SALTS OF 4-METHYL-N-[3-(4-METHYL-IMIDAZOL-1-YL)-5-TRIFLUOROMETHYL-PHENYL]-3-(4-PYRIDIN-3-YL-PYRIMIDIN-2-YLAMINO)-BENZAMIDE

This application claims the benefit of U.S. Provisional Patent Application No. 60/701,406, filed July 20, 2005, the entire disclosure of which is incorporated by reference herein.

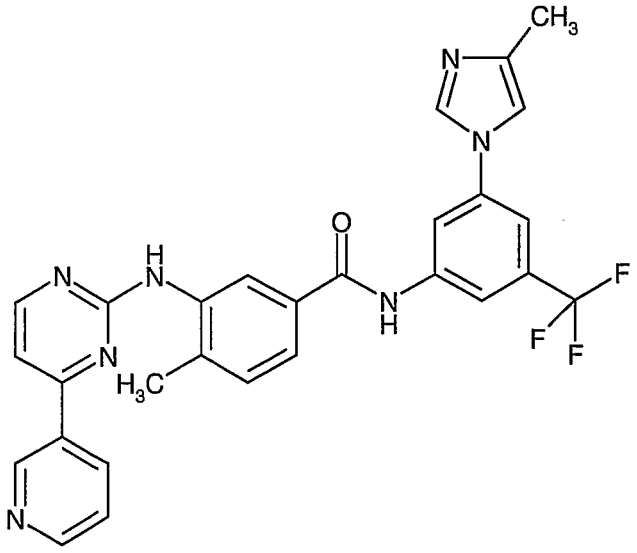
Background of the Invention

Field of the Invention

[0001] This invention relates to salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide, as well as to methods of making the same, pharmaceutical compositions comprising the same and methods of treatment using the same.

Related Background Art

[0002] The compound 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide of the formula



is described in WO 2004/005281 A1. Valuable pharmacological properties are attributed to this compound; thus, it can be used, for example, as a protein kinase inhibitor useful in therapy for diseases which respond to inhibition of protein kinase activity. WO 2004/005281 A1 does not disclose any specific salts or salt hydrates or solvates of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

Summary of the Invention

[0003] The present invention is directed to salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. Preferred embodiments of the present invention are directed to the hydrochloride, monophosphate, diphosphate, sulfate, methane sulfonate, ethane sulfonate, benzene sulfonate and p-toluene sulfonate salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0004] The present invention is further directed to a method of preparing a variety of crystalline salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide comprising the step of: reacting 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base with an acid of formula HB in a solvent.

[0005] The invention is further directed to pharmaceutical compositions comprising:

(a) a therapeutically effective amount of a salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide; and

(b) at least one pharmaceutically acceptable carrier, diluent, vehicle or excipient.

[0006] The present invention is also directed to a method of treating a disease which responds to an inhibition of protein kinase activity comprising the step of administering to a subject in need of such treatment a therapeutically effective amount of a salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

Brief Description of the Drawings

[0007] Figure 1 shows the x-ray powder diffraction patterns (XRPDs) for forms A and B of the hydrochloride salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0008] Figure 2 shows the x-ray powder diffraction pattern (XRPD) for the monophosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0009] Figure 3 shows the x-ray powder diffraction pattern for the diphosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0010] Figure 4 shows the x-ray powder diffraction patterns for forms A and B of the sulfate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0011] Figure 5 shows the x-ray powder diffraction pattern for the methane sulfonate (mesylate) salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0012] Figure 6 shows the x-ray powder diffraction pattern for the ethane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0013] Figure 7 shows the x-ray powder diffraction pattern for the benzene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

[0014] Figure 8 shows the x-ray powder diffraction pattern for the p-toluene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

Detailed Description of the Invention

[0015] The present invention is directed to salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide; preferred embodiments of those salts are described below. Generally, as used herein, "salt" refers to a compound prepared by the reaction of an organic acid or base drug with a pharmaceutically acceptable mineral or organic acid or base; as used herein, "salt" includes hydrates and solvates of salts made in accordance with this invention. Exemplary pharmaceutically acceptable mineral or organic acids or bases are as listed in Tables 1-8 in *Handbook of Pharmaceutical Salts*, P.H. Stahl and C.G. Wermuth (eds.), VHCA, Zurich, pp. 334-345 (2002). As used herein, "polymorph" refers to a distinct "crystal modification" or "polymorphic form" or "crystalline form", which differs from another with respect to x-ray powder diffraction pattern, physicochemical and/or pharmacokinetic properties, and thermodynamic stability. Co-pending U.S. Patent Application No. 60/701,405 (Attorney Docket No. 4-34384), filed concurrently herewith, addresses the various polymorphic forms of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide and salts thereof; the disclosure of that co-pending application is incorporated in its entirety by reference herein.

[0016] The first embodiment of the present invention is directed to the hydrochloride salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. The hydrochloride salt (form B, monohydrate) is reproducibly produced from methanol when one equivalent hydrochloric acid is used. It is hygroscopic (when first tested, moisture uptake was up to 2% at 60% relative humidity and up to 2.7% at 95% relative humidity, though subsequent testing has shown even greater moisture uptake). It is very slightly soluble in water and slightly soluble in 0.1 N HCl, ethanol and 2-propanol. When tested with thermogravimetric analysis (TGA), two weight loss stages occur. The first stage (onset at about 80°C) represents dehydration, and the second stage weight loss (at about 173°C) represents the loss of HCl (decomposition). Its crystal structure ranges from good to excellent, it becomes amorphous upon grinding and it can withstand compression. The hydrochloride salt is stable at room temperature in standard equilibration tests. Other polymorphic forms of the hydrochloride salt, i.e., forms A, A', A'', B', S_B, S_B',

C, C', S_C, D, and S_E, were also isolated. The XRPD pattern for forms A and B of the hydrochloride salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide are shown in Figure 1.

[0017] The second embodiment of the present invention is directed to the monophosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. The H_3PO_4 mono-salt is reproducibly produced from methanol when one equivalent phosphoric acid is used. The weight loss (room temperature to 200°C) is about 0.29%, and the sample melts at about 208°C and decomposes at about 212°C. Its crystal structure is excellent. The XRPD pattern for the monophosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 2.

