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-bromobenzenesulfonyl chloride (115 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 62 mg of pure product
(yield 31%). Mp 147.2 °C. Ret. time 15.54 min, purity 99.3%. HRESIMS m/z 440.0763 [M+H]⁺ (calcd for C_{17}H_{23}BrN_{5}O_{2}S⁺, 440.0750, Δ = -2.8 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.06 (t, 3H, CH₃), 2.01 (s, 3H, pyr-CH₃), 2.90 (m, 4H, pip-H3,5), 3.19 (br, 2H, NCH₂), 3.74 (m, 4H, pip-H2,6), 5.59 (s, 1H, pyr-H), 6.85 (br, 1H, NH), 7.67 (m, 2H, Ph-H2,6), 7.84 (m, 2H, Ph-H3,5); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.60 (CH₃), 23.71 (pyr-CH₃), 34.50 (NCH₂), 42.45 (pip-C2,6), 45.73 (pip-C3,5), 127.36 (Ph-C4), 129.55 (Ph-C2,6), 132.55 (Ph-C3,5), 134.09 (Ph-C1), 160.72 (pyr-C2), 162.94 (pyr-C4), 174.31(pyr-C6), n.d. (pyr-C5).

**N-ethyl-2-(4-((4-iodophenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidin-4-amine (5d).** Compound 5d was prepared following general procedure D using 4a (70 mg, 0.32 mmol), 4-iodobenzenesulfonyl chloride (96 mg, 0.32 mmol) and TEA (32 mg, 0.32 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 73 mg of pure product (yield 47%). Mp 159.4−160.4 °C. Ret. time 15.97 min, purity 99.0%. HRESIMS m/z 488.0625 [M+H]⁺ (calcd for C_{17}H_{23}IN_{5}O_{2}S⁺, 488.0612, Δ = -2.7 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.05 (t, 3H, CH₃), 2.01 (s, 3H, pyr-CH₃), 2.88 (m, 4H, pip-H3,5), 3.18 (br, 2H, NCH₂), 3.74 (m, 4H, pip-H2,6), 5.59 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.49 (m, 2H, Ph-H2,6), 8.01 (m, 2H, Ph-H3,5); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.61 (CH₃), 23.72 (pyr-CH₃), 34.52 (NCH₂), 42.44 (pip-2,6), 45.76 (pip-C3,5), 94.17 (pyr-C5), 101.87 (Ph-C4), 129.19 (Ph-C2,6), 134.38 (Ph-C1), 138.33 (Ph-C3,5), 160.62 (pyr-C2), 162.92 (pyr-C6), 174.34 (pyr-C4).

**N-ethyl-6-methyl-2-(4-((4-trifluoromethyl)phenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine (5e).** Compound 5e was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-(trifluoromethyl)-benzenesulfonyl chloride (115 mg, 0.47 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 62 mg of pure product (yield 32%). Mp 169.6−172.6 °C. Ret. time 16.13 min, purity 99.3%. HRESIMS
m/z 430.1528 [M+H]$^+$ (caled for C$_{18}$H$_{23}$F$_3$N$_5$O$_2$S$^+$, 430.1519, $\Delta = -2.2$ ppm). $^1$H NMR (500 MHz, d$_6$DMSO) $\delta =$ 1.05 (t, 3H, CH$_3$), 2.00 (s, 3H, pyr-CH$_3$), 2.95 (m, 4H, pip-H3,5), 3.18 (br, 2H, NCH$_2$), 3.75 (m, 4H, pip-H2,6), 5.58 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.96 (m, 2H, Ph-H2,6), 8.02 (m, 2H, Ph-H3,5); $^{13}$C NMR (125 MHz, d$_6$DMSO) $\delta =$ 14.61 (CH$_3$), 23.71 (pyr-CH$_3$), 34.54 (NCH$_2$), 42.43 (pip-2,6), 45.75 (pip-C3,5), 123.43 ($^3$/$^13$C, $^{19}$F) = 271.3 Hz, (CF$_3$), 126.67 ($^3$/$^13$C, $^{19}$F) = 3.6 Hz, Ph-C3,5), 128.56 (Ph-C2,6), 129.65 (pyr-C5), 132.86 ($^3$/$^13$C, $^{19}$F) = 32.0 Hz, Ph-C4), 138.93 (Ph-C1), 160.59 (pyr-C2), 162.92 (pyr-C6), 173.33 (pyr-C4). $^{19}$F NMR (400 MHz, d$_6$DMSO) $\delta =$ -61.65 (CF$_3$).

*N-ethyl-6-methyl-2-(4-((4-nitrophenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine* (5f).

Compound 5f was prepared following general procedure D using 4a (200 mg, 0.9 mmol), 4-nitrobenzenesulfonyl chloride (200 mg, 0.9 mmol) and TEA (92 mg, 0.9 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 177 mg of pure product (yield 48%). Mp 172 °C. Ret. time 14.60 min, purity 96.2%. HRESIMS m/z 407.1503 [M+H]$^+$ (caled for C$_{17}$H$_{23}$N$_6$O$_4$S$^+$, 407.1496, $\Delta = -1.7$ ppm). $^1$H NMR (500 MHz, d$_6$DMSO) $\delta =$ 1.04 (t, 3H, CH$_3$), 1.99 (s, 3H, pyr-CH$_3$), 2.96 (m, 4H, pip-H3,5), 3.17 (br, 2H, NCH$_2$), 3.75 (m, 4H, pip-H2,6), 5.58 (s, 1H, pyr-H), 6.83 (br, 1H, NH), 8.01 (m, 2H, Ph-H2,6), 8.42 (m, 2H, Ph-H3,5); $^{13}$C NMR (125 MHz, d$_6$DMSO) $\delta =$ 14.66 (CH$_3$), 23.73 (pyr-CH$_3$), 34.61 (NCH$_2$), 42.49 (pip-C2,6), 45.77 (pip-C3,5), 124.80 (Ph-C3,5), 129.19 (Ph-C2,6), 140.54 (Ph-C1), 150.18 (Ph-C4), 160.61 (pyr-C2), 162.99 (pyr-C6), 170.56 (pyr-C4), n.d. (pyr-C5).

*4-((4-(4-(ethylamino)-6-methylpyrimidin-2-yl)piperazin-1-yl)sulfonyl)benzonitrile* (5g).

Compound 5g was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-cyanobenzenesulfonyl chloride (91 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 36 mg of pure product.
(yield 21%). Mp 180 °C. Ret. time 13.88 min, purity 97.6%. HRESIMS m/z 387.1607 [M+H]+ (calcd for C18H23N6O2S+, 387.1607, Δ = -2.5 ppm). 1H NMR (500 MHz, d6DMSO) δ = 1.05 (t, 3H, CH3), 2.01 (s, 3H, pyr-CH3), 2.95 (m, 4H, pip-H3,5), 3.19 (br, 2H, NCH2), 3.75 (m, 4H, pip-H2,6), 5.59 (s, 1H, pyr-H), 6.85 (br, 1H, NH), 7.92 (m, 2H, Ph-H3,5), 8.11 (m, 2H, Ph-H2,6), 13C NMR (125 MHz, d6DMSO) δ = 14.59 (CH3), 23.70 (pyr-CH3), 34.61 (NCH2), 42.47 (pip-C2,6), 45.70 (pip-C3,5), 94.45 (pyr-C5), 115.73 (Ph-C1), 117.65 (CN), 128.28 (Ph-C3,5), 133.61 (Ph-C2,6), 139.13 (Ph-C4), 160.50 (pyr-C2), 162.89 (pyr-C6), 174.30 (pyr-C4).

N-ethyl-2-(4-((4-methoxyphenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidin-4-amine (5h). Compound 5h was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-methoxybenzenesulfonyl chloride (93 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 32 mg of pure product (yield 18%). Mp 183.2-194.0 °C. Ret. time 14.24 min, purity 95.5%. HRESIMS m/z 392.1760 [M+H]+ (calcd for C18H26N5O3S+, 392.1751, Δ = -2.3 ppm). 1H NMR (500 MHz, d6DMSO) δ = 1.09 (t, 3H, CH3), 2.18 (s, 3H, pyr-CH3), 2.97 (m, 4H, pip-H3,5), 3.32 (br, 2H, NCH2), 3.82 (m, 4H, pip-H2,6), 3.84 (s, 3H, OCH3), 5.85 (s, 1H, pyr-H), 7.16 (m, 2H, Ph-H3,5), 7.69 (m, 2H, Ph-H2,6), n.d. (NH); 13C NMR (125 MHz, d6DMSO) δ = 14.00 (CH3), 22.81 (pyr-CH3), 35.30 (NCH2), 43.60 (pip-C2,6), 45.27 (pip-C3,5), 55.76 (OCH3), 96.43 (pyr-C5), 114.66 (Ph-C3,5), 126.00 (Ph-C1), 129.89 (Ph-C2,6), 162.94 (Ph-C4), n.d. (pyr-C2), n.d. (pyr-C4), n.d. (pyr-C6).

N-ethyl-6-methyl-2-(4-tosylpiperazin-1-yl)pyrimidin-4-amine (5i). Compound 5i was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-methylbenzenesulfonyl chloride (86 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 87 mg of pure product (yield 51%). Mp 170.6-171.9
°C. Ret. time 14.76 min, purity 95.5%. HRESIMS m/z 376.1807 [M+H]+ (calcd for C₁₈H₂₆N₅O₂S⁺, 376.1802, Δ = -1.5 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.05 (t, 3H, CH₃), 2.00 (s, 3H, pyr-CH₃), 2.39 (s, 3H, Ph-CH₃), 2.83 (m, 4H, pip-H₃,5), 3.18 (br, 2H, NCH₂), 3.73 (m, 4H, pip-H₂,6), 5.58 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.44 (m, 2H, Ph-H₃,5), 7.62 (m, 2H, Ph-H₂,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.60 (CH₃), 21.03 (Ph-CH₃), 23.70 (pyr-CH₃), 34.64 (NCH₂), 42.46 (pip-2,6), 45.76 (pip-C₃,5), 94.12 (pyr-C5), 127.65 (ph-C₂,6), 129.88 (Ph-C₃,5), 131.67 (Ph-C1), 143.78 (Ph-C4), 160.61 (pyr-C2), 162.92 (pyr-C6), n.d. (pyr-C4).

N-ethyl-2-(4-((2-fluorophenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidin-4-amine (5j). Compound 5j was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 2-fluorobenzenesulfonyl chloride (88 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 22 mg of pure product (yield 13%). Mp 170.6−171.9 °C. Ret. time 14.12 min, purity 98.1%. HRESIMS m/z 380.1559 [M+H]+ (calcd for C₁₇H₂₃FN₅O₂S⁺, 380.1551, Δ = -2.2 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.06 (t, 3H, CH₃), 2.02 (s, 3H, pyr-CH₃), 3.05 (m, 4H, pip-H₃,5), 3.19 (br, 2H, NCH₂), 3.74 (m, 4H, pip-H₂,6), 5.60 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.43 (m, 1H, Ph-H₅), 7.48 (m, 1H, Ph-H₃), 7.76 (m, 1H, Ph-H₄), 7.78 (m, 1H, Ph-H₆); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.61 (CH₃), 23.71 (pyr-CH₃), 34.53 (NCH₂), 42.72 (pip-C₂,6), 45.43 (pip-C₃,5), 94.24 (pyr-C5), 117.69 (J(¹³C,¹⁹F) = 21.6 Hz, Ph-C₃), 123.64 (J(¹³C,¹⁹F) = 14.4 Hz, Ph-C1), 125.26 (J(¹³C,¹⁹F) = 3.4 Hz, Ph-C₅), 130.98 (Ph-C₆), 136.15 (J(¹³C,¹⁹F) = 8.7 Hz, Ph-C₄), 158.26 (J(¹³C,¹⁹F) = 252.6 Hz, Ph-C₂), 160.73 (pyr-C₂), 162.94 (pyr-C₆), n.d. (pyr-C₄); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -108.23 (Ph-F).

N-ethyl-2-(4-((3-fluorophenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidin-4-amine (5k). Compound 5k was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 3-
fluorobenzenesulfonyl chloride (88 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 62 mg of pure product (yield 36%). Mp 131.3–132.9 °C. Ret. time 14.45 min, purity 97.2%. HRESIMS m/z 380.1560 [M+H]^+ (calcd for C_{17}H_{23}FN_{5}O_{2}S, 380.1551, Δ = -2.5 ppm). ^1H NMR (500 MHz, d_{6}DMSO) δ = 1.06 (t, 3H, CH$_3$), 2.01 (s, 3H, pyr-CH$_3$), 2.93 (m, 4H, pip-H$_{3,5}$), 3.19 (br, 2H, NCH$_2$), 3.74 (m, 4H, pip-H$_{2,6}$), 5.59 (s, 1H, pyr-H), 6.85 (br, 1H, NH), 7.58 (m, 1H, Ph-H2), 7.60 (m, 1H, Ph-H4), 7.60 (m, 1H, Ph-H6), 7.70 (m, 1H, Ph-H5); $^{13}$C NMR (125 MHz, d$_6$DMSO) δ = 14.59 (CH$_3$), 23.69 (pyr-CH$_3$), 34.54 (NCH$_2$), 42.46 (pip-C$_{2,6}$), 45.80 (pip-C$_{3,5}$), 94.35 (pyr-C$_5$), 114.63 ($^3$J($^{13}$C, $^{19}$F) = 24.1 Hz, Ph-C2), 120.55 ($^3$J($^{13}$C, $^{19}$F) = 21.2 Hz, Ph-C4), 123.84 ($^3$J($^{13}$C, $^{19}$F) = 2.5 Hz, Ph-C6), 131.85 ($^3$J($^{13}$C, $^{19}$F) = 8.0 Hz, Ph-C5), 136.90 ($^3$J($^{13}$C, $^{19}$F) = 6.3 Hz, Ph-C1), 160.60 (pyr-C2), 163.24 (pyr-C6), n.d. (pyr-C4); $^{19}$F NMR (400 MHz, d$_6$DMSO) δ = -110.01 (Ph-F).

2-(4-((3,4-difluorophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine (5l).

Compound 5l was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 3,4-difluorobenzenesulfonyl chloride (96 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 71 mg of pure product (yield 40%). Mp 108.8 °C. Ret. time 14.86 min, purity 98.1%. HRESIMS m/z 398.1464 [M+H]^+ (calcd for C$_{17}$H$_{22}$F$_2$N$_5$O$_2$S, 398.1457, Δ = -1.8 ppm). ^1H NMR (500 MHz, d$_6$DMSO) δ = 1.06 (t, 3H, CH$_3$), 2.03 (s, 3H, pyr-CH$_3$), 2.95 (m, 4H, pip-H$_{3,5}$), 3.21 (br, 2H, NCH$_2$), 3.76 (m, 4H, pip-H$_{2,6}$), 5.62 (s, 1H, pyr-H), 6.90 (br, 1H, NH), 7.63 (m, 1H, Ph-H6), 7.71 (dt, 1H, J = 26.5 Hz, Ph-H5), 7.86 (ddd, 1H, J = 19.3 Hz, Ph-H2); $^{13}$C NMR (125 MHz, d$_6$DMSO) δ = 14.59 (CH$_3$), 23.51 (pyr-CH$_3$), 34.75 (NCH$_2$), 42.59 (pip-C$_{2,6}$), 45.77 (pip-C$_{3,5}$), 94.60 (pyr-C$_5$), 117.63 (d, $^3$J($^{13}$C, $^{19}$F) = 19.6 Hz, Ph-C2), 118.96 (d, $^3$J($^{13}$C, $^{19}$F) = 18.3 Hz, Ph-C5), 125.62 (dd, $^3$J($^{13}$C, $^{19}$F) =
8.0 Hz, 3.5 Hz, Ph-C6), 132.05 (dd, $^3J^{(13}C,^{19}F) = 4.8$ Hz, 3.5 Hz, Ph-C1), 149.55 (dd, $^3J^{(13}C,^{19}F) = 250.2$ Hz, 13.2 Hz, Ph-C3), 152.62 (dd, $^3J^{(13}C,^{19}F) = 252.5$ Hz, 12.3 Hz, Ph-C4), n.d. (pyr-C4), n.d. (pyr-C6), n.d. (pyr-C2); $^{19}$F NMR (400 MHz, d$_6$DMSO) $\delta = -130.60$ (d, 21.8 Hz, Ph-F), -134.72 (d, 21.8 Hz, Ph-F).

$2$-(4-((2,4-difluorophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine ($5m$).

Compound $5m$ was prepared following general procedure D using $4a$ (100 mg, 0.45 mmol), 2,4-difluorobenzenesulfonyl chloride (96 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 63 mg of pure product (yield 35%). Mp 134.2 °C. Ret. time 14.49 min, purity 98.5%. HRESIMS $m/z$ 398.1465 [M+H]$^+$ (calcd for C$_{17}$H$_{22}$F$_2$N$_5$O$_2$S, 398.1457, $\Delta = -2.2$ ppm). $^1$H NMR (500 MHz, d$_6$DMSO) $\delta = 1.06$ (t, 3H, CH$_3$), 2.02 (s, 3H, pyr-CH$_3$), 3.05 (m, 4H, pip-H$_3$-5), 3.20 (br, 2H, NCH$_2$), 3.75 (m, 4H, pip-H$_2$-6), 5.60 (s, 1H, pyr-H), 6.85 (br, 1H, NH), 7.33 (dt, 1H, J = 19.3 Hz, Ph-H5), 7.59 (ddd, 1H, J = 22.3 Hz, Ph-H3), 7.85 (dt, 1H, J = 23.3 Hz, Ph-H6); $^{13}$C NMR (125 MHz, d$_6$DMSO) $\delta = 14.61$ (CH$_3$), 23.72 (pyr-CH$_3$), 34.47 (NCH$_2$), 42.67 (pip-C2,6), 45.38 (pip-C3,5), 94.30 (pyr-C5), 106.42 (t, $^3J^{(13}C,^{19}F) = 26.4$ Hz, Ph-C3), 112.69 (dd, $^3J^{(13}C,^{19}F) = 25.3$ Hz, Ph-C5), 120.47 (dd, $^3J^{(13}C,^{19}F) = 18.1$ Hz, Ph-C1), 133.06 (d, $^3J^{(13}C,^{19}F) = 11.1$ Hz, Ph-C6), 159.19 (dd, $^3J^{(13}C,^{19}F) = 268.8$ Hz, Ph-C2), 160.70 (pyr-C2), 162.94 (pyr-C6), 165.29 (dd, $^3J^{(13}C,^{19}F) = 265$ Hz, Ph-C4), n.d. (pyr-C4); $^{19}$F NMR (400 MHz, d$_6$DMSO) $\delta = -100.98$ (d, 12.5 Hz, Ph-F4), -102.98 (d, 12.5 Hz, Ph-F2).

$N$-ethyl-6-methyl-2-(4-((3,4,5-trifluorophenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine ($5n$).

Compound $5n$ was prepared following general procedure D using $4a$ (100 mg, 0.45 mmol), 3,4,5-trifluorobenzenesulfonyl chloride (105 mg, 0.46 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 72 mg of
pure product (yield 39%). Mp 112.1 °C. Ret. time 15.52 min, purity 96.7%. HRESIMS m/z 416.1374 [M+H]^+ (calcd for C\textsubscript{17}H\textsubscript{21}F\textsubscript{3}N\textsubscript{5}O\textsubscript{2}S\textsuperscript{+}, 416.1363, Δ = -2.7 ppm). \textsuperscript{1}H NMR (500 MHz, d\textsubscript{6}DMSO) δ = 1.06 (t, 3H, J = 7.2 Hz, CH\textsubscript{3}), 2.01 (s, 3H, pyr-CH\textsubscript{3}), 2.98 (m, 4H, pip-H3,5), 3.19 (br, 2H, NCH\textsubscript{2}), 3.76 (m, 4H, pip-H2,6), 5.59 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.76 (t, 2H, J = 6.5 Hz, Ph-H2,6); \textsuperscript{13}C NMR (125 MHz, d\textsubscript{6}DMSO) δ = 14.62 (CH\textsubscript{3}), 23.69 (pyr-CH\textsubscript{3}), 34.66 (NCH\textsubscript{2}), 42.30 (pip-C2,6), 45.80 (pip-C3,5), 94.38 (pyr-C5), 113.31 (dd, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 23.8 Hz, Ph-C2,6), 131.32 (Ph-C1), 142.26 (dt, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 284.9 Hz, Ph-C4), 150.45 (dd, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 262.6 Hz, Ph-C3,5), 160.50 (pyr-C2), 162.93 (pyr-C6), n.d. (pyr-C4); \textsuperscript{19}F NMR (400 MHz, d\textsubscript{6}DMSO) δ = -131.07 (d, 21.2 Hz, Ph-F3,5), -153.14 (d, 21.2 Hz, Ph-F4).

**N-ethyl-6-methyl-2-(4-((2,3,4-trifluorophenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine**

(5o). Compound 5o was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 2,3,4-trifluorobenzenesulfonyl chloride (105 mg, 0.46 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 78 mg of pure product (yield 42%). Mp 142.7 °C. Ret. time 15.31 min, purity 98.2%. HRESIMS m/z 416.1373 [M+H]^+ (calcd for C\textsubscript{17}H\textsubscript{21}F\textsubscript{3}N\textsubscript{5}O\textsubscript{2}S\textsuperscript{+}, 416.1363, Δ = -2.5 ppm). \textsuperscript{1}H NMR (500 MHz, d\textsubscript{6}DMSO) δ = 1.06 (t, 3H, CH\textsubscript{3}), 2.02 (s, 3H, pyr-CH\textsubscript{3}), 3.08 (m, 4H, pip-H3,5), 3.20 (br, 2H, NCH\textsubscript{2}), 3.77 (m, 4H, pip-H2,6), 5.60 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.54 (m, 1H, Ph-H5), 7.63 (m, 1H, Ph-H6); \textsuperscript{13}C NMR (125 MHz, d\textsubscript{6}DMSO) δ = 14.63 (CH\textsubscript{3}), 23.72 (pyr-CH\textsubscript{3}), 35.00 (NCH\textsubscript{2}), 42.54 (pip-C2,6), 45.32 (pip-C3,5), 113.37 (Ph-C5), 121.60 (Ph-C1), 125.66 (Ph-C6), 140.03 (d, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 252.2 Hz, Ph-C3), 147.77 (d, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 250.3 Hz, Ph-C2), 153.44 (d, \textsuperscript{3}J(\textsuperscript{13}C,\textsuperscript{19}F) = 253.2 Hz, Ph-C4), 160.61 (pyr-C2), 162.94 (pyr-C6), 174.20 (pyr-C4), n.d. (pyr-C5); \textsuperscript{19}F NMR (400 MHz, d\textsubscript{6}DMSO) δ = -125.97 (Ph-F), -129.01 (Ph-F), -156.91 (Ph-F).
**N-ethyl-6-methyl-2-(4-((2,4,6-trifluorophenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine (5p).** Compound 5p was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 2,3,4-trifluorobenzenesulfonyl chloride (100 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by column chromatography (dichloromethane/20% methanol), resulting in 85 mg of pure product (yield 45%). Mp 140.3 °C. Ret. time 13.16 min, purity 96.5%. HRESIMS m/z 416.1364 [M+H]+ (calcd for C_{17}H_{21}F_{2}N_{5}O_{2}S, 416.1363, Δ = -0.4 ppm). \(^1\)H NMR (500 MHz, d<sub>6</sub>DMSO) δ = 1.07 (t, 3H, CH<sub>3</sub>), 2.02 (s, 3H, pyr-CH<sub>3</sub>), 3.12 (m, 4H, pip-H<sub>3,5</sub>), 3.20 (br, 2H, NCH<sub>2</sub>), 3.77 (m, 4H, pip-H<sub>2,6</sub>), 5.61 (s, 1H, pyr-H), 6.85 (br, 1H, NH), 7.47 (m, 1H, Ph-H<sub>3,5</sub>); \(^{13}\)C NMR (125 MHz, d<sub>6</sub>DMSO) δ = 14.64 (CH<sub>3</sub>), 23.73 (pyr-CH<sub>3</sub>), 34.61 (NCH<sub>2</sub>), 42.59 (pip-C<sub>2,6</sub>), 45.14 (pip-C<sub>3,5</sub>), 94.47 (pyr-C<sub>5</sub>), 102.97 (t, \(^3\)J\(^{(13}\)C,\(^{19}\)F) = 28.4 Hz, Ph-C<sub>3,5</sub>), 110.78 (Ph-C<sub>1</sub>), 160.07 (ddd, \(^3\)J\(^{(13}\)C,\(^{19}\)F) = 255.8, 16.6 and 7.4 Hz, Ph-C<sub>2,6</sub>), 160.70 (pyr-C<sub>2</sub>), 162.97 (pyr-C<sub>4</sub>), 163.31 (pyr-C<sub>6</sub>), 164.93 (dt, \(^3\)J\(^{(13}\)C,\(^{19}\)F) = 250.4, 15.7 and 15.7 Hz, Ph-C<sub>4</sub>); \(^{19}\)F NMR (400 MHz, d<sub>6</sub>DMSO) δ = -101.84 (t, 10.6 Hz, Ph-F<sub>2,6</sub>), -98.90 (m, Ph-F<sub>4</sub>).

**N-ethyl-6-methyl-2-(4-((perfluorophenyl)sulfonyl)piperazin-1-yl)pyrimidin-4-amine (5q).** Compound 5q was prepared following general procedure D using 4a (100 mg, 0.45 mmol), pentafluorobenzenesulfonyl chloride (120 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 33 mg of pure product (yield 16%). Mp 175.2−177.5 °C. Ret. time 16.15 min, purity 97.4%. HRESIMS m/z 452.1189 [M+H]+ (calcd for C_{17}H_{19}F_{15}N_{5}O_{2}S, 452.1174, Δ = -3.3 ppm). \(^1\)H NMR (500 MHz, d<sub>6</sub>DMSO) δ = 1.07 (t, 3H, CH<sub>3</sub>), 2.03 (s, 3H, pyr-CH<sub>3</sub>), 3.18 (m, 4H, pip-H<sub>3,5</sub>), 3.21 (br, 2H, NCH<sub>2</sub>), 3.81 (m, 4H, pip-H<sub>2,6</sub>), 3.61 (s, 1H, pyr-H), 6.85 (br, 1H, NH); \(^{13}\)C NMR (125 MHz, d<sub>6</sub>DMSO) δ = 14.67 (CH<sub>3</sub>), 34.64 (NCH<sub>2</sub>), 42.45 (pip-C<sub>2,6</sub>), 45.15 (pip-C<sub>3,5</sub>), 160.63 (pyr-C<sub>2</sub>), 163.05 (pyr-C<sub>6</sub>), n.d. (pyr-C<sub>4</sub>), n.d. (pyr-C<sub>5</sub>), n.d. (Ph-C<sub>1</sub>), n.d. (Ph-C<sub>2</sub>), n.d.
(Ph-C3), n.d. (Ph-C4), n.d. (Ph-C5), n.d. (Ph-C6), $^{19}$F NMR (400 MHz, d6DMSO) $\delta = -135.43$ (d, $J = 18.9$ Hz, F-2, F-6), -146.86 (t, $J = 22.3$ Hz, F-4), -159.44 (dd, $J = 22.3$ and 18.9 Hz, F-3, F-5).

2-(4-((3,4-dichlorophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine (5r).

Compound 5r was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 3,4-dichlorobenzoyl chloride (94 mg, 0.45 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 70 mg of pure product (yield 36%). Mp 116.5 °C. Ret. time 13.14 min, purity 90.8%. HRESIMS m/z 430.0870 [M+H]$^+$ (calcd for C$_{17}$H$_{22}$Cl$_2$N$_2$O$_2$S$^+$, 430.0866, $\Delta = -0.9$ ppm). $^1$H NMR (500 MHz, d$_6$DMSO) $\delta = 1.06$ (t, 3H, CH$_3$), 2.02 (s, 3H, pyr-CH$_3$), 2.97 (m, 4H, pip-H3,5), 3.19 (br, 2H, NCH$_2$), 3.76 (m, 4H, pip-H2,6), 5.60 (s, 1H, pyr-H), 6.84 (br, 1H, NH), 7.71 (dd, 8.4 and 2.1 Hz, 1H, Ph-H6), 7.90 (d, 8.4 Hz, 1H, Ph-H5), 7.94 (d, 2.1 Hz, 1H, Ph-H2); $^{13}$C NMR (125 MHz, d$_6$DMSO) $\delta = 14.59$ (CH$_3$), 23.70 (pyr-CH$_3$), 35.43 (NCH$_2$), 42.43 (pip-C2,6), 45.72 (pip-C3,5), 127.65 (Ph-C6), 129.20 (Ph-C2), 131.84 (Ph-C5), 132.55 (Ph-C2), 135.32 (Ph-C3), 136.55 (Ph-C4), n.d. (pyr-C2), n.d. (pyr-C4), n.d. (pyr-C5), n.d. (pyr-C6).

2-(4-((4-aminophenyl)sulfonyl)piperazin-1-yl)-N-ethyl-6-methylpyrimidin-4-amine (5s).

Compound 5f (200 mg, 0.49 mmol) and tin (II) chloride dihydrate (800 mg, 3.55 mmol) were dissolved in EtOAc and heated to 80 °C for 48 h under reflux. The mixture was diluted in ethyl acetate and extracted with saturated sodium hydrogen carbonate solution. The organic layer dried over sodium sulphate, filtered and concentrated in vacuum. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 122 mg of pure product (yield 66%). Mp 159.8 °C. Ret. time 12.19 min, purity 95.2%. HRESIMS m/z 377.1762 [M+H]$^+$ (calcd for C$_{17}$H$_{25}$N$_6$O$_2$S$^+$, 377.1754, $\Delta = -2.0$ ppm). $^1$H NMR (500 MHz, d$_6$DMSO) $\delta = 1.06$ (t, 3H, CH$_3$), 2.01 (s, 3H, pyr-CH$_3$), 2.77 (m, 4H, pip-H3,5), 3.19 (br, 2H, NCH$_2$), 3.71 (m, 4H, pip-H2,6), 5.58 (s, 1H, pyr-H),
6.08 (s, 2H, NH₂), 6.62 (m, 2H, Ph-H3,5), 6.82 (br, 1H, NH), 7.34 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.61 (CH₃), 23.74 (pyr-CH₃), 34.57 (NCH₂), 42.47 (pip-C2,6), 45.79 (pip-C3,5), 93.99 (pyr-C5), 112.64 (Ph-C3,5), 118.94 (Ph-C1), 129.64 (Ph-C2,6), 153.26 (Ph-C4), 160.71 (pyr-C2), 162.93 (pyr-C6), n.d. (pyr-C4).

(4-(4-(ethylamino)-6-methylpyrimidin-2-yl)piperazin-1-yl)(4-fluorophenyl)methanone (6a). Compound 6a was prepared following general procedure D using 4a (120 mg, 0.54 mmol), 4-fluorobenzoyl chloride (86 mg, 0.54 mmol) and TEA (55 mg, 0.54 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 90 mg of pure product (yield 49%). Mp 131.6–134.2 °C. Ret. time 12.39 min, purity 98.4%. HRESIMS m/z 344.1891 [M+H]⁺ (calcd for C₁₈H₂₃FN₅O⁺, 344.1881, Δ = -2.8 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.08 (t, 3H, CH₃), 2.05 (s, 3H, pyr-CH₃), 3.22 (br, 2H, NCH₂), 3.68 (br, 4H, pip-H3,5), 3.68 (br, 4H, pip-H2,6), 5.63 (s, 1H, pyr-H), 6.84 (br, 2H, NH₂), 7.29 (m, 2H, Ph-H3,5), 7.50 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.67 (CH₃), 23.78 (pyr-CH₃), 34.65 (NCH₂), 43.36 (pip-C2,6), 43.36 (pip-C3,5), 94.21 (pyr-C5), 115.39 (²J(¹³C,¹⁹F) = 21.2 Hz, Ph-C3,5), 129.66 (²J(¹³C,¹⁹F) = 8.6 Hz, Ph-C2,6), 132.32 (³J(¹⁹F) = 3.2 Hz, Ph-C1), 161.07 (pyr-C2), 162.54 (³J(¹³C,¹⁹F) = 244.9 Hz, Ph-C4), 162.96 (pyr-C6), 168.25 (amide-C), n.d. (pyr-C4); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -111.17 (Ph-F).

N-ethyl-2-(4-(4-fluorobenzyl)piperazin-1-yl)-6-methylpyrimidin-4-amine (6b). Compound 6b was prepared following general procedure D using 4a (100 mg, 0.45 mmol), 4-fluorobenzyl chloride (66 mg, 0.46 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by column chromatography (SiO₂, eluent: 80% DCM, 20% MeOH), resulting in 40 mg of pure product (yield 27%). Mp 124–127 °C, Ret. time 7.79 min, purity 94.5%. HRESIMS m/z 330.2098 [M+H]⁺ (calcd for C₁₈H₂₃FN₅⁺, 330.2089, Δ = -2.8 ppm). ¹H NMR (500 MHz, d₆DMSO)
δ = 1.07 (t, 3H, CH₃), 2.03 (s, 3H, pyr-CH₃), 2.35 (m, 4H, pip-H₃,5), 3.20 (br, 2H, NCH₂), 3.47 (s, 2H, Bn-CH₂), 3.63 (m, 4H, pip-H₂,6), 5.58 (s, 1H, pyr-H), 6.78 (br, 2H, NH₂), 7.15 (m, 2H, Ph-H₃,5), 7.35 (m, 2H, Ph-H₂,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.72 (CH₃), 23.77 (pyr-CH₂), 34.66 (NCH₂), 43.31 (pip-C₂,6), 52.54 (pip-C₃,5), 61.29 (Bn-C), 114.99 (d, ³J(¹³C,¹⁹F) = 21.2 Hz, Ph-C₃,5), 130.87 (d, ³J(¹³C,¹⁹F) = 7.4 Hz, Ph-C₂,6), 134.27 (Ph-C₁), 161.35 (d, ³J(¹³C,¹⁹F) = 240.6 Hz, Ph-C₄), 162.98 (pyr-C₆), n.d. (pyr-C₂), n.d. (pyr-C₄), n.d. (pyr-C₅); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -115.97 (Ph-F).