[0018] The third embodiment of the present invention is directed to the diphosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. The H_3PO_4 di-salt can be produced from methanol when two equivalents phosphoric acid are used. The weight loss (room temperature to 200°C) is about 0.2%, and the sample decomposes at about 210°C. The XRPD pattern for the diphosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 3.

[0019] The fourth embodiment of the present invention is directed to the sulfate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. The H_2SO_4 salt (form B) is reproducibly produced from methanol when one equivalent sulfuric acid is used. The weight loss (room temperature to 200°C) is about 0.15%, and the sample melts with decomposition at about 206°C. Its crystal structure ranges from poor to good. One other form (form A) and an amorphous form were isolated. The XRPD patterns for forms A and B of the sulfate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide are shown in Figure 4.

[0020] The fifth embodiment of the present invention is directed to the methane sulfonate (mesylate) salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. This salt is reproducibly produced from ethyl acetate when one equivalent methane sulfonic acid is used. The weight loss (room temperature to 150°C) is about 0.44%, and the sample melts at about 160°C and decomposes at about 260°C. Its crystal structure is poor. The XRPD pattern for the methane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 5.

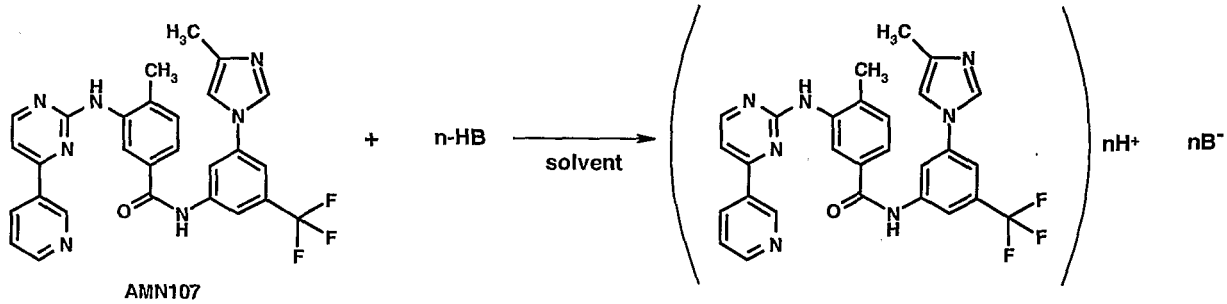
[0021] The sixth embodiment of the present invention is directed to the ethane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. This salt is reproducibly produced from ethyl acetate when one equivalent ethane sulfonic acid is used. The weight loss (room temperature to 150°C) is about 0.74%, and the sample melts at about 259°C and decomposes at about 220°C. Its crystal structure is poor. The XRPD pattern for the ethane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 6.

[0022] The seventh embodiment of the present invention is directed to the benzene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. This salt is reproducibly produced from ethyl acetate when one equivalent benzene sulfonic acid is used. The weight loss (room temperature to 250°C) is about 0.63%, and the sample melts with decomposition at about 260°C. Its crystal structure ranges from poor to good. The XRPD pattern for the benzene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 7.

[0023] The eighth embodiment of the present invention is directed to the p-toluene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. This salt is reproducibly produced from ethyl acetate when one equivalent p-toluene sulfonic acid is used. The weight loss (room temperature to 150°C) is about 0.26%, and the sample melts at about 187°C and decomposes at about 256°C. Its

crystal structure ranges from good to excellent. The XRPD pattern for the p-toluene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide is shown in Figure 8.

[0024] Another embodiment of the present invention is directed to a method of preparing a variety of crystalline salts of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide according to the following scheme:



AMN107 AMN107 salt

[0025] More specifically, 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide salts are made by reacting 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base with an acid of formula HB in a solvent. Such reaction is typically conducted in two steps, though it is within the scope of this invention to simply combine both the free base and the acid in the solvent at the same time.

[0026] In a first step, 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base is dissolved or suspended in an appropriate amount of solvent at an appropriate temperature. Solvents suitable for use in the present invention include, without limitation, methanol, ethanol, 2-propanol, acetone, ethyl acetate, acetonitrile, tetrahydrofuran and combinations thereof. It is within the skill of one of ordinary skill in the art to determine suitable amounts of base to be used, as well as suitable reaction temperatures.

[0027] In a second step of the present inventive method, the 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base is treated with an appropriate acid of the formula HB. Given the pKa values for

4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base of 5.1 and 3.9, salt forming acids with a pKa of ≤3.1 have the potential to form stable crystalline salts therewith. Suitable acids include, without limitation, inorganic acids such as hydrochloric acid, phosphoric acid, sulfuric acid, and sulfonic acid and organic acids such as methane sulfonic acid, ethane sulfonic acid, benzene sulfonic acid, p-toluene sulfonic acid, citric acid, fumaric acid, gentisic acid, malonic acid, maleic acid, and tartaric acid.

[0028] In optional steps of the present inventive method, the 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide salt is isolated by filtration or some other suitable means and the isolated salt is dried to remove residual solvent. In a preferred embodiment of this invention, the hydrochloride salt is first obtained as a methanol solvate which must be exposed to moisture in order to convert to the monohydrate hydrochloride salt.

[0029] A particularly preferred embodiment of the present invention is directed to a method of preparing 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate comprising the steps of:

(a) combining 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and hydrochloric acid in methanol under a nitrogen atmosphere;

(b) heating the reaction mixture to a temperature ranging from about 42-50°C;

(c) stirring the reaction mixture;

(d) filtering the reaction mixture while maintaining the temperature above 40°C to obtain a clear solution;

(e) cooling the clear solution to about 30°C while stirring under nitrogen atmosphere;

(f) seeding the solution;

(g) cooling the seeded solution to about 23°C;

(h) stirring the solution to obtain a suspension;

(i) cooling the suspension to about -10°C;

(j) stirring the suspension;

(k) filtering solids;

(l) rinsing solids with cold methanol; and

(m) drying the solids at about 50-55°C and 10-20 torr to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate salt.