*N-ethyl-2-(4-((4-fluorophenyl)sulfonyl)-1,4-diazepan-1-yl)-6-methylpyrimidin-4-amine (7a).* Compound 7a was prepared following general procedure D using 4b (146 mg, 0.62 mmol), 4-fluorobenzenesulfonyl chloride (79 mg, 0.62 mmol) and TEA (63 mg, 0.62 mmol) in DCM. The crude product was column chromatography (SiO₂, eluent: 80% DCM, 20% MeOH), resulting in 134 mg of pure product (yield 55%). Mp resinous substance, Ret. time 13.66 min, purity 97.9%. HRESIMS m/z 394.1721 [M+H]⁺ (calcd for C₁₈H₂₅FN₅O₂S⁺, 394.1708, Δ = -3.5 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.07 (t, 3H, J = 7.2 Hz, CH₃), 1.73 (m, 2H, dia-H₆), 2.00 (s, 3H, pyr-CH₃), 3.18 (br, 2H, NCH₂), 3.22 (m, 2H, dia-H₅), 3.34 (m, 2H, dia-H₃), 3.64 (t, 2H, dia-H₇), 3.76 (t, 2H, dia-H₂), 5.56 (s, 1H, pyr-H), 6.76 (br, 1H, NH), 7.33 (tt, 2H, Ph-H₃,5), 7.77 (m, 2H, Ph-H₂,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.79 (CH₃), 23.93 (pyr-CH₃), 28.11 (dia-C₆), 34.62 (NCH₂), 45.29 (dia-C₇), 47.06 (dia-C₂), 47.06 (dia-C₅), 47.93 (dia-C₃), 93.67 (pyr-C₅), 116.41 (d, ³J(¹³C,¹⁹F) = 22.5 Hz, Ph-C₃,5), 129.67 (d, ³J(¹³C,¹⁹F) = 9.4 Hz, Ph-C₂,6), 135.43 (d, ³J(¹³C,¹⁹F) = 2.8 Hz, Ph-C₁), 160.36 (pyr-C₂), 163.01 (pyr-C₄), 163.01 (pyr-C₆), 164.25 (d, ³J(¹³C,¹⁹F) = 249.9 Hz, Ph-C₄); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -106.68 (Ph-F).

*N-ethyl-2-(4-((4-fluorophenyl)sulfonyl)-3,4-dihydroquinoxalin-1(2H)-yl)-6-methylpyrimidin-4-amine (7b).* Compound 7b was prepared following general procedure D using
4c (345 mg, 1.28 mmol), 4-fluorobenzenesulfonyl chloride (249 mg, 1.28 mmol) and TEA (130 mg, 1.28 mmol) in DCM. The crude product was purified by column chromatography (SiO₂, eluent: 80% DCM, 20% MeOH), resulting in 154 mg of pure product (yield 28%). Mp 124-127 °C, Ret. time 15.08 min, purity 95.0%. HRESIMS m/z 428.1569 [M+H]+ (calcd for C₂₁H₂₃FN₅O₃S⁺, 428.1551, Δ = -4.1 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.06 (t, 3H, CH₃), 2.03 (s, 3H, pyr-CH₃), 3.13 (quint, 2H, NCH₂), 3.71 (m, 2H, qu-H3), 3.90 (m, 2H, qu-H2), 5.74 (s, 1H, pyr-H), 6.95 (br, 1H, NH), 7.04 (m, 2H, Ph-H3,5), 7.05 (m, 1H, qu-H7), 7.16 (m, 1H, qu-H6), 7.44 (m, 2H, Ph-H2,6), 7.50 (d, 1H, qu-H8), 7.70 (d, 1H, qu-H5); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.71 (CH₃), 23.68 (pyr-CH₃), 34.71 (NCH₂), 44.02 (qu-C₃), 47.44 (qu-C₂), 96.74 (pyr-C₅), 116.10 (d, ³J(¹³C,₁⁹F) = 22.7 Hz, Ph-C₃,5), 122.61 (qu-C₇), 125.55 (qu-C₈), 125.70 (qu-C₆), 126.11 (qu-C₅), 129.60 (qu-8a), 129.62 (d, ³J(¹³C,₁⁹F) = 9.6 Hz, Ph-C₂,6), 134.10 (Ph-C₁), 136.64 (qu-C₄a), 158.94 (pyr-C₂), 162.49 (pyr-C₄), 162.52 (d, ³J(¹³C,₁⁹F) = 250.7 Hz, Ph-C₄), n.d. (pyr-C₆). ¹⁹F NMR (400 MHz, d₆DMSO) δ = -105.49 (Ph-F).

2-(4-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-N-isopropyl-6-methylpyrimidin-4-amine (8a).

Compound 8a was prepared following general procedure D using 4d (180 mg, 0.76 mmol), 4-fluorobenzenesulfonyl chloride (143 mg, 0.73 mmol) and TEA (77 mg, 0.45 mmol) in DCM. The crude product was by column chromatography (SiO₂, eluent: 45 % Hexane, 45 % EtOAC and 10 % EtOH), resulting in 94 mg of pure product (yield 33 %). Mp 180.7 °C, Ret. time 15.12 min, purity 96.5%. HRESIMS m/z 394.1719 [M+H]+ (calcd for C₁₈H₂₅FN₅O₂S⁺, 394.1708, Δ = -2.9 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.07 (d, 3H, ipr-CH₃), 1.99 (s, 3H, pyr-CH₃), 2.88 (m, 4H, pip-H₃,5), 3.73 (m, 4H, pip-H₂,6), 3.95 (br, 1H, ipr-CH), 5.57 (s, 1H, pyr-H), 6.71 (br, 1H, NH), 7.47 (m, 2H, Ph-H₃,5), 7.81 (m, 2H, Ph-H₂,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 22.49 (ipr-CH₃), 23.74 (pyr-CH₃), 41.24 (ipr-CH), 42.50 (pip-C₂,6), 45.83 (pip-C₃,5), 94.50 (pyr-C₅),
$J^{(13C,19F)} = 22.7$ Hz, Ph-C3,5), 130.77 ($J^{(13C,19F)} = 9.5$ Hz, Ph-C2,6), 131.14 ($J^{(13C,19F)} = 2.9$ Hz, Ph-C1), 160.70 (pyr-C2), 162.36 (pyr-C4), 163.30 (pyr-C6), 164.76 ($J^{(13C,19F)} = 250.5$ Hz, Ph-C4); $^{19}$F NMR (400 MHz, d6DMSO) $\delta = -105.57$ (Ph-F).

**N-(tert-butyl)-6-(4-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-2-methylpyrimidin-4-amine (8b).** Compound 8b was prepared following general procedure D using 4e (110 mg, 0.44 mmol), 4-fluorobenzenesulfonyl chloride (86 mg, 0.44 mmol) and TEA (45 mg, 0.44 mmol) in DCM. The crude product was purified by recrystallization (DIPE/ethyl acetate), resulting in 78 mg of N-(tert-butyl)-6-(4-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-2-methylpyrimidin-4-amine (yield 41%). Mp 144.7 °C Ret. time 14.36 min, purity 96.8%. HRESIMS $m/z$ 408.1877 [M+H]$^+$ (calcd for C19H27FN5O2S, 408.1864, $\Delta = -0.1$ ppm). $^1$H NMR (500 MHz, d6DMSO) $\delta = 1.32$ (s, 9H, tBu-CH3), 1.99 (s, 3H, pyr-CH3), 2.92 (s, 4H, pip-H3,5), 3.74 (m, 4H, pip-H2,6), 5.65 (s, 1H, pyr-H), 6.57 (br, 1H, NH), 7.48 (m, 2H, Ph-H3,5), 7.82 (m, 2H, Ph-H2,6); $^{13}$C NMR (125 MHz, d6DMSO) $\delta = 28.84$ (tBu-CH3), 42.74 (pip-C2,6), 45.67 (pip-C3,5), 50.36 (tBu-C), 95.68 (pyr-C5), 116.70 (d, $^3J^{(13C,19F)} = 22.7$ Hz, Ph-C3,5), 130.72 (d, $^3J^{(13C,19F)} = 9.4$ Hz, Ph-C2,6), 131.13 (d, $^3J^{(13C,19F)} = 3.2$ Hz, Ph-C1), 164.72 (d, $^3J^{(13C,19F)} = 250.8$ Hz, Ph-C4), n.d. (pyr-CH3), n.d. (pyr-C2), n.d. (pyr-C4), n.d. (pyr-C6); $^{19}$F NMR (400 MHz, d6DMSO) $\delta = -105.56$ (Ph-F).

**4-ethoxy-2-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidine (8c).** Compound 8c was prepared following general procedure D using 4f (107 mg, 0.48 mmol), 4-fluorobenzenesulfonyl chloride (91 mg, 0.47 mmol) and TEA (45 mg, 0.44 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 88 mg of pure product (yield 53%). Mp 156.5 °C. Ret. time 25.03 min, purity 98.6%. HRESIMS $m/z$ 381.1396 [M+H]$^+$ (calcd for C17H22FN4O3S, 381.1391, $\Delta = -1.2$ ppm). $^1$H NMR (500 MHz, d6DMSO) $\delta = 1.25$ (t, 3H, CH3), 2.14 (s, 3H, pyr-CH3), 2.93 (m, 4H, pip-H3,5), 3.80 (m, 4H, pip-H2,6), 4.23 (q, 2H,
OCH₂), 5.93 (s, 1H, pyr-H), 7.48 (m, 2H, Ph-H3,5), 7.82 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.30 (CH₃), 23.66 (pyr-CH₃), 42.50 (pip-C3,5), 45.68 (pip-C2,6), 61.14 (OCH₂), 95.24 (pyr-C5), 116.71 (J(¹³C,¹⁹F) = 22.8 Hz, Ph-C3,5), 130.69 (J(¹³C,¹⁹F) = 9.9 Hz, Ph-C2,6), 131.12 (J(¹³C,¹⁹F) = 2.6 Hz, Ph-C1), 160.43 (pyr-C2), 164.72 (J(¹³C,¹⁹F) = 250.4 Hz, Ph-C4), 167.85 (pyr-C6), 169.58 (pyr-C4); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -105.58 (Ph-F).

2-(4-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-4-methyl-6-(pyrrolidin-1-yl)pyrimidine (8d).

Compound 8d was prepared following general procedure D using 4g (208 mg, 0.84 mmol), 4-fluorobenzenesulfonyl chloride (164 mg, 0.84 mmol) and TEA (86 mg, 0.85 mmol) in DCM. The crude product was purified by column chromatography (SiO₂, eluent: 80 % DCM, 20 % MeOH), resulting in 251 mg of pure product (yield 74 %). Mp 147 °C. Ret. time 15.21 min, purity 96.4%. HRESIMS m/z 406.1718 [M+H]⁺ (calcd for C₁₉H₂₅FN₅O₂S⁺, 406.1708, Δ = -2.6 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.85 (br, 4H, pyrrolidine-H3,4), 2.06 (s, 3H, pyr-CH₃), 3.30 (br, 4H, pyrrolidine-H2,5), 2.88 (m, 4H, pip-H3,5), 3.76 (m, 4H, pip-H2,6), 5.65 (s, 1H, pyr-H), 7.47 (m, 2H, Ph-H3,5), 7.81 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 23.90 (pyr-CH₃), 24.78 (pyrrolidine-C3,4), 42.58 (pip-C2,6), 45.77 (pip-C3,5), 45.83 (pyrrolidine-C2,5), 92.83 (pyr-C5), 116.76 (J(¹³C,¹⁹F) = 22.7 Hz, Ph-C3,5), 130.77 (J(¹³C,¹⁹F) = 9.4 Hz, Ph-C2,6), 131.13 (J(¹³C,¹⁹F) = 2.7 Hz, Ph-C1), 160.28 (pyr-C2), 160.62 (pyr-C6), 164.43 (pyr-C4), 164.76 (J(¹³C,¹⁹F) = 250.6 Hz, Ph-C4); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -105.56 (Ph-F).

N-ethyl-4-(4-((4-fluorophenyl)sulfonyl)piperazin-1-yl)-6-methylpyrimidin-2-amine (9a).

Compound 9a was prepared following general procedure D using 4h (109 mg, 0.49 mmol), 4-fluorobenzenesulfonyl chloride (96 mg, 0.49 mmol) and TEA (50 mg, 0.49 mmol) in DCM. The crude product was purified by column chromatography (SiO₂, eluent: 87.5 % DCM, 12.5 % MeOH), resulting in 165 mg of pure product (yield 89%). Mp 158.1-159.9 °C. Ret. time 14.20
min, purity 98.5%. HRESIMS m/z 380.1560 [M+H]⁺ (calcd for C₁₇H₂₃F₅N₅O₂S⁺, 380.1551, Δ = -2.5 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.03 (t, 3H, CH₃), 2.04 (s, 3H, pyr-CH₃), 2.90 (m, 4H, pip-H3,5), 3.17 (m, 2H, NCH₂), 3.62 (m, 4H, pip-H2,6), 5.85 (s, 1H, pyr-H), 6.45 (br, 1H, NH), 7.48 (m, 2H, Ph-H3,5), 7.82 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.94 (CH₃), 23.89 (pyr-CH₃), 35.18 (NCH₂), 45.51 (pip-C3,5), 90.99 (pyr-C5), 116.74 (J(¹³C,¹⁹F) = 22.5 Hz, Ph-C3,5), 130.69 (J(¹³C,¹⁹F) = 9.6 Hz, Ph-C2,6), 131.06 (J(¹³C,¹⁹F) = 2.4 Hz, Ph-C1), 162.40 (pyr-C4), 164.74 (d, J(¹³C,¹⁹F) = 250.5 Hz, Ph-C4), 165.91 (pyr-C6); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -105.45 (Ph-F).

**N-ethyl-6-(4-(4-fluorophenylsulfonyl)piperazin-1-yl)-2-methylpyrimidin-4-amine (9b).** Compound 9b was prepared following general procedure D using 4i (86 mg, 0.39 mmol), 4-fluorobenzenesulfonyl chloride (76 mg, 0.39 mmol) and TEA (39 mg, 0.39 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 72 mg of pure product (yield 49%). Mp 166.1-168.6 °C. Ret. time 13.97 min, purity 97.1%. HRESIMS m/z 380.1561 [M+H]⁺ (calcd for C₁₇H₂₃F₅N₅O₂S⁺, 380.1551, Δ = -2.7 ppm). ¹H NMR (500 MHz, d₆DMSO) δ = 1.04 (t, 3H, CH₃), 2.13 (s, 3H, pyr-CH₃), 2.91 (m, 4H, pip-H3,5), 3.13 (m, 2H, NCH₂), 3.55 (m, 4H, pip-H2,6), 5.37 (s, 1H, pyr-H), 6.57 (t, 1H, NH), 7.48 (t, 2H, Ph-H3,5), 7.82 (m, 2H, Ph-H2,6); ¹³C NMR (125 MHz, d₆DMSO) δ = 14.65 (CH₃), 25.88 (pyr-CH₃), 35.13 (NCH₂), 42.93 (pip-C3,5), 45.60 (pip-C3,5), 116.80 (J(¹³C,¹⁹F) = 22.3 Hz, Ph-C3,5), 130.77 (J(¹³C,¹⁹F) = 9.5 Hz, Ph-C2,6), 131.11 (J(¹³C,¹⁹F) = 2.2 Hz, Ph-C1), 162.04 (pyr-C6), 163.55 (pyr-C4), 164.80 (J(¹³C,¹⁹F) = 250.5 Hz, Ph-C4), 165.44 (pyr-C2), n.d. (pyr-C5); ¹⁹F NMR (400 MHz, d₆DMSO) δ = -105.45 (Ph-F).

**N-ethyl-2-(4-(4-fluorophenylsulfonyl)piperazin-1-yl)pyrimidin-4-amine (9c).** Compound 9c was prepared following general procedure D using 4j (117 mg, 0.56 mmol), 4-
fluorobenzenesulfonyl chloride (94 mg, 0.48 mmol) and TEA (57 mg, 0.56 mmol) in DCM. The crude product was purified by recrystallization (DIPE/EtOAc), resulting in 89 mg of pure product (yield 51%). Mp 123.0-124.5 °C. Ret. time 13.75 min, purity 97.1%. HRESIMS m/z 366.1404 [M+H]^+ (calcld for C_{16}H_{21}FN_{5}O_{2}S^+, 366.1395, Δ = -2.6 ppm). ^1H NMR (500 MHz, d_6DMSO) δ = 1.06 (t, 3H, CH_3), 2.89 (m, 4H, pip-H3,5), 3.20 (br, 2H, NCH_2), 3.74 (m, 4H, pip-H2,6), 5.72 (d, 1H, pyr-H), 7.02 (br, 1H, NH), 7.48 (m, 2H, Ph-H3,5), 7.65 (br, 1H, pyr-H6), 7.82 (m, 2H, Ph-H2,6); ^13C NMR (125 MHz, d_6DMSO) δ = 14.47 (CH_3), 34.31 (NCH_2), 42.44 (pip-C2,6), 45.71 (pip-C3,5), 96.36 (pyr-C5), 116.69 (\(^3J(13C,^{19}F) = 22.3\) Hz, Ph-C3,5), 130.68 (\(^3J(13C,^{19}F) = 9.4\) Hz, Ph-C2,6), 131.11 (\(^3J(13C,^{19}F) = 2.2\) Hz, Ph-C1), 154.44 (pyr-C6), 160.72 (pyr-C2), 162.23 (pyr-C4), 164.69 (\(^3J(13C,^{19}F) = 250.5\) Hz, Ph-C4); ^19F NMR (400 MHz, d_6DMSO) δ = -105.57 (Ph-F).

**N-ethyl-4-(4-(4-fluorophenyl)sulfonyl)piperazin-1-yl)pyrimidin-2-amine (9d).** Compound 9d was prepared following general procedure D using 4k (95 mg, 0.46 mmol), 4-fluorobenzenesulfonyl chloride (90 mg, 0.46 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by column chromatography (SiO_2, eluent: 80% DCM, 20% MeOH), resulting in 140 mg of pure product (yield 83%). Mp 188-189 °C. Ret. time 13.65 min, purity 95.3%. HRESIMS m/z 366.1404 [M+H]^+ (calcld for C_{16}H_{21}FN_{5}O_{2}S^+, 366.1395, Δ = -2.6 ppm). ^1H NMR (500 MHz, d_6DMSO) δ = 1.03 (t, 3H, CH_3), 2.91 (m, 4H, pip-H3,5), 3.18 (m, 2H, NCH_2), 3.62 (m, 4H, pip-H2,6), 5.95 (d, 1H, pyr-H), 6.50 (br, 1H, NH), 7.48 (t, 2H, Ph-H3,5), 7.76 (d, 1H, pyr-H6), 7.82 (m, 2H, Ph-H2,6); ^13C NMR (125 MHz, d_6DMSO) δ = 14.96 (CH_3), 35.27 (NCH_2), 42.52 (pip-C2,6), 45.59 (pip-C3,5), 92.57 (pyr-C5), 116.81 (\(^3J(13C,^{19}F) = 22.6\) Hz, Ph-C3,5), 130.77 (\(^3J(13C,^{19}F) = 9.5\) Hz, Ph-C2,6), 131.09 (\(^3J(13C,^{19}F) = 3.0\) Hz, Ph-C1), 157.04 (pyr-C6), 161.73 (pyr-C2), 161.78 (pyr-C4), 164.82 (d, \(^3J(13C,^{19}F) = 250.8\) Hz, Ph-C4); ^19F NMR (400 MHz, d_6DMSO) δ = -105.43 (Ph-F).
Compound 10 was prepared following general procedure D using 4I (148 mg, 0.67 mmol), 4-fluorobenzenesulfonyl chloride (131 mg, 0.67 mmol) and TEA (68 mg, 0.64 mmol) in DCM. The crude product was purified by recrystallization (DIPE / ethyl acetate), resulting in 81 mg of pure product (yield 32%). Mp 174.4 °C. Ret. time 14.11 min, purity 97.5%. HRESIMS m/z 378.1403 [M+H]^+ (calcd for C_{17}H_{21}FN_{5}O_{2}S^+, 378.1395, Δ = -2.3 ppm). ^1H NMR (500 MHz, d_6 DMSO) δ = 0.41 (m, 2H, CH\_2), 0.68 (m, 2H, CH\_2), 2.92 (m, 4H, pip-H3,5), 3.76 (m, 4H, pip-H2,6), 5.94 (br, 1H, pyr-H), 5.94 (br, 1H, NH), 7.48 (t, 2H, Ph-H3,5), 7.74 (m, 1H, pyr-H6), 7.82 (m, 2H, Ph-H2,6), n.d. (NCH); ^13C NMR (125 MHz, d_6 DMSO) δ = 6.78 (CH\_2), 42.75 (pip-C2,6), 45.60 (pip-C3,5), 116.79 (^3^J(^13C,^19F) = 22.6 Hz, Ph-C3,5), 130.77 (^3^J(^13C,^19F) = 9.5 Hz, Ph-C2,6), 131.16 (^3^J(^13C,^19F) = 3.0 Hz, Ph-C1), n.d. (pyr-C2), n.d. (pyr-C4), n.d. (pyr-C5), n.d. (pyr-C6), n.d. (Ph-C4), n.d. (NCH); ^19F NMR (400 MHz, d_6 DMSO) δ = -105.51 (Ph-F).

(3-chlorophenyl)(4-(2-(ethylamino)-6-methylpyrimidin-4-yl)piperazin-1-yl)methanone (11a).

Compound 11a was prepared following general procedure D using 4h (169 mg, 0.76 mmol), 4-chlorobenzoyl chloride (134 mg, 0.76 mmol) and TEA (77 mg, 0.76 mmol) in DCM. The crude product was purified by column chromatography (dichloromethane/20% methanol), resulting in 178 mg of pure product (yield 65%). Mp 181 °C. Ret. Time 13.74 min, purity 99.9 %. HRESIMS m/z 360.1593 [M+H]^+ (calcd for C_{18}H_{23}ClN_{5}O^+, 360.1586, Δ = -2.0 ppm). ^1H NMR (500 MHz, d_6 DMSO) δ = 1.06 (t, 3H, NCH\_3), 2.08 (s, 3H, pyr-CH\_3), 3.22 (br, 2H, NCH\_2), 3.37/3.54 (br, 4H, pip-H2,6), 3.64 (br, 4H, pip-H3,5), 5.91 (s, 1H, pyr-H5), 6.48 (br, 1H, NH), 7.47 (m, 2H, ph-H2,6), 7.53 (m, 2H, ph-H3,5); ^13C NMR (500 MHz, d_6 DMSO) δ = 14.99 (CH\_3), 23.86 (pyr-CH\_3), 35.22 (NCH\_2), 43.20 (pip-C3,5), 43.20 (pip-C2,6), 91.20 (pyr-C5), 128.55 (ph-C3,5), 129.09 (ph-C2,6), 130.57 (Ph-H3,5), 132.21 (Ph-H2,6).
134.30 (ph-C4), 134.56 (ph-C1), 161.48 (pyr-C2), 162.72 (pyr-C4), 165.54 (pyr-C6), 168.12 (amide-C).

*(4-chlorophenyl)(4-(2-(ethylamino)pyrimidin-4-yl)piperazin-1-yl)methanone* *(11b).*

Compound 11b was prepared following general procedure D using 4k (95 mg, 0.46 mmol), 4-chlorobenzoyl chloride (85 mg, 0.46 mmol) and TEA (46 mg, 0.45 mmol) in DCM. The crude product was purified by column chromatography (dichloromethane/20% methanol), resulting in 53 mg of pure product (yield 34%). Mp 180 °C. Ret. Time 13.13 min, purity 96.2%. HRESIMS m/z 346.1435 [M+H]\(^+\) (calcd for C\(_{17}\)H\(_{21}\)ClN\(_5\)O\(_2\)\(^+\), 346.1429, \(\Delta = -1.7\) ppm). \(^1\)H NMR (500 MHz, d\(_6\)DMSO) \(\delta = 1.06\) (t, 3H, NCH\(_3\)), 3.21 (quint, 2H, NCH\(_2\)), 3.37/3.54 (br, 4H, pip-H\(_2\),6), 3.64/3.65 (br, 4H, pip-H\(_3\),5), 6.01 (s, 1H, pyr-H\(_5\)), 6.52 (br, 1H, NH), 7.47 (m, 2H, ph-2,6), 7.53 (m, 2H, ph-H3,5), 7.81 (d, 1H, pyr-H6); \(^13\)C NMR (500 MHz, d\(_6\)DMSO) \(\delta = 15.01\) (NCH\(_3\)), 35.31 (NCH\(_2\)), 41.48/43.13 (pip-C3,5), 43.13/46.87 (pip-C2,6), 92.84 (pyr-C5), 128.63 (ph-C3,5), 129.16 (ph-C2,6), 134.39 (ph-C4), 134.58 (ph-C1), 156.86 (pyr-C6), 161.74 (pyr-C2), 162.11 (pyr-C4), 168.26 (amide-C).

*(4-fluorophenyl)(4-(2-(isopropylamino)-6-methylpyrimidin-4-yl)piperazin-1-yl)methanone* *(11c).* Compound 11c was prepared following general procedure D using 4m (176 mg, 0.75 mmol), 4-chlorobenzoyl chloride (119 mg, 0.68 mmol) and TEA (76 mg, 0.75 mmol) in DCM. The crude product was purified by column chromatography (dichloromethane/20% methanol), resulting in 140 mg of pure product (yield 52%). Mp 74-75 °C. Ret. Time 13.37 min, purity 98.4%. HRESIMS m/z 358.2044 [M+H]\(^+\) (calcd for C\(_{19}\)H\(_{23}\)FN\(_5\)O\(_2\)\(^+\), 358.2038, \(\Delta = -1.7\) ppm). \(^1\)H NMR (500 MHz, d\(_6\)DMSO) \(\delta = 1.08\) (d, 6H, iPr-CH\(_3\)), 2.08 (s, 3H, pyr-CH\(_3\)), 3.61 (br, 4H, pip-H2,6), 3.61 (br, 4H, pip-H3,5), 3.98 (m, 1H, iPr-CH), 5.90 (s, 1H, pyr-H5), 6.31 (br, 1H, NH), 7.29 (m, 2H, ph-3,5), 7.51 (m, 2H, ph-H2,6); \(^13\)C NMR (500 MHz, d\(_6\)DMSO) \(\delta = 22.68\) (iPr-CH\(_3\)), 41.72
(iPr-CH), 115.50 ($^3$J(C, F) = 21.6 Hz, Ph-C3,5), 129.76 ($^3$J(C, F) = 8.3 Hz, Ph-C2,6), 132.20
($^3$J(C, F) = 3.0 Hz, Ph-C1), 161.01 (pyr-C2), 162.67 (d, $^3$J(C, F) = 245.1 Hz, Ph-C4), 162.81
(pyr-C4), 165.62 (pyr-C6), 168.42 (amide-C), n.d. (pyr-CH3), n.d. (pip-C3,5), n.d. (pip-C2,6), n.d.
(pyr-C5); $^{19}$F NMR (400 MHz, d$_6$DMSO) $\delta$ = -111.00 (Ph-F).
Copies of 1H- and 13C-NMR Spectra
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 1
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5a
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5b
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5c
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5d
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5e
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5f
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5g
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5h
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5i
\(^1\)H- and \(^{13}\)C-NMR Spectra in DMSO-d6 of compound 5j
$^{1}$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5k
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5l
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5m
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound $5n$
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5o
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5p
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 5q
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 5r
$^1$H- and $^13$C-NMR Spectra in DMSO-d6 of compound 5s
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 6a
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 6b
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 7a
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 7b
$^{1}H$- and $^{13}C$-NMR Spectra in DMSO-d$_6$ of compound 8a

![NMR Spectra Image]
$^{1}H$- and $^{13}C$-NMR Spectra in DMSO-d$_6$ of compound 8b
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 8c
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d6 of compound 8d
$^{1}$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 9a
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 9b
$^{1}\text{H}$- and $^{13}\text{C}$-NMR Spectra in DMSO-d$_6$ of compound 9c
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 9d
$^{1}$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 10
$^{1}$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 11a
$^{1}H$- and $^{13}C$-NMR Spectra in DMSO-d$_6$ of compound 11b
$^1$H- and $^{13}$C-NMR Spectra in DMSO-d$_6$ of compound 11c
HPLC determined purity of the Compounds
HPLC determined purity of compound 1

Peak Table:

| Peak# | Ret Time | Area  | Height | Height% | Area%  |
|-------|----------|-------|--------|---------|--------|
| 1     | 2.231    | 2154  | 536    | 0.013   | 0.008  |
| 2     | 3.349    | 6329  | 418    | 0.010   | 0.023  |
| 3     | 3.571    | 56294 | 3805   | 0.094   | 0.207  |
| 4     | 3.989    | 31352 | 6215   | 0.154   | 0.115  |
| 5     | 4.353    | 42409 | 1261   | 0.031   | 0.156  |
| 6     | 10.297   | 2868  | 349    | 0.009   | 0.011  |
| 7     | 10.425   | 2180  | 271    | 0.007   | 0.008  |
| 8     | 10.825   | 1647  | 193    | 0.005   | 0.006  |
| 9     | 10.997   | 1678  | 213    | 0.005   | 0.006  |
| 10    | 11.134   | 2553  | 370    | 0.009   | 0.009  |
| 11    | 11.295   | 3515  | 602    | 0.017   | 0.013  |
| 12    | 11.686   | 3437  | 336    | 0.008   | 0.013  |
| 13    | 11.979   | 1086  | 66     | 0.002   | 0.004  |
| 14    | 12.321   | 1189  | 204    | 0.005   | 0.004  |
| 15    | 12.607   | 4699  | 1089   | 0.027   | 0.017  |
| 16    | 12.976   | 26360640 | 3995065 | 98.732  | 96.910 |
| 17    | 13.884   | 1086  | 264    | 0.007   | 0.004  |
| 18    | 14.633   | 1824  | 337    | 0.008   | 0.007  |
| 19    | 15.712   | 1027  | 81     | 0.002   | 0.004  |
| 20    | 16.356   | 9246  | 865    | 0.021   | 0.034  |
| 21    | 18.873   | 6915  | 418    | 0.010   | 0.025  |
| 22    | 19.339   | 1760  | 96     | 0.002   | 0.006  |
| Peak# | Ret. Time | Area  | Height | Height% | Area% |
|------|-----------|-------|--------|---------|-------|
| 23   | 20.392    | 1212  | 164    | 0.004   | 0.004 |
| 24   | 21.547    | 1120  | 86     | 0.002   | 0.004 |
| 25   | 23.707    | 8307  | 672    | 0.017   | 0.031 |
| 26   | 24.011    | 2303  | 242    | 0.006   | 0.008 |
| 27   | 24.171    | 1794  | 197    | 0.005   | 0.006 |
| 28   | 24.448    | 1112  | 91     | 0.002   | 0.004 |
| 29   | 26.299    | 6916  | 642    | 0.016   | 0.025 |
| 30   | 26.475    | 4968  | 540    | 0.013   | 0.018 |
| 31   | 26.721    | 6968  | 850    | 0.021   | 0.026 |
| 32   | 26.912    | 1365  | 170    | 0.004   | 0.005 |
| 33   | 27.944    | 6057  | 536    | 0.013   | 0.022 |
| 34   | 28.437    | 1030  | 52     | 0.001   | 0.004 |
| 35   | 28.928    | 2373  | 190    | 0.005   | 0.009 |
| 36   | 29.840    | 9552  | 696    | 0.017   | 0.035 |
| 37   | 30.187    | 2801  | 163    | 0.004   | 0.010 |
| 38   | 30.673    | 5574  | 339    | 0.008   | 0.020 |
| 39   | 31.043    | 6999  | 423    | 0.010   | 0.026 |
| 40   | 31.463    | 28190 | 1843   | 0.046   | 0.104 |
| 41   | 31.925    | 10232 | 584    | 0.014   | 0.038 |
| 42   | 32.736    | 34217 | 875    | 0.022   | 0.126 |
| 43   | 33.024    | 20136 | 1402   | 0.035   | 0.074 |
| 44   | 33.216    | 12140 | 1231   | 0.030   | 0.045 |
| 45   | 33.398    | 13870 | 1343   | 0.033   | 0.051 |
| 46   | 33.605    | 25365 | 1952   | 0.048   | 0.093 |
| 47   | 34.475    | 115010| 2146   | 0.053   | 0.423 |
| 48   | 34.982    | 38882 | 2114   | 0.052   | 0.143 |
| 49   | 35.414    | 98547 | 5715   | 0.141   | 0.362 |
| 50   | 35.945    | 42994 | 2117   | 0.052   | 0.158 |
| 51   | 36.395    | 8296  | 662    | 0.016   | 0.030 |
| 52   | 36.683    | 2879  | 189    | 0.005   | 0.011 |
| 53   | 44.042    | 134145| 5022   | 0.124   | 0.493 |
| Total| 27201220  | 4046360| 100.000| 100.000 |

S74
HPLC determined purity of compound 5a

**<Chromatogram>**

![Chromatogram Image]

**<Peak Table>**

| Peak# | Ret. Time | Area     | Height  | Conc. | Area% | Height% |
|-------|-----------|----------|---------|-------|-------|---------|
| 1     | 12.633    | 8558     | 1237    | 0.058 | 0.058 | 0.070   |
| 2     | 13.801    | 14585087 | 1749773 | 99.169 | 99.169 | 99.184  |
| 3     | 14.803    | 15141    | 2452    | 0.103 | 0.103 | 0.139   |
| 4     | 15.616    | 13076    | 1910    | 0.089 | 0.089 | 0.108   |
| 5     | 17.808    | 8283     | 1829    | 0.056 | 0.056 | 0.104   |
| 6     | 31.810    | 77144    | 6965    | 0.525 | 0.525 | 0.385   |
| **Total** | **14707288** | **1764166** |         | 100.000 | 100.000 |
HPLC determined purity of compound 5b