In more preferred embodiments, stirring is conducted for about 15 minutes in step (c), cooling is accomplished over a period of about 30 minutes in step (e), cooling is accomplished over a period of about 45 minutes in step (g), stirring is conducted for about 3 hours in step (h), cooling is accomplished over a period of about 1.5 hours in step (i), stirring is conducted for about 30 minutes in step (j), the cold methanol of step (l) has a temperature of about -10°C, and/or drying is accomplished over a period of about 8-16 hours.

[0030] The tenth embodiment of the present invention is directed to a pharmaceutical composition comprising:

(a) a therapeutically effective amount of a salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide; and

(b) at least one pharmaceutically acceptable carrier, diluent, vehicle or excipient.

[0031] A "therapeutically effective amount" is intended to mean the amount of the inventive salt that, when administered to a subject in need thereof, is sufficient to effect treatment for disease conditions alleviated by the inhibition of protein kinase activity. The amount of a given compound of the invention that will be therapeutically effective will vary depending upon factors such as the disease condition and the severity thereof, the identity of the subject in need thereof, etc., which amount may be routinely determined by artisans of ordinary skill in the art.

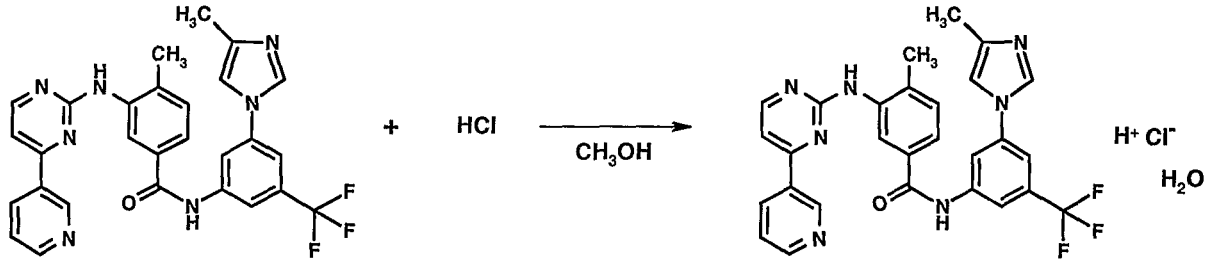
[0032] The at least one pharmaceutically acceptable carrier, diluent, vehicle or excipient can readily be selected by one of ordinary skill in the art and will be determined by the desired mode of administration. Illustrative examples of suitable modes of administration include oral, nasal, parenteral, topical, transdermal, and rectal. The pharmaceutical compositions of

this invention may take any pharmaceutical form recognizable to the skilled artisan as being suitable. Suitable pharmaceutical forms include solid, semisolid, liquid, or lyophilized formulations, such as tablets, powders, capsules, suppositories, suspensions, liposomes, and aerosols.

[0033] The eleventh embodiment of the present invention is directed to a method of treating a disease which responds to an inhibition of protein kinase activity comprising the step of administering to a subject in need of such treatment a therapeutically effective amount of a salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide. As noted above, illustrative modes of administration include oral, nasal, parenteral, topical, transdermal, and rectal. Administration of the crystalline form may be accomplished by administration of a pharmaceutical composition of the ninth embodiment of the invention or via any other effective means.

[0034] Specific embodiments of the invention will now be demonstrated by reference to the following examples. It should be understood that these examples are disclosed solely by way of illustrating the invention and should not be taken in any way to limit the scope of the present invention.

Example 1 **Preparation of Monohydrochloride Monohydrate Salt**



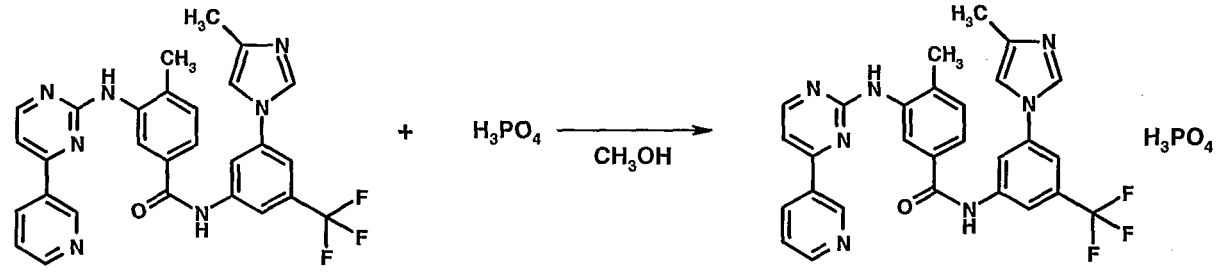
AMN107 AMN107 HCl H_2O salt

[0035] A 1 L, 4-neck, round-bottom flask equipped with a mechanical stirrer, a thermometer, heating/cooling capacity, and an addition funnel was charged in sequence with 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base (10 g), methanol (250 mL), and 37% hydrochloric acid (1.85 g) under nitrogen purge. The mixture was heated to 42-50°C and stirred for an additional 15 minutes. The resulting solution was filtered through a polypropylene pad, while maintaining the batch temperature above 40°C. The clear solution was transferred under nitrogen

atmosphere to another 1 L, 4-neck, and round-bottom flask equipped with a mechanical stirrer, a thermometer, and heating/cooling capacity. The batch was stirred and cooled to 30°C over a period of 30 minutes. Seeds (20 mg) were added at this temperature, and the batch was cooled to 23°C over a period of 45 minutes. The batch was stirred for an additional 3 hours to obtain a thick white suspension. The suspension was cooled to -10°C over a period of 1.5 hours and stirred for an additional 30 minutes. Any solid was collected by filtration and rinsed with cold (-10°C) methanol (20 mL). The solid was dried at 50-55°C/10-20 torr for 8-16 hours to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate salt (9.8 g) as a white solid.