<Chromatogram>

<Pack Table>

| Peak | Ret. Time | Area    | Height | Conc.  | Area%  | Height% |
|------|-----------|---------|--------|--------|--------|---------|
| 1    | 13.612    | 36296   | 4654   | 0.000  | 0.276  | 0.279   |
| 2    | 14.280    | 21581   | 2997   | 0.000  | 0.164  | 0.180   |
| 3    | 15.284    | 13024787| 1654000| 0.000  | 99.072 | 99.176  |
| 4    | 16.016    | 20486   | 1996   | 0.000  | 0.156  | 0.120   |
| 5    | 29.280    | 15761   | 1497   | 0.000  | 0.120  | 0.090   |
| 6    | 31.392    | 11653   | 1259   | 0.000  | 0.089  | 0.075   |
| 7    | 36.275    | 16213   | 1331   | 0.000  | 0.123  | 0.080   |
| Total|           | 13146778| 1667734| 100.000| 100.000|          |
HPLC determined purity of compound 5c

**<Chromatogram>**

```
[Image of chromatogram]
```

**<Peak Table>**

```
| Peak# | Ret. Time | Area   | Height | Conc. | Height% | Area%  |
|-------|-----------|--------|--------|-------|---------|--------|
| 1     | 13.805    | 19254  | 1800   | 0.000 | 0.067   | 0.096  |
| 2     | 14.281    | 33931  | 4911   | 0.000 | 0.182   | 0.170  |
| 3     | 15.303    | 7071   | 1243   | 0.000 | 0.046   | 0.035  |
| 4     | 15.543    | 19818058 | 2684918 | 0.000 | 99.414  | 99.306 |
| 5     | 16.172    | 13444  | 1783   | 0.000 | 0.066   | 0.067  |
| 6     | 16.468    | 5961   | 1024   | 0.000 | 0.038   | 0.030  |
| 7     | 17.102    | 6634   | 672    | 0.000 | 0.025   | 0.033  |
| 8     | 18.251    | 4655   | 438    | 0.000 | 0.016   | 0.023  |
| 9     | 20.419    | 9645   | 784    | 0.000 | 0.029   | 0.048  |
| 10    | 25.160    | 8832   | 650    | 0.000 | 0.024   | 0.044  |
| 11    | 30.353    | 15376  | 1310   | 0.000 | 0.049   | 0.077  |
| 12    | 37.012    | 13734  | 1221   | 0.000 | 0.045   | 0.069  |
| Total | 19956594  | 2700755 |        |       | 100.000 | 100.00 |
```
HPLC determined purity of compound 5d

**<Chromatogram>**

**<Peak Table>**

| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 1     | 14.123    | 72174 | 4361   | 0.000 | 0.110   | 0.265 |
| 2     | 15.324    | 52360 | 8289   | 0.000 | 0.210   | 0.193 |
| 3     | 15.972    | 26932955 | 3919007 | 0.000 | 99.299  | 99.047 |
| 4     | 16.521    | 41400 | 5080   | 0.000 | 0.129   | 0.152 |
| 5     | 16.970    | 36177 | 3697   | 0.000 | 0.094   | 0.133 |
| 6     | 17.627    | 18770 | 1717   | 0.000 | 0.044   | 0.069 |
| 7     | 18.770    | 25995 | 2172   | 0.000 | 0.055   | 0.096 |
| 8     | 20.994    | 12190 | 2361   | 0.000 | 0.060   | 0.045 |
| Total | 27192021  | 3947583 |        | 100.000 | 100.000 |
HPLC determined purity of compound 5e

<Chromatogram>

| Peak# | Ret. Time | Area   | Height | Conc. | Height% | Area% |
|-------|-----------|--------|--------|-------|---------|-------|
| 1     | 14.160    | 76196  | 11658  | 0.000 | 0.289   | 0.246 |
| 2     | 14.638    | 10011  | 1650   | 0.000 | 0.041   | 0.032 |
| 3     | 15.324    | 37121  | 6262   | 0.000 | 0.155   | 0.120 |
| 4     | 15.599    | 90774  | 15656  | 0.000 | 0.385   | 0.293 |
| 5     | 16.133    | 30757004 | 3996922 | 0.000 | 99.035  | 99.258 |
| 6     | 17.946    | 9381   | 2419   | 0.000 | 0.060   | 0.030 |
| 7     | 21.101    | 6501   | 1413   | 0.000 | 0.035   | 0.021 |
| Total | 30986988  | 4035881|        |       | 100.000 | 100.000 |

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HPLC determined purity of compound 5f
| Peak# | Ret. Time | Area    | Height   | Height% | Area%  |
|------|----------|---------|----------|---------|--------|
| 23   | 16.332   | 2854    | 324      | 0.009   | 0.011  |
| 24   | 16.949   | 6617    | 909      | 0.024   | 0.026  |
| 25   | 17.279   | 1315    | 161      | 0.004   | 0.005  |
| 26   | 17.658   | 5467    | 583      | 0.016   | 0.022  |
| 27   | 18.972   | 166826  | 25728    | 0.688   | 0.660  |
| 28   | 20.062   | 3695    | 476      | 0.013   | 0.015  |
| 29   | 22.476   | 4359    | 509      | 0.014   | 0.017  |
| 30   | 24.278   | 1081    | 111      | 0.003   | 0.004  |
| 31   | 26.663   | 72951   | 5883     | 0.157   | 0.289  |
| 32   | 26.965   | 43524   | 3324     | 0.089   | 0.172  |
| 33   | 27.144   | 55745   | 3514     | 0.094   | 0.221  |
| 34   | 27.431   | 45751   | 2644     | 0.071   | 0.181  |
| 35   | 27.926   | 17339   | 1448     | 0.039   | 0.069  |
| 36   | 28.364   | 3834    | 377      | 0.010   | 0.015  |
| 37   | 29.096   | 1813    | 195      | 0.005   | 0.007  |
| 38   | 29.232   | 6661    | 638      | 0.017   | 0.028  |
| 39   | 31.190   | 1594    | 166      | 0.004   | 0.006  |
| 40   | 32.580   | 2742    | 257      | 0.007   | 0.011  |
| 41   | 32.832   | 2585    | 174      | 0.005   | 0.010  |
| 42   | 33.355   | 1321    | 113      | 0.003   | 0.005  |
| 43   | 34.240   | 3730    | 230      | 0.006   | 0.015  |
| 44   | 34.731   | 1748    | 159      | 0.004   | 0.007  |
| 45   | 39.466   | 4240    | 208      | 0.006   | 0.017  |
| 46   | 49.150   | 97666   | 3365     | 0.090   | 0.386  |
| Total|          | 25272127| 3737263  | 100.000 | 100.000 |
HPLC determined purity of compound 5g

**<Chromatogram>**

![Chromatogram Image]

**<Peak Table>**

| Peak # | Ret. Time | Area   | Height | Conc. | Height% | Area% |
|--------|-----------|--------|--------|-------|---------|-------|
| 1      | 3.537     | 15924  | 1943   | 0.115 | 0.117   | 0.115 |
| 2      | 3.974     | 8180   | 4389   | 0.059 | 0.263   | 0.059 |
| 3      | 4.264     | 21812  | 856    | 0.158 | 0.051   | 0.158 |
| 4      | 10.688    | 1232   | 74     | 0.009 | 0.004   | 0.009 |
| 5      | 11.184    | 8720   | 739    | 0.063 | 0.044   | 0.063 |
| 6      | 11.413    | 1130   | 152    | 0.008 | 0.009   | 0.008 |
| 7      | 11.574    | 3587   | 339    | 0.026 | 0.020   | 0.026 |
| 8      | 12.034    | 9530   | 1104   | 0.069 | 0.066   | 0.069 |
| 9      | 12.613    | 76387  | 10158  | 0.553 | 0.610   | 0.553 |
| 10     | 12.960    | 1494   | 169    | 0.011 | 0.010   | 0.011 |
| 11     | 13.880    | 13486001 | 1634141 | 97.584 | 98.071 | 97.584 |
| 12     | 14.717    | 1502   | 242    | 0.011 | 0.015   | 0.011 |
| 13     | 14.969    | 5848   | 870    | 0.042 | 0.052   | 0.042 |
| 14     | 15.360    | 20428  | 2930   | 0.148 | 0.176   | 0.148 |
| 15     | 15.643    | 2235   | 314    | 0.016 | 0.019   | 0.016 |
| 16     | 16.001    | 1598   | 171    | 0.012 | 0.010   | 0.012 |
| 17     | 16.213    | 1112   | 204    | 0.008 | 0.012   | 0.008 |
| 18     | 16.432    | 1355   | 194    | 0.010 | 0.012   | 0.010 |
| 19     | 17.227    | 1259   | 77     | 0.009 | 0.005   | 0.009 |
| 20     | 17.886    | 16321  | 1042   | 0.118 | 0.063   | 0.118 |
| 21     | 18.069    | 8883   | 875    | 0.064 | 0.052   | 0.064 |
| 22     | 18.443    | 3598   | 388    | 0.026 | 0.023   | 0.026 |
| Peak# | Ret. Time | Area  | Height | Conc.  | Height% | Area%  |
|-------|-----------|-------|--------|--------|---------|--------|
| 23    | 20.542    | 3676  | 332    | 0.027  | 0.020   | 0.027  |
| 24    | 23.282    | 1365  | 166    | 0.010  | 0.010   | 0.010  |
| 25    | 28.651    | 1168  | 99     | 0.008  | 0.006   | 0.008  |
| 26    | 32.864    | 2876  | 157    | 0.019  | 0.009   | 0.019  |
| 27    | 33.387    | 1589  | 78     | 0.012  | 0.005   | 0.012  |
| 28    | 34.251    | 4083  | 236    | 0.030  | 0.014   | 0.030  |
| 29    | 34.741    | 2398  | 205    | 0.017  | 0.012   | 0.017  |
| 30    | 35.040    | 1338  | 74     | 0.010  | 0.004   | 0.010  |
| 31    | 37.269    | 1874  | 114    | 0.014  | 0.007   | 0.014  |
| 32    | 39.445    | 2718  | 151    | 0.020  | 0.009   | 0.020  |
| 33    | 49.141    | 98824 | 3304   | 0.715  | 0.198   | 0.715  |
| Total |           | 13819845 | 1666290 | 100.000 | 100.000 |
HPLC determined purity of compound 5h

<Chromatogram>

<PDA Table>

| Peak# | Ret. time | Area    | Height | Conc  | Height% | Area% |
|-------|-----------|---------|--------|-------|---------|-------|
| 1     | 2.598     | 1452    | 172    | 0.015 | 0.013   | 0.015 |
| 2     | 2.837     | 3391    | 464    | 0.034 | 0.036   | 0.034 |
| 3     | 3.537     | 42565   | 2396   | 0.427 | 0.188   | 0.427 |
| 4     | 3.973     | 19037   | 7154   | 0.191 | 0.562   | 0.191 |
| 5     | 4.265     | 17706   | 727    | 0.178 | 0.057   | 0.178 |
| 6     | 7.851     | 11904   | 860    | 0.119 | 0.068   | 0.119 |
| 7     | 8.378     | 8151    | 1174   | 0.082 | 0.092   | 0.082 |
| 8     | 9.311     | 1208    | 174    | 0.012 | 0.014   | 0.012 |
| 9     | 10.469    | 8409    | 886    | 0.084 | 0.070   | 0.084 |
| 10    | 11.458    | 1956    | 163    | 0.020 | 0.013   | 0.020 |
| 11    | 12.008    | 15427   | 1882   | 0.155 | 0.148   | 0.155 |
| 12    | 12.213    | 1650    | 286    | 0.017 | 0.022   | 0.017 |
| 13    | 12.451    | 23441   | 2949   | 0.235 | 0.232   | 0.235 |
| 14    | 12.984    | 5488    | 787    | 0.055 | 0.062   | 0.055 |
| 15    | 13.627    | 1684    | 201    | 0.017 | 0.016   | 0.017 |
| 16    | 14.241    | 9519087 | 1232386| 96.551| 96.837  | 96.551|
| 17    | 14.799    | 6710    | 1234   | 0.067 | 0.097   | 0.067 |
| 18    | 15.008    | 7059    | 1001   | 0.071 | 0.079   | 0.071 |
| 19    | 15.612    | 6559    | 1090   | 0.066 | 0.086   | 0.066 |
| 20    | 15.944    | 47319   | 2487   | 0.475 | 0.195   | 0.475 |
| 21    | 16.176    | 20778   | 2145   | 0.209 | 0.169   | 0.209 |
| 22    | 16.693    | 3874    | 175    | 0.039 | 0.014   | 0.039 |
| Peak# | Ret. Time | Area  | Height | Conc.  | Height% | Area% |
|-------|-----------|-------|--------|--------|---------|-------|
| 23    | 17.291    | 1326  | 104    | 0.013  | 0.008   | 0.013 |
| 24    | 17.879    | 1426  | 164    | 0.014  | 0.013   | 0.014 |
| 25    | 18.183    | 1873  | 328    | 0.019  | 0.026   | 0.019 |
| 26    | 18.522    | 1611  | 233    | 0.016  | 0.018   | 0.016 |
| 27    | 19.044    | 1940  | 332    | 0.019  | 0.026   | 0.019 |
| 28    | 19.509    | 1606  | 115    | 0.016  | 0.009   | 0.016 |
| 29    | 20.524    | 7403  | 483    | 0.074  | 0.038   | 0.074 |
| 30    | 21.256    | 5878  | 638    | 0.059  | 0.050   | 0.059 |
| 31    | 21.773    | 2313  | 285    | 0.023  | 0.022   | 0.023 |
| 32    | 22.280    | 1815  | 249    | 0.018  | 0.020   | 0.018 |
| 33    | 22.707    | 3167  | 392    | 0.032  | 0.031   | 0.032 |
| 34    | 23.951    | 4622  | 502    | 0.046  | 0.039   | 0.046 |
| 35    | 24.361    | 26676 | 2563   | 0.268  | 0.201   | 0.268 |
| 36    | 25.607    | 1149  | 111    | 0.012  | 0.009   | 0.012 |
| 37    | 26.123    | 1333  | 92     | 0.013  | 0.007   | 0.013 |
| 38    | 26.511    | 2126  | 187    | 0.021  | 0.015   | 0.021 |
| 39    | 28.538    | 2490  | 204    | 0.025  | 0.016   | 0.025 |
| 40    | 31.933    | 7801  | 730    | 0.078  | 0.057   | 0.078 |
| 41    | 33.192    | 1084  | 75     | 0.011  | 0.006   | 0.011 |
| 42    | 34.240    | 3884  | 211    | 0.039  | 0.017   | 0.039 |
| 43    | 34.709    | 2012  | 186    | 0.020  | 0.015   | 0.020 |
| 44    | 34.944    | 1600  | 126    | 0.016  | 0.010   | 0.016 |
| 45    | 37.205    | 3108  | 287    | 0.031  | 0.023   | 0.031 |
| 46    | 39.435    | 5838  | 191    | 0.059  | 0.015   | 0.059 |
| 47    | 49.103    | 93327 | 3054   | 0.937  | 0.240   | 0.937 |
| Total |           | 9962261 | 1272633 |        | 100,000 | 100,000 |
HPLC determined purity of compound 5i
| Peak# | Ret Time | Area  | Height | Conc  | Height% | Area% |
|-------|----------|-------|--------|-------|---------|-------|
| 23    | 16.645   | 18342 | 2263   | 0.129 | 0.130   | 0.129 |
| 24    | 17.061   | 3380  | 486    | 0.024 | 0.028   | 0.024 |
| 25    | 17.820   | 1186  | 126    | 0.008 | 0.007   | 0.008 |
| 26    | 18.436   | 5754  | 689    | 0.040 | 0.039   | 0.040 |
| 27    | 18.780   | 1295  | 199    | 0.009 | 0.011   | 0.009 |
| 28    | 19.139   | 38771 | 5786   | 0.273 | 0.332   | 0.273 |
| 29    | 19.959   | 2924  | 336    | 0.021 | 0.019   | 0.021 |
| 30    | 20.327   | 3379  | 256    | 0.024 | 0.015   | 0.024 |
| 31    | 21.020   | 2946  | 318    | 0.021 | 0.018   | 0.021 |
| 32    | 21.286   | 1048  | 139    | 0.007 | 0.008   | 0.007 |
| 33    | 21.832   | 5794  | 662    | 0.041 | 0.038   | 0.041 |
| 34    | 22.525   | 2754  | 274    | 0.019 | 0.016   | 0.019 |
| 35    | 22.720   | 1437  | 135    | 0.010 | 0.008   | 0.010 |
| 36    | 22.998   | 24777 | 2442   | 0.174 | 0.140   | 0.174 |
| 37    | 23.429   | 10214 | 987    | 0.072 | 0.057   | 0.072 |
| 38    | 25.749   | 1659  | 137    | 0.012 | 0.008   | 0.012 |
| 39    | 26.496   | 6581  | 674    | 0.046 | 0.039   | 0.046 |
| 40    | 30.605   | 3444  | 294    | 0.024 | 0.017   | 0.024 |
| 41    | 32.843   | 4792  | 241    | 0.034 | 0.014   | 0.034 |
| 42    | 33.365   | 1570  | 91     | 0.011 | 0.005   | 0.011 |
| 43    | 34.251   | 3460  | 203    | 0.024 | 0.012   | 0.024 |
| 44    | 34.741   | 2967  | 303    | 0.021 | 0.017   | 0.021 |
| 45    | 37.245   | 2587  | 231    | 0.018 | 0.013   | 0.018 |
| 46    | 39.435   | 23044 | 523    | 0.162 | 0.030   | 0.162 |
| 47    | 39.876   | 7802  | 349    | 0.055 | 0.020   | 0.055 |
| 48    | 49.144   | 92151 | 3276   | 0.648 | 0.188   | 0.648 |
| **Total** | **14224764** | **1744866** | **100,000** | **100,000** |
HPLC determined purity of compound 5j