[0036] ^{1}H NMR 300 MHz, DMSO-d_6), δ 10.9 (s, 1H), 9.58 (s, 1H), 9.29 (s, 1H), 9.20 (s, 1H), 8.70 (d, 1H), 8.63 (s, 1H), 8.55 (d, 1H), 8.49 (d, 1H), 8.32 (d, 2H), 8.00 (s, 1H), 7.91 (s, 1H), 7.84 (d, 1H), 7.56-7.44 (m, 3H), 2.50 (s, 3H), 2.35 (s, 3H); x-ray diffraction pattern showing maxima at 2θ = 7.4°, 9.4°, 11.6°, 12.1°, 15.8°, 19.3°, 19.6°, 22.1°, 24.1°, 25.7°.

Example 2 Preparation of Monophosphate Salt

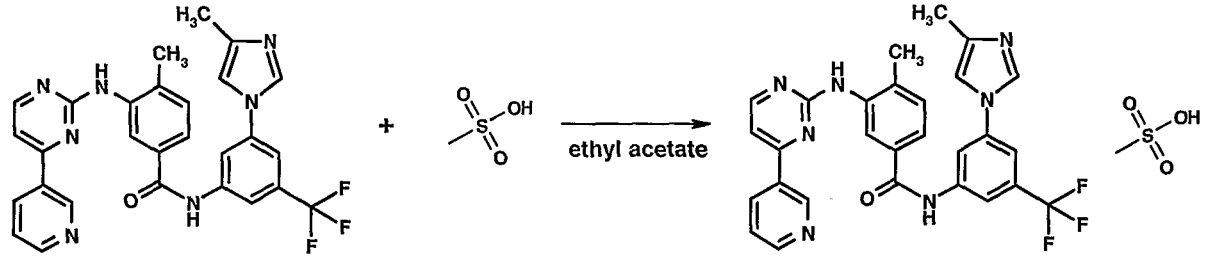


AMN107 AMN107 H_3PO_4 salt

[0037] To a 1 L round-bottom flask equipped with a mechanical stirrer, a thermometer, and a condenser, 4 g of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and 500 mL of methanol were charged. The slurry was stirred and heated to 64°C and held at that temperature for ~30 minutes. To the resulting clear solution, 7.5 mL of 1 M phosphorous acid solution (in methanol) was added. The mixture was stirred at 64°C for one hour, cooled down to room temperature by natural cooling (cooling rate ~0.5°C/min) and held at room temperature for 3-4 hours. The solid was collected by filtration and was dried at 50-55°C/10-20 torr for 8-16 hours to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-

pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monophosphate salt (3.25 g) as a white solid. Melting point = ~208°C (dec.); x-ray diffraction pattern showing maxima at 2θ = 6.1°, 7.5°, 9.1°, 15.8°, 17.5°, 18.3°, 21.8°, 23.1°, 24.9°, 26.6°.

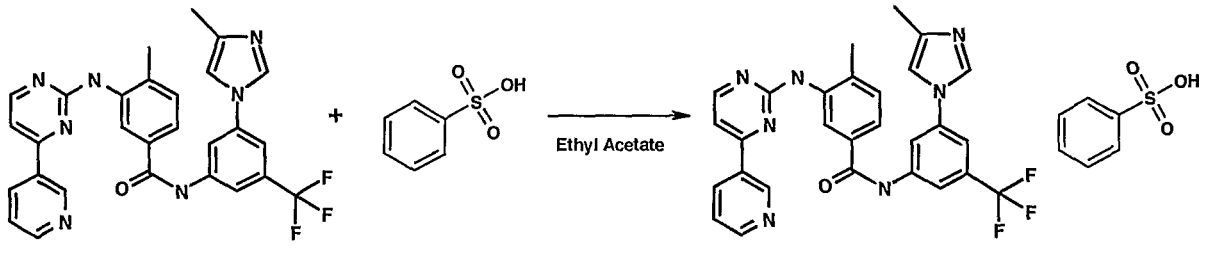
Example 3 Preparation of Methane Sulfonate Salt



AMN107 AMN107 mesylate salt

[0038] To a 75 mL reactor equipped with a temperature probe and a condenser, 307 mg of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and 30 mL of ethyl acetate were charged. The slurry was stirred and heated to 76°C. To the solution, 580 µL of 1 M methane sulfonic acid solution (in ethyl acetate) was added. The mixture was stirred at 76°C for six hours, cooled to 25°C at a rate of 0.5°C/minute and held at 25°C overnight. The solid was collected by filtration and was dried at 50-55°C/10-20 torr for 8-16 hours to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide mesylate salt (~250 mg) as a yellowish solid. X-ray diffraction pattern showing maxima at 2θ = 7.7°, 10.1°, 20.3°, 26.2°.

Example 4 Preparation of Benzylsulfonate Salt

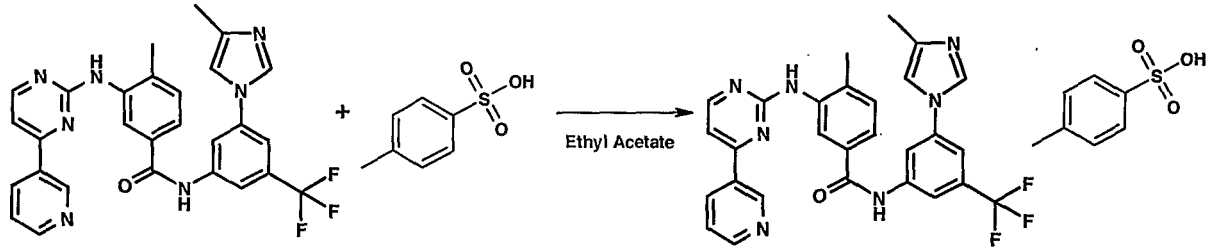


AMN107 AMN107 benzylsulfonate salt

[0039] To a 1 L round-bottom flask equipped with a mechanical stirrer, a thermometer, and a condenser, 4 g of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and 500 mL of ethyl acetate were charged. The slurry was stirred and heated to 76°C (reflux) and held at that temperature for

40 minutes. To the resulting clear solution, 7.5 mL of 1 M benzene sulfonic acid solution (in ethyl acetate) was added. The mixture was stirred at 76°C for 5 hours, cooled down to room temperature by natural cooling (cooling rate ~0.5°C/min) and held at room temperature for ~1 hour. The solid was collected by filtration and was dried at 50-55°C/10-20 torr for 8-16 hours to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide mono benzyl sulfonate salt as a yellowish solid. Melting point = ~260°C; x-ray diffraction pattern showing maxima at 2θ = 6.5°, 7.8°, 9.4°, 10.4°, 13.7°, 17.0°, 17.5°, 17.9°, 18.8°, 21.2°.