**<Chromatogram>**

![Chromatogram](image)

**<Peak Table>**

| Peak# | Ret. Time | Area  | Height | Conc.  | Height% | Area% |
|------|-----------|-------|--------|--------|---------|-------|
| 1    | 3.541     | 15340 | 1974   | 0.117  | 0.126   | 0.117 |
| 2    | 4.273     | 21392 | 753    | 0.164  | 0.048   | 0.164 |
| 3    | 7.868     | 21799 | 1521   | 0.167  | 0.097   | 0.167 |
| 4    | 8.391     | 14411 | 2081   | 0.110  | 0.133   | 0.110 |
| 5    | 11.480    | 1130  | 154    | 0.009  | 0.010   | 0.009 |
| 6    | 11.717    | 2506  | 269    | 0.019  | 0.017   | 0.019 |
| 7    | 12.226    | 9320  | 1024   | 0.071  | 0.066   | 0.071 |
| 8    | 12.876    | 11804 | 1506   | 0.090  | 0.096   | 0.090 |
| 9    | 13.876    | 2463  | 336    | 0.019  | 0.021   | 0.019 |
| 10   | 14.123    | 12807480 | 1543587 | 98.093 | 98.811   | 98.093 |
| 11   | 14.918    | 2275  | 445    | 0.017  | 0.029   | 0.017 |
| 12   | 15.074    | 2313  | 408    | 0.018  | 0.026   | 0.018 |
| 13   | 15.354    | 1802  | 307    | 0.014  | 0.020   | 0.014 |
| 14   | 15.499    | 1478  | 203    | 0.011  | 0.013   | 0.011 |
| 15   | 18.219    | 5901  | 662    | 0.045  | 0.062   | 0.045 |
| 16   | 18.794    | 1028  | 152    | 0.008  | 0.010   | 0.008 |
| 17   | 20.632    | 2634  | 211    | 0.020  | 0.013   | 0.020 |
| 18   | 22.505    | 1817  | 206    | 0.014  | 0.013   | 0.014 |
| 19   | 25.112    | 1066  | 83     | 0.008  | 0.005   | 0.008 |
| 20   | 28.128    | 1246  | 122    | 0.010  | 0.008   | 0.010 |
| 21   | 32.793    | 18370 | 1653   | 0.141  | 0.106   | 0.141 |
| 22   | 34.283    | 3425  | 201    | 0.026  | 0.013   | 0.026 |
| 23   | 34.773    | 2257  | 193    | 0.017  | 0.012   | 0.017 |
| 24   | 35.019    | 1962  | 101    | 0.015  | 0.006   | 0.015 |
| 25   | 37.237    | 3057  | 279    | 0.023  | 0.018   | 0.023 |
| 26   | 39.467    | 3376  | 154    | 0.026  | 0.010   | 0.026 |
| 27   | 49.144    | 94836 | 3281   | 0.726  | 0.210   | 0.726 |
| Total| 13056488  | 1562164 | 100.000 | 100.000 | 100.000 |
HPLC determined purity of compound 5k

<Chromatogram>

<Pepk Table>

| Peak# | Ret. Time | Area   | Height | Height% | Area% |
|-------|-----------|--------|--------|---------|-------|
| 1     | 2.596     | 1092   | 135    | 0.009   | 0.009 |
| 2     | 3.542     | 50324  | 2567   | 0.169   | 0.399 |
| 3     | 3.977     | 17533  | 6282   | 0.413   | 0.139 |
| 4     | 4.277     | 21017  | 748    | 0.049   | 0.167 |
| 5     | 7.867     | 33091  | 2363   | 0.155   | 0.262 |
| 6     | 8.391     | 22534  | 3079   | 0.202   | 0.179 |
| 7     | 8.871     | 2683   | 370    | 0.024   | 0.021 |
| 8     | 9.130     | 1891   | 203    | 0.013   | 0.015 |
| 9     | 9.338     | 2308   | 302    | 0.020   | 0.018 |
| 10    | 10.890    | 2569   | 252    | 0.017   | 0.020 |
| 11    | 11.491    | 2038   | 287    | 0.019   | 0.016 |
| 12    | 12.225    | 3286   | 327    | 0.021   | 0.026 |
| 13    | 12.547    | 2479   | 205    | 0.013   | 0.020 |
| 14    | 13.104    | 2873   | 408    | 0.027   | 0.023 |
| 15    | 13.251    | 2640   | 353    | 0.023   | 0.021 |
| 16    | 13.525    | 4196   | 585    | 0.038   | 0.033 |
| 17    | 14.451    | 12266466 | 1491405 | 98.045 | 97.193 |
| 18    | 15.359    | 12792  | 1732   | 0.114   | 0.101 |
| 19    | 15.610    | 1892   | 246    | 0.016   | 0.015 |
| 20    | 16.229    | 1689   | 269    | 0.018   | 0.013 |
| 21    | 18.635    | 14185  | 568    | 0.037   | 0.112 |
| 22    | 19.533    | 1439   | 195    | 0.013   | 0.011 |
| Peak# | Ret. Time | Area  | Height | Height% | Area% |
|-------|-----------|-------|--------|---------|-------|
| 23    | 22.500    | 1741  | 203    | 0.013   | 0.014 |
| 24    | 26.037    | 2396  | 210    | 0.014   | 0.019 |
| 25    | 28.779    | 2410  | 150    | 0.010   | 0.019 |
| 26    | 29.109    | 1243  | 95     | 0.006   | 0.010 |
| 27    | 32.885    | 4043  | 210    | 0.014   | 0.032 |
| 28    | 33.441    | 35659 | 3166   | 0.208   | 0.283 |
| 29    | 33.803    | 3891  | 282    | 0.019   | 0.031 |
| 30    | 34.293    | 3283  | 192    | 0.013   | 0.026 |
| 31    | 34.741    | 1299  | 140    | 0.009   | 0.010 |
| 32    | 37.259    | 2570  | 240    | 0.016   | 0.020 |
| 33    | 39.467    | 5881  | 262    | 0.017   | 0.047 |
| 34    | 49.149    | 85270 | 3119   | 0.205   | 0.676 |
| Total |           | 12620682 | 1521150 | 100.000 | 100.000 |
HPLC determined purity of compound 51

<Chromatogram>

<Peonk Table>

| Peak# | Ret. Time | Area   | Height | Height% | Area% |
|-------|-----------|--------|--------|---------|-------|
| 1     | 8.365     | 45376  | 6107   | 0.360   | 0.385 |
| 2     | 8.834     | 8438   | 1131   | 0.067   | 0.072 |
| 3     | 13.291    | 113067 | 18907  | 1.114   | 0.959 |
| 4     | 14.238    | 7509   | 1154   | 0.068   | 0.064 |
| 5     | 14.860    | 11567300 | 1661295 | 97.889 | 98.066 |
| 6     | 15.264    | 31421  | 5038   | 0.297   | 0.266 |
| 7     | 16.241    | 8134   | 1372   | 0.081   | 0.069 |
| 8     | 34.345    | 14234  | 2118   | 0.125   | 0.121 |
| Total | 11795480  | 1697124 | 100.000 | 100.000 |
HPLC determined purity of compound 5m
| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 23    | 28,904    | 2969  | 259    | 0.015 | 0.010   | 0.015 |
| 24    | 29,848    | 3195  | 308    | 0.016 | 0.012   | 0.016 |
| 25    | 32,928    | 2936  | 149    | 0.014 | 0.006   | 0.014 |
| 26    | 33,845    | 2494  | 179    | 0.012 | 0.007   | 0.012 |
| 27    | 34,223    | 6426  | 362    | 0.032 | 0.014   | 0.032 |
| 28    | 34,731    | 2028  | 138    | 0.010 | 0.005   | 0.010 |
| 29    | 34,944    | 1712  | 157    | 0.008 | 0.006   | 0.008 |
| 30    | 35,179    | 1651  | 115    | 0.008 | 0.004   | 0.008 |
| 31    | 37,199    | 3360  | 340    | 0.016 | 0.013   | 0.016 |
| 32    | 37,749    | 1617  | 121    | 0.008 | 0.005   | 0.008 |
| 33    | 39,413    | 1768  | 117    | 0.009 | 0.005   | 0.009 |
| 34    | 49,132    | 98793 | 3279   | 0.485 | 0.128   | 0.485 |
| Total |           | 20387119 | 2559949 | 100,000 | 100,000 |
HPLC determined purity of compound 5n

![Chromatogram](image)

| Peak# | Ret. Time | Area  | Height | Conc  | Height% | Area%  |
|-------|-----------|-------|--------|-------|---------|--------|
| 1     | 3.545     | 13550 | 1747   | 0.069 | 0.071   | 0.069  |
| 2     | 3.980     | 6465  | 4015   | 0.033 | 0.162   | 0.033  |
| 3     | 4.257     | 23952 | 1015   | 0.123 | 0.041   | 0.123  |
| 4     | 7.785     | 1502  | 94     | 0.008 | 0.004   | 0.008  |
| 5     | 8.281     | 1098  | 151    | 0.006 | 0.006   | 0.006  |
| 6     | 11.595    | 3401  | 376    | 0.017 | 0.015   | 0.017  |
| 7     | 12.008    | 1878  | 210    | 0.010 | 0.009   | 0.010  |
| 8     | 12.448    | 1321  | 107    | 0.007 | 0.004   | 0.007  |
| 9     | 12.738    | 3234  | 383    | 0.017 | 0.015   | 0.017  |
| 10    | 13.706    | 21344 | 21825  | 1.092 | 0.883   | 1.092  |
| 11    | 14.429    | 3801  | 353    | 0.019 | 0.014   | 0.019  |
| 12    | 14.707    | 2401  | 256    | 0.012 | 0.010   | 0.012  |
| 13    | 14.948    | 37768 | 4927   | 0.193 | 0.199   | 0.193  |
| 14    | 15.325    | 12887 | 2201   | 0.066 | 0.089   | 0.066  |
| 15    | 15.519    | 18904450 | 2409165 | 96.722 | 97.421 | 96.722 |
| 16    | 16.254    | 10411 | 1349   | 0.053 | 0.055   | 0.053  |
| 17    | 16.568    | 10815 | 1608   | 0.055 | 0.065   | 0.055  |
| 18    | 17.172    | 28298 | 3838   | 0.145 | 0.155   | 0.145  |
| 19    | 17.500    | 20748 | 2776   | 0.106 | 0.112   | 0.106  |
| 20    | 17.845    | 4122  | 441    | 0.021 | 0.018   | 0.021  |
| 21    | 18.079    | 3100  | 492    | 0.016 | 0.020   | 0.016  |
| 22    | 18.380    | 2293  | 141    | 0.012 | 0.006   | 0.012  |
| Peak# | Ret. Time | Area   | Height | Conc. | Height% | Area% |
|------|-----------|--------|--------|-------|---------|-------|
| 23   | 18.616    | 1970   | 319    | 0.010 | 0.013   | 0.010 |
| 24   | 18.813    | 29531  | 3150   | 0.151 | 0.127   | 0.151 |
| 25   | 20.434    | 4325   | 374    | 0.022 | 0.015   | 0.022 |
| 26   | 20.707    | 1628   | 211    | 0.008 | 0.009   | 0.008 |
| 27   | 21.171    | 1871   | 220    | 0.010 | 0.009   | 0.010 |
| 28   | 22.455    | 2785   | 298    | 0.014 | 0.012   | 0.014 |
| 29   | 22.675    | 8522   | 917    | 0.044 | 0.037   | 0.044 |
| 30   | 23.638    | 3544   | 338    | 0.018 | 0.014   | 0.018 |
| 31   | 24.785    | 2389   | 264    | 0.012 | 0.011   | 0.012 |
| 32   | 25.858    | 11569  | 1052   | 0.059 | 0.043   | 0.059 |
| 33   | 26.207    | 2316   | 176    | 0.012 | 0.007   | 0.012 |
| 34   | 26.477    | 5590   | 548    | 0.029 | 0.022   | 0.029 |
| 35   | 28.858    | 2469   | 257    | 0.013 | 0.010   | 0.013 |
| 36   | 30.852    | 352    | 117    | 0.007 | 0.005   | 0.007 |
| 37   | 31.913    | 6547   | 455    | 0.033 | 0.018   | 0.033 |
| 38   | 32.843    | 2892   | 160    | 0.015 | 0.006   | 0.015 |
| 39   | 33.771    | 1281   | 130    | 0.007 | 0.005   | 0.007 |
| 40   | 34.220    | 5496   | 309    | 0.028 | 0.012   | 0.028 |
| 41   | 34.901    | 3565   | 153    | 0.018 | 0.006   | 0.018 |
| 42   | 35.232    | 2417   | 156    | 0.012 | 0.006   | 0.012 |
| 43   | 35.732    | 24411  | 1817   | 0.125 | 0.073   | 0.125 |
| 44   | 37.183    | 3934   | 355    | 0.020 | 0.014   | 0.020 |
| 45   | 39.360    | 1667   | 155    | 0.009 | 0.006   | 0.009 |
| 46   | 40.889    | 1523   | 137    | 0.008 | 0.006   | 0.008 |
| 47   | 49.120    | 100719 | 3405   | 0.515 | 0.138   | 0.515 |
| Total| 19545157  | 2472943| 100,000|       | 100,000 |
HPLC determined purity of compound 5o

**Chromatogram**

![Chromatogram Image]

**Peak Table**

| Peak# | Ret. Time | Area | Height | Conc. | Height% | Area% |
|-------|-----------|------|--------|-------|---------|-------|
| 1     | 3.545     | 13957| 1760   | 0.112 | 0.113   | 0.112 |
| 2     | 4.281     | 26205| 973    | 0.209 | 0.063   | 0.209 |
| 3     | 7.744     | 4558 | 281    | 0.036 | 0.018   | 0.036 |
| 4     | 8.298     | 3894 | 452    | 0.031 | 0.029   | 0.031 |
| 5     | 13.301    | 1819 | 153    | 0.015 | 0.010   | 0.015 |
| 6     | 13.635    | 20100| 2177   | 0.161 | 0.140   | 0.161 |
| 7     | 14.062    | 7254 | 983    | 0.058 | 0.063   | 0.058 |
| 8     | 14.539    | 1467 | 219    | 0.012 | 0.014   | 0.012 |
| 9     | 14.882    | 3602 | 427    | 0.029 | 0.027   | 0.029 |
| 10    | 15.308    | 12290732| 1539513| 98.228| 99.006  | 98.228 |
| 11    | 15.630    | 10940| 1091   | 0.083 | 0.109   | 0.083 |
| 12    | 16.193    | 1107 | 141    | 0.009 | 0.009   | 0.009 |
| 13    | 18.230    | 1159 | 172    | 0.009 | 0.011   | 0.009 |
| 14    | 21.902    | 3708 | 416    | 0.030 | 0.027   | 0.030 |
| 15    | 23.084    | 3238 | 267    | 0.019 | 0.017   | 0.019 |
| 16    | 26.144    | 1336 | 87     | 0.011 | 0.006   | 0.011 |
| 17    | 28.876    | 2696 | 251    | 0.022 | 0.016   | 0.022 |
| 18    | 31.221    | 1417 | 144    | 0.011 | 0.009   | 0.011 |
| 19    | 32.853    | 3005 | 165    | 0.024 | 0.011   | 0.024 |
| 20    | 33.771    | 1347 | 132    | 0.011 | 0.009   | 0.011 |
| 21    | 34.207    | 5619 | 330    | 0.045 | 0.021   | 0.045 |
| 22    | 34.677    | 1424 | 116    | 0.011 | 0.007   | 0.011 |
| 23    | 34.901    | 1763 | 147    | 0.014 | 0.009   | 0.014 |
| 24    | 35.819    | 1550 | 152    | 0.012 | 0.010   | 0.012 |
| 25    | 37.175    | 3874 | 363    | 0.031 | 0.023   | 0.031 |
| 26    | 39.381    | 2640 | 162    | 0.021 | 0.010   | 0.021 |
| 27    | 49.127    | 93571| 3296   | 0.748 | 0.212   | 0.748 |
| Total | 12512472  | 1554966|        | 100.000| 100.000 |
HPLC determined purity of compound 5p