Example 5 Preparation of p-Toluene Sulfonate Salt



AMN107

AMN107 p-tolysulfonate salt

[0040] To a 75 mL reactor equipped with a temperature probe and a condenser, 305.6 mg of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and 30 mL of ethyl acetate were charged. The slurry was stirred and heated to 76°C. To the solution, 580 µL of 1 M p-toluene sulfonic acid solution (in ethyl acetate) was added. The mixture was stirred at 76°C for six hours, cooled to 25°C at a rate of 0.5°C/minute and held at 25°C overnight. The solid was collected by filtration and was dried at 50-55°C/10-20 torr for 8-16 hours to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide p-toluene sulfonate salt (~250 mg) as a white solid. Melting point = ~187°C; x-ray diffraction pattern showing maxima at 2θ = 7.3°, 15.4°, 16.1°, 17.5°, 18.3°, 19.0°, 19.7°, 22.5°.

Example 6 Hydrochloride Salt

[0041] 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and about 400 mL methanol are charged into a flask. While stirring, 744.4 mg of 37% HCl solution is added dropwise. The slurry becomes clear. The solution is stirred for 30 minutes. The solution is concentrated to 100 mL. The

solution is then stirred for 2 hours; a slurry is obtained. The slurry is filtered and dried under house vacuum overnight at 50°C. Polymorphic form B is obtained with a yield of about 72.6%.

Example 7

[0042] About 50-60 mg of form A of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base was suspended in 0.75 mL of a listed solvent. The stoichiometric amount of a noted acid was subsequently added to the suspension. For inorganic acids, the mixture was stirred at ambient temperature for about 5 hours, and for sulfonic acids, it was stirred at 50°C overnight. Solids were collected by filtration and analyzed by XRPD and NMR.

Table 1. Formation of Hydrochloride Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Methanol	Slurry becomes thinner after HCl addition.	Good; form B	No solvent peak
Ethanol	Slurry becomes thinner after HCl addition.	Good; forms A & B	No solvent peak
2-Propanol	Slurry becomes thinner after HCl addition.	Good; form A	No solvent peak
Acetone	Slurry becomes thinner after HCl addition.	Excellent; form A	---
Ethyl acetate	Slurry becomes thinner after HCl addition.	Good; forms A & B	---
Tetrahydrofuran	Slurry becomes thinner after HCl addition.	Excellent; form A	---
Acetonitrile	Slurry becomes thinner after HCl addition.	Excellent; forms A & B	---

* excellent = when main peaks are sharp and their intensities above 70 counts
good = when main peaks are sharp and their intensities within 30-70 counts

Table 2. Formation of Sulfate Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Methanol	Slurry becomes thinner after H_2SO_4 addition.	Good; forms A & B	No solvent peak
Ethanol	Slurry becomes thinner after H_2SO_4 addition.	Good; form B	No solvent peak
2-Propanol	Slurry becomes thinner after H_2SO_4 addition.	Poor	---
Acetone	Slurry becomes thinner after H_2SO_4 addition.	Poor	---
Ethyl acetate	Slurry becomes thinner after H_2SO_4 addition.	Poor	---
Tetrahydrofuran	Slurry becomes thinner after H_2SO_4 addition.	Poor	---
Acetonitrile	Slurry becomes thinner after H_2SO_4 addition.	Poor	---

* good = when main peaks are sharp and their intensities within 30-70 counts
poor = when main peaks are broad and their intensities below 30 counts; could be amorphous salt and free base form A

Table 3. Formation of Methane Sulfonate Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Acetone	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	1) 1.3% (w) acetone 2) acid:base = 1.2:1.0
Tetrahydrofuran	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Amorphous	---

* poor = when main peaks are broad and their intensities below 30 counts

Table 4. Formation of Ethane Sulfonate Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Acetone	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Good	1) 0.9% (w) acetone 2) acid:base = 1.4:1.0
Tetrahydrofuran	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	---

* good = when main peaks are sharp and their intensities within 30-70 counts
poor = when main peaks are broad and their intensities below 30 counts

[0043] The ethane sulfonate salt from acetone has an x-ray diffraction pattern showing maxima at 2θ = 6.6°, 7.9°, 9.5°, 14.2°, 17.8°.

Table 5. Formation of Benzene Sulfonate Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Tetrahydrofuran	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	1) 1.2% (w) THF 2) acid:base = 1.4:1.0
Acetone	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	---

* poor = when main peaks are broad and their intensities below 30 counts

Table 6. Formation of p-Toluene Sulfonate Salt

Solvent	Comments	Results	
		Crystallinity*	^{1}H-NMR
Tetrahydrofuran	Slurry became thinner after acid addition. It did not become clear at 50°C. White solid was obtained by filtration.	Good	1) 4.6% (w) THF 2) acid:base = 1.2:1.0
Acetone	Slurry became thinner after acid addition. It did not become clear at 50°C. White solid was obtained by filtration.	Good	---

* good = when main peaks are sharp and their intensities within 30-70 counts

Example 8

[0044] About 300-310 mg of form B of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base was suspended in 9 mL of 2-propanol for HCl and 15 mL acetone for the sulfonic acids. The stoichiometric amount of the noted acid was subsequently added to the suspension. For HCl, the mixture was stirred at ambient temperature for 5 hours, and for sulfonic acids, it was stirred at 50°C overnight. Then, the mixture was cooled to ambient temperature, collected by filtration and analyzed by XRPD and NMR.

Table 7.

Acid	Comments	Results	
		Crystallinity	^{1}H-NMR
HCl	After HCl addition, the slurry became yellow, then off-white. After 4 hours of holding, the slurry was like paste, difficult to pour and filter.	1) good 2) form A	1) shifts changed 2) no solvent peak
Methane sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	1) shifts changed 2) 0.67% (w) acetone
Ethane sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	1) shifts changed 2) no solvent peak
p-Toluene sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C. White solid was obtained by filtration.	Good	1) shifts changed 2) no solvent peak

Example 9

[0045] About 100 mg of form B of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base was suspended in 15 mL of methanol for the inorganic acids and in 15 mL THF for the sulfonic acids noted below. The stoichiometric amount of the listed acid was subsequently added to the suspension, except for H_3PO_4, for which two equivalents were added. The solution was stirred at 50°C for about 5 hours and then cooled to ambient temperature. Solids were collected by filtration if slurry formed; otherwise, a slow N_2 flow was applied to evaporate

some solvent to yield thicker slurry for filtration. The solids were analyzed by XRPD and NMR.

Table 8.

Acid	Comments	Results	
		Crystallinity	^{1}H-NMR
HCl	The slurry became clear while heating and remained so. Slow N_2 flow was used to evaporate some solvent.	1) good 2) Form B	1) shifts changed 2) no solvent peak
H_2SO_4	The slurry became clear after heating. It became slurry during cooling.	1) good 2) form A + B	1) shifts changed 2) <2% methanol
H_3PO_4 (diphosphate)	Slurry becomes thicker after acid addition.	1) excellent 2) different from free base and mono-salt	1) no shift change 2) no solvent peak
Methane sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Poor	1) shifts changed 2) no solvent peak
Benzene sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C.	Good	1) shifts changed 2) no solvent peak
p-Toluene sulfonic acid	Slurry became thinner and turned yellow after acid addition. It did not become clear at 50°C. White solid was obtained by filtration.	Excellent	1) shifts changed 2) no solvent peak

[0046] Elemental analysis was used to check salt formation for the diphosphate salt. The results are as follows:

Table 9.

	C	H	N	P
Theoretical	45.91	3.83	13.39	8.47
H_3PO_4 above	45.86	3.81	13.32	9.01

Example 10

[0047] About 100 mg of form B of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base was suspended in 15 mL of methanol for HCl and H_2SO_4 and in 15 mL of ethyl acetate for methane sulfonic acid. The listed amount of the listed acid was subsequently added to the

suspension. The solution was stirred at ambient temperature (HCl) or 50°C (H_2SO_4 and methane sulfonic acid). The solids were obtained by evaporating solvent to dryness using a slow N_2 flow and analyzed by XRPD and NMR.

Table 10.

Acid	Comments	Results	
		Crystallinity	^{1}H-NMR
1 equivalent HCl	The slurry became clear while heating and remained so.	1) good 2) form B	1) shifts changed 2) no solvent peak
2 equivalents HCl	The slurry became clear while heating and remained so.	Amorphous	---
0.5 equivalents H_2SO_4	The slurry became clear while heating and remained so.	1) good 2) form A & free base form B	1) shifts changed 2) small solvent peak
1 equivalent H_2SO_4	The slurry became clear after acid addition and remained so.	1) good 2) form A	1) shifts changed 2) no solvent peak
1 equivalent methane sulfonic acid	Slurry became clear after acid addition and remained so after 4 hours holding.	Poor	1) acid:base = 1.3:1.0 2) no solvent peak
2 equivalents methane sulfonic acid	Slurry became clear after acid addition and remained so after 4 hours holding.	Poor	1) acid:base = 1.9:1.0 2) no solvent peak

Example 11

[0048] About 300 mg of form B of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base was suspended in 30 mL of methanol for the inorganic acids and in 30 mL ethyl acetate for the sulfonic acids. The suspension was heated to reflux temperature -64°C for methanol and 76°C for ethyl acetate. The stoichiometric amount of the listed acid, dissolved in the corresponding solvent, was subsequently added to the solution. The solution was stirred under reflux for 5 hours and then cooled to ambient temperature. The solid was collected by filtration and analyzed by XRPD.

Table 11.

Acid	Comments	Form
H_2SO_4	The slurry became clear under reflux. Solid precipitated out after holding.	1) sulfate 2) form B
H_3PO_4	The slurry became clear under reflux. Solid precipitated out after holding.	Monophosphate
Methane sulfonic acid	The solution remained slurry under reflux. It became thinner and turned yellow after acid addition.	Methane sulfonate
Benzene sulfonic acid	The solution remained slurry under reflux. It became thinner and turned yellow after acid addition.	Benzene sulfonate
p-Toluene sulfonic acid	The solution remained slurry under reflux. It became clear after acid addition.	p-Toluene sulfonate

Thermal Behavior

[0049] The LOD and decomposition temperature of the salts of the invention were determined by TGA, and the melting point was determined by DSC.

Table 12.

Salt	LOD	Decomposition temperature (°C)*	Melting point (°C)
Hydrochloride (form B)	2.60% (RT-150°C) 4.87% (150-250°C)		
Monophosphate	0.29% (RT-200°C)	212	~208
Sulfate (form B)	0.15% (RT-200°C)	201	1) 126.5 2) 206.2
Methane sulfonate	0.44% (RT-150°C)	260	160.1
Ethane sulfonate	0.74% (RT-150°C)	220	1) 259.2 2) 261.3
Benzene sulfonate	0.63% (RT-250°C)	260	>258.7
p-Toluene sulfonate	0.26% (RT-150°C)	256	1) 187 2) 232

* The decomposition temperature was determined by the onset of the first derivative of the sample weight loss v. temperature of TGA data

Hygroscopicity

[0050] The hygroscopicity of the salts of the invention was determined by TGA after one day at ambient temperature and 93% relative humidity.

Table 13.

Salt	% moisture gain
Hydrochloride (form B)	0.20
Monophosphate	1.33
Sulfate (form B)	0.22
Methane sulfonate	0.22
Ethane sulfonate	1.11
Benzene sulfonate	0.11
p-Toluene sulfonate	1.02
Control – free base form B	0.08

[0051] It should be noted that, upon further testing, hygroscopicity results have varied. At least with regard to the hydrochloride salt, moisture is lost too quickly upon testing to capture the true value; such may be true for the other salts as well.