<Chromatogram>

<Peark Table>

| Peak# | Ret. Time | Area   | Height | Height% | Area% |
|-------|-----------|--------|--------|---------|-------|
| 1     | 10.483    | 8864   | 1381   | 0.039   | 0.062 |
| 2     | 11.211    | 40132  | 2259   | 0.065   | 0.282 |
| 3     | 11.527    | 15688  | 3300   | 0.095   | 0.110 |
| 4     | 11.735    | 58383  | 11879  | 0.342   | 0.410 |
| 5     | 13.159    | 13738507 | 3380101 | 97.232  | 96.508 |
| 6     | 13.601    | 218966 | 49736  | 1.431   | 1.538 |
| 7     | 13.997    | 21209  | 3602   | 0.104   | 0.149 |
| 8     | 15.084    | 18025  | 3950   | 0.114   | 0.127 |
| 9     | 15.412    | 7032   | 1186   | 0.034   | 0.049 |
| 10    | 15.762    | 43876  | 5898   | 0.170   | 0.308 |
| 11    | 16.254    | 25795  | 6040   | 0.174   | 0.181 |
| 12    | 16.925    | 16431  | 3977   | 0.114   | 0.115 |
| 13    | 19.836    | 5711   | 1119   | 0.032   | 0.040 |
| 14    | 21.886    | 10497  | 985    | 0.028   | 0.074 |
| 15    | 27.267    | 6510   | 930    | 0.027   | 0.048 |
| Total | 14235625  | 3476324 | 100.000 | 100.000 |
HPLC determined purity of compound 5q

| Peak# | Ret. Time | Area   | Height | Conc. | Height% | Area% |
|-------|-----------|--------|--------|-------|---------|-------|
| 1     | 3.545     | 13843  | 1759   | 0.114 | 0.115   | 0.114 |
| 2     | 4.278     | 25709  | 936    | 0.212 | 0.061   | 0.212 |
| 3     | 13.171    | 1685   | 232    | 0.014 | 0.015   | 0.014 |
| 4     | 13.496    | 7669   | 1073   | 0.065 | 0.070   | 0.065 |
| 5     | 14.170    | 7403   | 729    | 0.061 | 0.047   | 0.061 |
| 6     | 14.520    | 14171  | 1902   | 0.117 | 0.124   | 0.117 |
| 7     | 15.259    | 7253   | 980    | 0.060 | 0.064   | 0.060 |
| 8     | 15.432    | 11712  | 1436   | 0.097 | 0.093   | 0.097 |
| 9     | 15.958    | 7207   | 1286   | 0.060 | 0.084   | 0.060 |
| 10    | 16.151    | 11792788 | 1510500 | 97.406 | 98.319 | 97.406 |
| 11    | 17.227    | 7220   | 810    | 0.060 | 0.053   | 0.060 |
| 12    | 17.547    | 2663   | 394    | 0.022 | 0.026   | 0.022 |
| 13    | 18.295    | 5877   | 729    | 0.049 | 0.047   | 0.049 |
| 14    | 18.655    | 9708   | 1364   | 0.080 | 0.089   | 0.080 |
| 15    | 19.062    | 4153   | 582    | 0.034 | 0.038   | 0.034 |
| 16    | 19.257    | 1133   | 149    | 0.009 | 0.010   | 0.009 |
| 17    | 20.150    | 2906   | 381    | 0.024 | 0.025   | 0.024 |
| 18    | 21.318    | 7339   | 1000   | 0.061 | 0.065   | 0.061 |
| 19    | 22.462    | 2472   | 317    | 0.020 | 0.021   | 0.020 |
| 20    | 24.607    | 42738  | 3985   | 0.353 | 0.259   | 0.353 |
| 21    | 26.155    | 1282   | 80     | 0.011 | 0.005   | 0.011 |
| 22    | 26.472    | 2701   | 245    | 0.022 | 0.016   | 0.022 |
| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 23    | 28.857    | 2253  | 237    | 0.019 | 0.015   | 0.019 |
| 24    | 32.000    | 1250  | 23     | 0.010 | 0.001   | 0.010 |
| 25    | 32.864    | 3584  | 140    | 0.030 | 0.009   | 0.030 |
| 26    | 33.771    | 1294  | 129    | 0.011 | 0.008   | 0.011 |
| 27    | 34.214    | 5256  | 308    | 0.043 | 0.020   | 0.043 |
| 28    | 34.923    | 2701  | 129    | 0.022 | 0.008   | 0.022 |
| 29    | 37.183    | 4145  | 401    | 0.034 | 0.026   | 0.034 |
| 30    | 37.429    | 5602  | 618    | 0.046 | 0.040   | 0.046 |
| 31    | 39.445    | 1726  | 103    | 0.014 | 0.007   | 0.014 |
| 32    | 49.127    | 99204 | 3367   | 0.819 | 0.219   | 0.819 |
| Total |           | 1210687 | 1536323 | 100.000 | 100.000 |

S99
HPLC determined purity of compound 5r

**<Chromatogram>**

![Chromatogram Image]

**<Peak Table>**

| Peak # | Ret. Time | Area   | Height | Height% | Area% |
|-------|-----------|--------|--------|---------|-------|
| 1     | 11.176    | 162052 | 18165  | 0.971   | 1.214 |
| 2     | 12.308    | 44250  | 7854   | 0.420   | 0.331 |
| 3     | 13.137    | 12124946 | 1701507 | 90.941 | 90.818 |
| 4     | 13.568    | 589804 | 95901  | 5.126   | 4.418 |
| 5     | 13.807    | 120926 | 14823  | 0.792   | 0.906 |
| 6     | 14.413    | 66662  | 8523   | 0.456   | 0.499 |
| 7     | 15.923    | 26831  | 4461   | 0.238   | 0.201 |
| 8     | 18.140    | 53119  | 5649   | 0.302   | 0.398 |
| 9     | 21.180    | 162274 | 14116  | 0.754   | 1.215 |
| Total |           | 13350862 | 1870998 | 100.000 | 100.000 |
HPLC determined purity of compound 5s
| Peak# | Ret. Time | Area   | Height  | Conc. | Height% | Area% |
|------|-----------|--------|---------|-------|---------|-------|
| 23   | 14.684    | 32533  | 5056    | 0.125 | 0.127   | 0.125 |
| 24   | 14.850    | 103931 | 13757   | 0.401 | 0.346   | 0.401 |
| 25   | 15.185    | 1557   | 264     | 0.006 | 0.007   | 0.006 |
| 26   | 15.355    | 3992   | 559     | 0.015 | 0.014   | 0.015 |
| 27   | 15.636    | 22393  | 2339    | 0.086 | 0.059   | 0.086 |
| 28   | 16.048    | 19240  | 2021    | 0.074 | 0.051   | 0.074 |
| 29   | 16.330    | 10375  | 582     | 0.040 | 0.015   | 0.040 |
| 30   | 17.004    | 1402   | 195     | 0.005 | 0.005   | 0.005 |
| 31   | 17.301    | 1170   | 92      | 0.005 | 0.002   | 0.005 |
| 32   | 18.727    | 4056   | 433     | 0.016 | 0.011   | 0.016 |
| 33   | 18.998    | 1071   | 126     | 0.004 | 0.003   | 0.004 |
| 34   | 20.021    | 1423   | 115     | 0.005 | 0.003   | 0.005 |
| 35   | 20.437    | 3704   | 399     | 0.014 | 0.010   | 0.014 |
| 36   | 22.491    | 7200   | 517     | 0.028 | 0.013   | 0.028 |
| 37   | 26.520    | 2213   | 216     | 0.009 | 0.005   | 0.009 |
| 38   | 31.840    | 1839   | 71      | 0.006 | 0.002   | 0.006 |
| 39   | 32.853    | 5515   | 253     | 0.021 | 0.006   | 0.021 |
| 40   | 33.376    | 1791   | 89      | 0.007 | 0.002   | 0.007 |
| 41   | 34.251    | 3274   | 197     | 0.013 | 0.005   | 0.013 |
| 42   | 37.237    | 3253   | 282     | 0.013 | 0.007   | 0.013 |
| 43   | 39.477    | 7471   | 201     | 0.029 | 0.005   | 0.029 |
| 44   | 49.145    | 98810  | 3382    | 0.381 | 0.085   | 0.381 |
| Total | 259933271 | 3971355|         | 100.000 | 100.000 |
HPLC determined purity of compound 6a

<Chromatogram>

<Peak Table>

| Peak# | Ret. Time | Area  | Height | Conc  | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 1     | 2.495     | 2278  | 314    | 0.006 | 0.008   | 0.006 |
| 2     | 3.538     | 53159 | 2339   | 0.149 | 0.058   | 0.149 |
| 3     | 3.968     | 11966 | 5354   | 0.033 | 0.132   | 0.033 |
| 4     | 4.267     | 26543 | 1659   | 0.074 | 0.026   | 0.074 |
| 5     | 7.725     | 2628  | 152    | 0.007 | 0.004   | 0.007 |
| 6     | 8.290     | 1870  | 235    | 0.005 | 0.006   | 0.005 |
| 7     | 9.560     | 1914  | 237    | 0.005 | 0.006   | 0.005 |
| 8     | 9.801     | 7480  | 916    | 0.021 | 0.023   | 0.021 |
| 9     | 9.961     | 10459 | 1333   | 0.029 | 0.033   | 0.029 |
| 10    | 10.550    | 2977  | 346    | 0.008 | 0.009   | 0.008 |
| 11    | 11.514    | 6070  | 405    | 0.017 | 0.010   | 0.017 |
| 12    | 11.784    | 59502 | 8068   | 0.166 | 0.199   | 0.166 |
| 13    | 11.976    | 19222 | 2853   | 0.054 | 0.070   | 0.054 |
| 14    | 12.101    | 14760 | 1985   | 0.041 | 0.049   | 0.041 |
| 15    | 12.389    | 35168954 | 3990084 | 98.349 | 98.460 | 98.349 |
| 16    | 13.157    | 3694  | 580    | 0.010 | 0.014   | 0.010 |
| 17    | 13.449    | 24327 | 3685   | 0.068 | 0.091   | 0.068 |
| 18    | 13.753    | 75484 | 9446   | 0.211 | 0.233   | 0.211 |
| 19    | 14.078    | 3236  | 411    | 0.009 | 0.010   | 0.009 |
| 20    | 14.478    | 7454  | 748    | 0.021 | 0.018   | 0.021 |
| 21    | 14.821    | 1188  | 196    | 0.003 | 0.005   | 0.003 |
| 22    | 15.124    | 94424 | 14158  | 0.264 | 0.349   | 0.264 |
| Peak# | Ret. Time | Area   | Height | Conc. | Height% | Area% |
|-------|-----------|--------|--------|-------|---------|-------|
| 23    | 16.006    | 5881   | 697    | 0.016 | 0.017   | 0.016 |
| 24    | 17.266    | 1610   | 222    | 0.005 | 0.005   | 0.005 |
| 25    | 18.595    | 2251   | 279    | 0.006 | 0.007   | 0.006 |
| 26    | 20.404    | 2212   | 202    | 0.006 | 0.005   | 0.006 |
| 27    | 22.916    | 6889   | 673    | 0.019 | 0.017   | 0.019 |
| 28    | 25.813    | 1372   | 85     | 0.004 | 0.002   | 0.004 |
| 29    | 26.080    | 1156   | 105    | 0.003 | 0.003   | 0.003 |
| 30    | 26.454    | 2001   | 193    | 0.006 | 0.005   | 0.006 |
| 31    | 28.834    | 3022   | 278    | 0.008 | 0.007   | 0.008 |
| 32    | 31.413    | 1240   | 60     | 0.003 | 0.001   | 0.003 |
| 33    | 31.904    | 1004   | 37     | 0.003 | 0.001   | 0.003 |
| 34    | 32.821    | 2999   | 158    | 0.008 | 0.004   | 0.008 |
| 35    | 33.739    | 1378   | 143    | 0.004 | 0.004   | 0.004 |
| 36    | 34.183    | 5906   | 330    | 0.017 | 0.008   | 0.017 |
| 37    | 34.880    | 3700   | 158    | 0.010 | 0.004   | 0.010 |
| 38    | 35.136    | 1384   | 90     | 0.004 | 0.002   | 0.004 |
| 39    | 37.150    | 4586   | 418    | 0.013 | 0.010   | 0.013 |
| 40    | 39.371    | 5261   | 215    | 0.015 | 0.005   | 0.015 |
| 41    | 49.103    | 105979 | 3402   | 0.296 | 0.084   | 0.296 |
| Total |           | 35759393 | 4061647 | 100.00% | 100.00% |


HPLC determined purity of compound 6b

<Chromatogram>

<PDA Ch2 254nm>

| Peak# | Ret. Time | Area   | Height | Height% | Area%  |
|-------|----------|--------|--------|---------|--------|
| 1     | 4.827    | 25773  | 12016  | 0.972   | 0.261  |
| 2     | 5.843    | 22994  | 10552  | 0.854   | 0.233  |
| 3     | 6.573    | 9188   | 1274   | 0.103   | 0.093  |
| 4     | 7.497    | 14131  | 2085   | 0.169   | 0.143  |
| 5     | 7.757    | 9313930| 1148618| 92.834  | 94.467 |
| 6     | 8.362    | 254509 | 30955  | 2.805   | 2.811  |
| 7     | 8.855    | 8173   | 1456   | 0.118   | 0.083  |
| 8     | 9.236    | 130720 | 18462  | 1.494   | 1.326  |
| 9     | 11.399   | 6445   | 1017   | 0.082   | 0.065  |
| 10    | 11.650   | 38319  | 4675   | 0.378   | 0.389  |
| 11    | 12.513   | 10519  | 1422   | 0.115   | 0.107  |
| 12    | 13.193   | 11001  | 1672   | 0.135   | 0.112  |
| 13    | 21.018   | 8804   | 1138   | 0.092   | 0.089  |
| 14    | 24.545   | 4919   | 610    | 0.049   | 0.050  |
| Total | 9859425  | 1235952| 100.000| 100.000 |
HPLC determined purity of compound 7a

<Chromatogram>

<Pink Table>
HPLC determined purity of compound 7b
| Peak# | Ret_Time | Area  | Height | Height% | Area% |
|------|----------|-------|--------|---------|-------|
| 22   | 16.403   | 2747  | 504    | 0.019   | 0.015 |
| 23   | 17.376   | 1316  | 84     | 0.003   | 0.007 |
| 24   | 17.850   | 3836  | 554    | 0.020   | 0.021 |
| 25   | 18.656   | 3436  | 259    | 0.010   | 0.019 |
| 26   | 18.811   | 2068  | 209    | 0.008   | 0.012 |
| 27   | 20.288   | 1979  | 209    | 0.008   | 0.011 |
| 28   | 20.448   | 2126  | 234    | 0.009   | 0.012 |
| 29   | 23.011   | 2355  | 163    | 0.006   | 0.013 |
| 30   | 23.595   | 1145  | 84     | 0.003   | 0.006 |
| 31   | 23.897   | 7434  | 853    | 0.031   | 0.042 |
| 32   | 24.384   | 2238  | 197    | 0.007   | 0.012 |
| 33   | 24.984   | 1351  | 166    | 0.006   | 0.008 |
| 34   | 26.080   | 2077  | 173    | 0.006   | 0.012 |
| 35   | 26.496   | 5116  | 241    | 0.009   | 0.029 |
| 36   | 27.138   | 48472 | 5289   | 0.194   | 0.271 |
| 37   | 27.413   | 3239  | 377    | 0.014   | 0.018 |
| 38   | 28.882   | 1863  | 194    | 0.007   | 0.010 |
| 39   | 29.986   | 7914  | 914    | 0.034   | 0.044 |
| 40   | 31.027   | 4126  | 321    | 0.012   | 0.023 |
| 41   | 31.492   | 13772 | 12961  | 0.476   | 0.769 |
| 42   | 32.951   | 7786  | 490    | 0.018   | 0.043 |
| 43   | 33.344   | 2927  | 139    | 0.006   | 0.016 |
| 44   | 33.792   | 1381  | 135    | 0.005   | 0.008 |
| 45   | 34.244   | 7722  | 446    | 0.016   | 0.043 |
| 46   | 34.514   | 3184  | 307    | 0.011   | 0.018 |
| 47   | 34.699   | 3291  | 251    | 0.009   | 0.018 |
| 48   | 35.103   | 5687  | 580    | 0.021   | 0.032 |
| 49   | 37.191   | 7886  | 596    | 0.022   | 0.044 |
| 50   | 39.385   | 120222| 4973   | 0.183   | 0.671 |
| 51   | 39.817   | 48221 | 2664   | 0.098   | 0.269 |
| 52   | 49.079   | 82683 | 2581   | 0.095   | 0.462 |
| Total| 17910053 | 2722661| 100.000| 100.000 |
HPLC determined purity of compound 8a
| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|------|-----------|-------|--------|-------|---------|-------|
| 23   | 20.463    | 3144  | 351    | 0.017 | 0.014   | 0.017 |
| 24   | 21.738    | 3456  | 318    | 0.019 | 0.013   | 0.019 |
| 25   | 24.687    | 5014  | 521    | 0.028 | 0.021   | 0.028 |
| 26   | 26.048    | 2274  | 178    | 0.013 | 0.007   | 0.013 |
| 27   | 26.464    | 2853  | 166    | 0.016 | 0.007   | 0.016 |
| 28   | 28.853    | 1506  | 192    | 0.008 | 0.008   | 0.008 |
| 29   | 30.901    | 2135  | 190    | 0.012 | 0.008   | 0.012 |
| 30   | 31.393    | 5408  | 403    | 0.030 | 0.016   | 0.030 |
| 31   | 32.923    | 6875  | 459    | 0.038 | 0.019   | 0.038 |
| 32   | 33.301    | 3282  | 142    | 0.018 | 0.006   | 0.018 |
| 33   | 33.760    | 1246  | 140    | 0.007 | 0.006   | 0.007 |
| 34   | 34.219    | 8283  | 467    | 0.046 | 0.019   | 0.046 |
| 35   | 34.677    | 2921  | 200    | 0.016 | 0.008   | 0.016 |
| 36   | 37.191    | 6680  | 567    | 0.037 | 0.023   | 0.037 |
| 37   | 39.369    | 121316| 4882   | 0.668 | 0.198   | 0.668 |
| 38   | 39.798    | 40651 | 2635   | 0.224 | 0.107   | 0.224 |
| 39   | 40.075    | 12775 | 991    | 0.070 | 0.040   | 0.070 |
| 40   | 49.901    | 113708| 3248   | 0.627 | 0.132   | 0.627 |
| Total|           | 18149098 | 2459913| 100.000 | 100.000 |
HPLC determined purity of compound 8b