Solubility

[0052] The solubility of the salts of the invention was determined in pH 6.8, pH 3.0 and pH 1.0 buffers by suspending 1-5 mg of each salt in 10 mL of corresponding aqueous solution. The samples were allowed to equilibrate at ambient temperature for at least 20 hours for pH 6.8 and 3.0 or about 5 hours for pH 1.0. The supernatant was filtered and used for the solubility determination by UV-VIS spectroscopy. The solid residue was analyzed by XRPD.

Table 14.

Solute	Solubility at pH 6.8 (μg/mL)	Solubility at pH 3.0 (μg/mL)	Solubility at pH 1.0 (μg/mL)
Hydrochloride salt (form B)	0.3	0.9	1040
Monophosphate salt	----	----	1160
Sulfate salt (form B)	0.1	6.5	1380
Methane sulfonate salt	0.4	5.2	1330
Ethane sulfonate salt	0.4	2.8	----
Benzene sulfonate salt	<3.0	----	1420
p-Toluene sulfonate salt	<8.0	<10.0	1340
Control – free base form B	0.2	2.8	839

Comparative Testing

[0053] The stability of both 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base (form B) and 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrate hydrochloride salt (form B) were evaluated as described below.

Table 15.

	Salt form			
	Free base (form B)		**Hydrochloride monohydrate (form B)**	
Test conditions	Degradation products Assay [% area]	Appearance	Degradation products Assay [% area]	Appearance
Unstressed	0.00 100.99 [100.00]	----	0.00 99.10 [100.00]	----
0.1% solutions or suspensions, 1 week at 80°C				
pH 1 (pH measured: 1.26) PH 1; 1 week @ 50°C	60.61 50.22 [45.31] 6.58 94.01 [93.44]	A* A*	62.06 46.68 [42.93] 6.86 94.14 [93.21]	A* A*
pH 2 (pH measured: 2.00)	5.20 96.00 [94.86]	B↓	8.41 91.77 [91.61]	B↓
pH 3 (pH measured: 2.94)	0.00 102.19 [100.00]	A↓	0.00 98.84 [100.00]	B↓
pH 5 (pH measured: 5.01)	0.00 100.80 [100.00]	A↓	0.00 100.02 [100.00]	A↓
pH 7 (pH measured: 6.02)	0.00 100.14 [100.00]	A↓	0.00 99.56 [100.00]	B↓
pH 9 (pH measured: 8.92)	0.00 99.19 [100.00]	A↓	0.00 101.19 [100.00]	B↓
pH 11 (pH measured: 10.86)	0.00 100.50 [100.00]	A↓	0.00 102.19 [100.00]	B↓
Water (pH measured: 4.74)(pH measured for HCl salt: 4.22)	0.00 101.93 [100.00]	A↓	0.00 101.43 [100.00]	A↓
Ethanol	0.04 99.85 [99.96]	A*	0.06 100.41 [100.00]	A*
Acetonitrile	0.00 100.16 [100.00]	A*	0.00 100.33 [100.00]	B↓
Methanol	1.06 98.04 [98.90]	A*	1.29 99.169 [98.72]	A*

Test conditions	Salt form			
	Free base (form B)		Hydrochloride monohydrate (form B)	
	Degradation products Assay [% area]	Appearance	Degradation products Assay [% area]	Appearance
2% solutions or suspensions, 1 day at room temperature				
0.5% CMC	0.00 98.28 [100.00]	A↓	0.00 103.06 [100.00]	A↓
0.5% HPMC cellulose 4000	0.00 98.27 [100.00]	A↓	0.00 100.44 [100.00]	A↓
0.8% Tween 80	0.00 98.78 [100.00]	A↓	0.00 102.42 [100.00]	A↓
5% solutions in DMSO, 1 day at room temperature				
1:100 dilution in pH 6.8 buffer	0.00 96.98 [100.00]	A↓	0.00 101.85 [100.00]	A↓
Solid state, 1 week 80°C, tight container				
Bulk (HPLC)	0.00 99.77 [100.00]	A	0.00 100.77 [100.00]	A
Bulk (XRPD)	No change		No change	
30% in mixture 1	0.00 100.11 [100.00]	A	0.00 101.23 [100.00]	A
30% in mixture 2	2.17 94.28 [97.75]	A	2.08 93.43 [97.82]	A
Solid state, 1 week 80°C, 75% relative humidity				
Bulk (HPLC)	0.00 99.97 [100.00]	A	0.00 100.71 [100.00]	A
Bulk (XRPD)	No change		No change	
30% in mixture 1	0.00 99.38 [100.00]	B	0.00 100.88 [100.00]	B
30% in mixture 2	3.71 89.37 [96.02]	B	1.89 92.17 [97.99]	B
Xenon light (approximately 1200 kLuxh)				
Bulk (HPLC)	0.00 96.03 [100.00]	A	0.00 99.73 [100.00]	A
Bulk (XRPD)	No change		No change	
Bulk corrosivity				
2 day, 80% relative humidity with steel coupon	N/A		No change	

↓ suspension
A no change of color
* clear solution after stress test
B slight discoloration

Mixture 1: 30% 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide (free base or salt), 63% lactose 100 mesh/lactose 200 mesh (50:50), 5% crosprovidone, 1% Aerosil 200, 1% magnesium stearate

Mixture 2: 30% 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide (free base or salt), 34% mannitol 60, 34% Avicel PH102, 1% Aerosil 200, 1% magnesium stearate (% by weight of free base or salt)

Table 16. Forced Decomposition Test

Test condition	Appearance	Degradation products	Assay [% area]
Unstressed		0.00 (0)	99.22 [100.00]
Bulk 3 days/100°C	A	0.00 (0)	99.02 [100.00]
10 mg/1.5 mL DMSO + 0.5 mL water 3 days/100°C	A*	0.75 (4)	97.04 [99.24]
10 mg/1.5 mL DMSO + 0.5 mL 0.1 N HCl 3 days/50°C	A* A*	11.64 (7) 0.00 (0)	89.15 [88.45] 100.04 [100.00]
10 mg/1.5 mL DMSO + 0.5 mL 0.1 N NaOH 3 days/50°C	A*	6.79 (3)	94.64 [93.30]
10 mg/1.5 mL DMSO + 0.5 mL water containing 200 ppm Fe^{3+}, Ni^{2+} and Cu^{2+} saturated with O_2 3 days/100°C	A*	1.66 (5)	96.89 [98.32]
10 mg/1.5 mL DMSO + 0.5 mL water saturated with 0_2 3 days/100°C	A*	0.58 (2)	99.37 [99.42]
10 mg/1.5 mL DMSO + 0.5 mL 10% H_2O_2 3 days/100°C	B*	0.34 (2)	98.85 [99.66]
10 mg/1.5 mL DMSO + 0.5 mL water xenon light (1200 kLux)	B*	2.74 (5)	96.10 [97.23]

[0054] The chemical, physicochemical and morphic characteristics of both 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base (form B) and 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrate hydrochloride salt (form B) were evaluated as described below.

[0055] Determination of Approximate Solubility: A weighted amount (20-50 mg) of sample was charged into 2 mL of the solvent. The obtained slurry was allowed to equilibrate for 24 hours at room temperature and then filtered. The concentration of DS in saturated filtrate was measured by either UV or HPLC.

[0056] Intrinsic Dissolution Rate (IDR): Dissolution rate measurements were performed at 37°C using the rotating disk method (VanKell Instrument). A single rotation speed of 200 rpm was used. For IDR in 0.1 N HCl, an 800 mL volume, and for IDR in water, a 200 mL volume were used. The solution was continuously pumped through a UV measuring cell and recycled to the dissolution vessel.

[0057] Hygroscopicity: Sorption/desorption isotherms were collected using a Surface Measurements Systems dynamic vapor sorption device (DVS-1). The measurements were carried out at 25°C.

Table 17. Chemical and Physicochemical Characteristics

Parameter	Salt form			
	Free base form B		Hydrochloride monohydrate (form B)	
Elementary analysis	Calculated	Found	Calculated	Found
%C	63.46	63.58	57.58	57.66
%H	4.15	3.97	4.29	4.25
%F	10.76	10.22	9.77	9.83
%N	18.51	18.57	16.80	16.58
%O	3.02	3.56	5.48	5.68
%Cl	N/A	N/A	6.08	6.00
DSC purity (mol %) (10°C/minute)	98.65		N/A due to decomposition prior to melting	
HPLC purity (area %)	100.00		100.00	
DSC melting point (°C) (10°C/minute)	249.0		N/A due to decomposition prior to melting	
Melting enthalpy (J/g)	153.9		N/A due to decomposition prior to melting	
pH of 1% solution or suspension in water	7.99		2.53	
Solubility (approximately at 25°C, mg/mL)				
0.1 N HCl	0.60		0.94	
0.01 N HCl	0.0014		0.08	
Phosphate buffer, pH 6.8	0.0002		Below detection	
Water	Below detection		0.17	
Ethanol	0.63		3.69	
Isopropanol	0.33		1.93	
Thermogravimetry (weight loss %) (10°C/minute)	0.026 (RT to 200°C)		0.91 (RT to 80°C)	
Residual solvents (%)	0.2		0.0	
Intrinsic dissolution rate (mg $min^{-1}cm^{-2}$)				
pH 1 (0.1 N HCl)	0.17		0.17	
Water	0.0013		0.0024	

[0058] While the invention has been described above with reference to specific embodiments thereof, it is apparent that many changes, modifications, and variations can be made without departing from the inventive concept disclosed herein. Accordingly, it is intended to embrace all such changes, modifications, and variations that fall within the spirit and broad scope of the appended claims. All patent applications, patents, and other publications cited herein are incorporated by reference in their entirety.

WHAT IS CLAIMED IS:

1. A salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

2. The salt of Claim 1, wherein the salt is a hydrochloride salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

3. The salt of Claim 2, wherein the salt is 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate.

4. The salt of Claim 1, wherein the salt is a monophosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

5. The salt of Claim 1, wherein the salt is a diphosphate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

6. The salt of Claim 1, wherein the salt is a sulfate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

7. The salt of Claim 1, wherein the salt is a methane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

8. The salt of Claim 1, wherein the salt is an ethane sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

9. The salt of Claim 1, wherein the salt is a benzene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

10. The salt of Claim 1, wherein the salt is a p-toluene sulfonate salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide.

11. A method of preparing a salt of 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide comprising the step of: reacting 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base with an acid of formula HB in a solvent.

12. The method of Claim 11, wherein the acid is selected from the group consisting of hydrochloric acid, phosphoric acid, sulfuric acid, sulfonic acid, methane sulfonic acid, ethane sulfonic acid, benzene sulfonic acid, p-toluene sulfonic acid, citric acid, fumaric acid, gentisic acid, malonic acid, maleic acid, and tartaric acid.

13. A method of preparing 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate comprising the steps of:

(a) combining 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide free base and hydrochloric acid in methanol under a nitrogen atmosphere;

(b) heating the reaction mixture to a temperature ranging from about 42-50°C;

(c) stirring the reaction mixture;

(d) filtering the reaction mixture while maintaining the temperature above 40°C to obtain a clear solution;

(e) cooling the clear solution to about 30°C while stirring under nitrogen atmosphere;

(f) seeding the solution;

(g) cooling the seeded solution to about 23°C;

(h) stirring the solution to obtain a suspension;

(i) cooling the suspension to about -10°C;

(j) stirring the suspension;

(k) filtering solids;

(l) rinsing solids with cold methanol; and

(m) drying the solids at about 50-55°C and 10-20 torr to obtain 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate salt.

14. A pharmaceutical composition comprising:

(a) a therapeutically effective amount of a salt according to claim 1; and

(b) at least one pharmaceutically acceptable carrier, diluent, vehicle or excipient.

15. The pharmaceutical composition of Claim 14, wherein the salt is 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate.

16. A method of treating a disease which responds to an inhibition of protein kinase activity comprising the step of administering to a subject in need of such treatment a therapeutically effective amount of a salt according to Claim 1.

17. The method of Claim 16, wherein the salt is 4-methyl-N-[3-(4-methyl-imidazol-1-yl)-5-trifluoromethyl-phenyl]-3-(4-pyridin-3-yl-pyrimidin-2-ylamino)-benzamide monohydrochloride monohydrate.