**<Chromatogram>**

**<Peak Table>**

| Peak | Ret. Time | Area   | Height | Height% | Area%  |
|------|-----------|--------|--------|---------|--------|
| 1    | 9.605     | 70886  | 14299  | 0.365   | 0.413  |
| 2    | 9.782     | 32395  | 8655   | 0.221   | 0.189  |
| 3    | 9.980     | 27811  | 3214   | 0.082   | 0.162  |
| 4    | 13.482    | 11948  | 17050  | 0.435   | 0.693  |
| 5    | 13.951    | 15286  | 3057   | 0.078   | 0.089  |
| 6    | 14.228    | 29279  | 13463  | 0.344   | 0.171  |
| 7    | 14.380    | 1662092| 3813811| 97.400  | 96.849 |
| 8    | 15.172    | 26622  | 6304   | 0.161   | 0.156  |
| 9    | 15.327    | 10273  | 2202   | 0.056   | 0.060  |
| 10   | 15.653    | 67219  | 13990  | 0.357   | 0.392  |
| 11   | 18.070    | 11093  | 2926   | 0.075   | 0.065  |
| 12   | 19.819    | 8146   | 1644   | 0.042   | 0.047  |
| 13   | 21.712    | 5728   | 1409   | 0.036   | 0.033  |
| 14   | 23.460    | 30368  | 3634   | 0.093   | 0.177  |
| 15   | 25.472    | 40082  | 3698   | 0.094   | 0.234  |
| 16   | 28.017    | 17035  | 2407   | 0.061   | 0.099  |
| 17   | 31.847    | 29480  | 3843   | 0.098   | 0.172  |
| Total|           |        | 3915605| 100.000 | 100.000|
HPLC determined purity of compound 8c

### Chromatogram

![Chromatogram Image]

### Peak Table

| Peak# | Ret. Time | Area  | Height | Height% | Area% |
|-------|-----------|-------|--------|---------|-------|
| 1     | 13.834    | 33057 | 4440   | 0.732   | 0.324 |
| 2     | 24.147    | 54784 | 5746   | 0.947   | 0.536 |
| 3     | 25.027    | 10067019 | 591373 | 97.491  | 98.550 |
| 4     | 30.000    | 11728 | 0      | 0.000   | 0.115 |
| 5     | 39.364    | 37837 | 3769   | 0.621   | 0.370 |
| 6     | 39.795    | 10695 | 1265   | 0.209   | 0.105 |
| **Total** | **10215121** | **606593** | **100.000** | **100.000** |
HPLC determined purity of compound 8d
| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area%  |
|-------|-----------|-------|--------|-------|---------|--------|
| 23    | 22.670    | 7899  | 921    | 0.051 | 0.042   | 0.051  |
| 24    | 23.488    | 1354  | 68     | 0.009 | 0.003   | 0.009  |
| 25    | 25.280    | 1233  | 80     | 0.008 | 0.004   | 0.008  |
| 26    | 25.628    | 8962  | 828    | 0.058 | 0.038   | 0.058  |
| 27    | 26.016    | 2495  | 199    | 0.016 | 0.009   | 0.016  |
| 28    | 26.443    | 3261  | 166    | 0.021 | 0.008   | 0.021  |
| 29    | 28.843    | 2772  | 286    | 0.018 | 0.013   | 0.018  |
| 30    | 29.035    | 1047  | 114    | 0.007 | 0.005   | 0.007  |
| 31    | 30.869    | 1995  | 176    | 0.013 | 0.008   | 0.013  |
| 32    | 32.907    | 6470  | 430    | 0.042 | 0.020   | 0.042  |
| 33    | 33.291    | 2892  | 144    | 0.019 | 0.007   | 0.019  |
| 34    | 33.739    | 2067  | 150    | 0.013 | 0.007   | 0.013  |
| 35    | 34.195    | 8503  | 473    | 0.055 | 0.022   | 0.055  |
| 36    | 34.688    | 2867  | 189    | 0.018 | 0.009   | 0.018  |
| 37    | 34.869    | 1791  | 153    | 0.012 | 0.007   | 0.012  |
| 38    | 37.165    | 9426  | 671    | 0.061 | 0.031   | 0.061  |
| 39    | 39.357    | 123552| 4767   | 0.797 | 0.220   | 0.797  |
| 40    | 39.788    | 48483 | 2543   | 0.313 | 0.117   | 0.313  |
| 41    | 49.055    | 82711 | 2530   | 0.534 | 0.119   | 0.534  |
| Total |           | 15497340 | 2171615| 100.000 | 100.000 |
HPLC determined purity of compound 9a

<Chromatogram>

<PDA Table>

| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 1     | 3.900     | 21549 | 2630   | 0.070 | 0.065   | 0.070 |
| 2     | 4.828     | 9835  | 2920   | 0.032 | 0.072   | 0.032 |
| 3     | 5.844     | 147722| 13055  | 0.478 | 0.324   | 0.478 |
| 4     | 5.988     | 6481  | 716    | 0.021 | 0.018   | 0.021 |
| 5     | 10.962    | 1361  | 204    | 0.004 | 0.005   | 0.004 |
| 6     | 12.016    | 2000  | 210    | 0.006 | 0.005   | 0.006 |
| 7     | 12.241    | 3140  | 492    | 0.010 | 0.012   | 0.010 |
| 8     | 12.412    | 1141  | 184    | 0.004 | 0.005   | 0.004 |
| 9     | 13.067    | 1564  | 70     | 0.005 | 0.002   | 0.005 |
| 10    | 13.444    | 1123  | 152    | 0.004 | 0.004   | 0.004 |
| 11    | 13.820    | 4508  | 686    | 0.015 | 0.017   | 0.015 |
| 12    | 14.203    | 30441488| 3997565| 98.515| 99.160  | 98.515|
| 13    | 15.862    | 2016  | 238    | 0.007 | 0.006   | 0.007 |
| 14    | 17.344    | 1215  | 106    | 0.004 | 0.003   | 0.004 |
| 15    | 20.423    | 2071  | 214    | 0.007 | 0.005   | 0.007 |
| 16    | 26.027    | 1991  | 166    | 0.006 | 0.004   | 0.006 |
| 17    | 28.835    | 1611  | 207    | 0.005 | 0.005   | 0.005 |
| 18    | 30.869    | 1700  | 175    | 0.006 | 0.004   | 0.006 |
| 19    | 32.909    | 6892  | 458    | 0.022 | 0.011   | 0.022 |
| 20    | 33.269    | 3083  | 166    | 0.010 | 0.004   | 0.010 |
| 21    | 33.749    | 1180  | 142    | 0.004 | 0.004   | 0.004 |
| 22    | 34.201    | 8298  | 469    | 0.027 | 0.012   | 0.027 |

| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 23    | 34.688    | 2944  | 188    | 0.010 | 0.005   | 0.010 |
| 24    | 34.912    | 1098  | 102    | 0.004 | 0.003   | 0.004 |
| 25    | 37.183    | 8032  | 603    | 0.026 | 0.015   | 0.026 |
| 26    | 39.363    | 106910| 4634   | 0.346 | 0.115   | 0.346 |
| 27    | 39.794    | 41194 | 2377   | 0.133 | 0.059   | 0.133 |
| 28    | 49.049    | 68335 | 2302   | 0.221 | 0.057   | 0.221 |

Total: 30900482 4031432 100,000 100,000
HPLC determined purity of compound 9b

|Peak#| Ret. Time| Area  | Height| Height% | Area% |
|-----|----------|-------|-------|---------|-------|
|1    | 7.806    | 4667  | 757   | 0.130   | 0.100 |
|2    | 13.971   | 4525060 | 574241 | 98.341 | 97.060 |
|3    | 17.226   | 12285 | 1436  | 0.246   | 0.263 |
|4    | 32.888   | 15010 | 1290  | 0.221   | 0.322 |
|5    | 33.686   | 21105 | 1999  | 0.342   | 0.453 |
|6    | 39.369   | 84018 | 4204  | 0.720   | 1.802 |
|Total|          | 4662145 | 583928 | 100.000 | 100.000 |
HPLC determined purity of compound 9c

<Chromatogram>

<Peak Table>

| Peak# | Ret. Time | Area  | Height | Conc  | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 1     | 3.895     | 21960 | 2639   | 0.104 | 0.093   | 0.104 |
| 2     | 4.820     | 13553 | 3872   | 0.064 | 0.137   | 0.064 |
| 3     | 5.830     | 138709| 14363  | 0.654 | 0.508   | 0.64  |
| 4     | 5.954     | 4733  | 601    | 0.022 | 0.021   | 0.022 |
| 5     | 7.699     | 6263  | 684    | 0.030 | 0.024   | 0.030 |
| 6     | 8.211     | 5709  | 685    | 0.027 | 0.025   | 0.027 |
| 7     | 8.543     | 1397  | 125    | 0.007 | 0.004   | 0.007 |
| 8     | 8.802     | 1081  | 136    | 0.005 | 0.005   | 0.005 |
| 9     | 10.883    | 1364  | 132    | 0.006 | 0.005   | 0.006 |
| 10    | 11.502    | 6233  | 904    | 0.029 | 0.032   | 0.029 |
| 11    | 11.894    | 2735  | 375    | 0.013 | 0.013   | 0.013 |
| 12    | 12.260    | 26790 | 3536   | 0.126 | 0.125   | 0.126 |
| 13    | 12.572    | 1184  | 158    | 0.006 | 0.006   | 0.006 |
| 14    | 12.945    | 4676  | 513    | 0.022 | 0.018   | 0.022 |
| 15    | 13.351    | 3402  | 512    | 0.016 | 0.018   | 0.016 |
| 16    | 13.750    | 2061382| 2777050| 97.146 | 98.224  | 97.146 |
| 17    | 14.660    | 3267  | 552    | 0.015 | 0.020   | 0.015 |
| 18    | 14.935    | 10220 | 1677   | 0.048 | 0.059   | 0.048 |
| 19    | 15.911    | 4571  | 573    | 0.022 | 0.020   | 0.022 |
| 20    | 16.268    | 3421  | 202    | 0.016 | 0.007   | 0.016 |
| 21    | 17.323    | 2238  | 132    | 0.011 | 0.005   | 0.011 |
| 22    | 17.579    | 1081  | 130    | 0.005 | 0.005   | 0.005 |
| Peak# | Ret. Time | Area  | Height | Conc. | Height% | Area% |
|-------|-----------|-------|--------|-------|---------|-------|
| 23    | 17.867    | 1904  | 201    | 0.009 | 0.007   | 0.009 |
| 24    | 18.074    | 14536 | 2226   | 0.069 | 0.079   | 0.006 |
| 25    | 18.590    | 4912  | 479    | 0.023 | 0.017   | 0.023 |
| 26    | 19.864    | 4521  | 507    | 0.021 | 0.018   | 0.021 |
| 27    | 20.434    | 2539  | 261    | 0.012 | 0.009   | 0.012 |
| 28    | 21.480    | 8038  | 942    | 0.038 | 0.033   | 0.038 |
| 29    | 26.027    | 1784  | 172    | 0.008 | 0.006   | 0.008 |
| 30    | 27.472    | 4953  | 545    | 0.023 | 0.019   | 0.023 |
| 31    | 28.843    | 1724  | 203    | 0.008 | 0.007   | 0.008 |
| 32    | 32.900    | 7669  | 446    | 0.033 | 0.016   | 0.033 |
| 33    | 33.237    | 2214  | 158    | 0.010 | 0.006   | 0.010 |
| 34    | 33.739    | 1189  | 145    | 0.006 | 0.005   | 0.006 |
| 35    | 34.188    | 8775  | 490    | 0.041 | 0.017   | 0.041 |
| 36    | 34.688    | 3440  | 225    | 0.016 | 0.008   | 0.016 |
| 37    | 34.880    | 2202  | 155    | 0.010 | 0.005   | 0.010 |
| 38    | 37.166    | 9101  | 669    | 0.043 | 0.024   | 0.043 |
| 39    | 39.358    | 118272| 4639   | 0.557 | 0.164   | 0.557 |
| 40    | 39.787    | 44522 | 2456   | 0.210 | 0.087   | 0.210 |
| 41    | 49.062    | 99150 | 2776   | 0.467 | 0.098   | 0.467 |
| **Total** | **21216902** | **2827255** | **100,000** | **100,000** |

S118
HPLC determined purity of compound 9d

<Chromatogram>

<Peak Table>

| Peak# | Ret. Time | Area     | Height   | Height%  | Area%  |
|-------|-----------|----------|----------|----------|--------|
| 1     | 5.865     | 119788   | 12383    | 0.808    | 1.024  |
| 2     | 13.385    | 341003   | 59373    | 3.875    | 2.914  |
| 3     | 13.649    | 11155650 | 1454774  | 94.336   | 95.325 |
| 4     | 14.269    | 9997     | 1686     | 0.110    | 0.085  |
| 5     | 39.368    | 76321    | 4155     | 0.271    | 0.652  |
| Total |           | 11702760 | 1532373  | 100.000  | 100.000|
HPLC determined purity of compound 10

*<Chromatogram>*

*<Peak Table>*

| Peak# | Ret. Time | Area   | Height | Height% | Area% |
|-------|-----------|--------|--------|---------|-------|
| 1     | 7.976     | 5171   | 1031   | 0.482   | 0.418 |
| 2     | 8.500     | 4864   | 477    | 0.223   | 0.393 |
| 3     | 11.554    | 2321   | 239    | 0.112   | 0.188 |
| 4     | 13.922    | 8533   | 2017   | 0.943   | 0.690 |
| 5     | 14,107    | 1205555| 208282 | 97.400  | 97.501|
| 6     | 15,235    | 10014  | 1796   | 0.840   | 0.810 |
| Total | 1236458   | 213842 | 100.00 | 100.00  |
HPLC determined purity of compound 11a

<Chromatogram>

<Pink Table>

| Peak# | Ret. Time | Area   | Height  | Height%  | Area%  |
|-------|-----------|--------|---------|----------|--------|
| 1     | 13.740    | 2655235| 459390  | 99,944   | 99,931 |
| 2     | 15.239    | 1833   | 257     | 0,056    | 0,069  |
| Total |           | 2657068| 459647  | 100,000  | 100,000|
HPLC determined purity of compound 11b

<Chromatogram>

<PDA Ch2 254 nm Table>

| Peak | Ret. Time | Area   | Height | Height% | Area%  |
|------|-----------|--------|--------|---------|--------|
| 1    | 13,131    | 3203156| 536018 | 97.508  | 96.229 |
| 2    | 13,591    | 2631   | 572    | 0.104   | 0.079  |
| 3    | 13,750    | 4329   | 795    | 0.145   | 0.130  |
| 4    | 15,117    | 2487   | 304    | 0.055   | 0.075  |
| 5    | 21,696    | 108371 | 11309  | 2.057   | 3.256  |
| 6    | 27,715    | 7702   | 722    | 0.131   | 0.231  |
| Total| 3328675   | 549719 | 100,000| 100,000 |
HPLC determined purity of compound 11c

<Chromatogram>

<PDA Table> 254nm

| Peak# | Ret. Time | Area   | Height | Height%  | Area%   |
|-------|-----------|--------|--------|----------|---------|
| 1     | 12.891    | 2477   | 328    | 0.086    | 0.107   |
| 2     | 13.372    | 2281492| 378016 | 98.781   | 98.416  |
| 3     | 15.124    | 8301   | 1469   | 0.384    | 0.358   |
| 4     | 18.885    | 25941  | 2867   | 0.749    | 1.119   |
| Total | 2318212   | 382680 | 100.000| 100.000  |