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(54) Title: COMPOSITIONS FOR THE TREATMENT OF CANCER AND USES THEREOF

(57) Abstract: The invention pertains to compositions comprising inhibitors of PI3K, AKT and/or mTOR, one or more 4-quinoline-methanols and a pharmaceutically acceptable excipient. These compositions can contain subtherapeutic amounts of each active ingredient (PI3K, AKT, mTOR, one or more 4-quinolinemethanols and various combinations thereof). The invention also provides a method of treating various forms of cancer, such as breast cancer, prostate cancer, multiple myeloma, hepatocyte carcinoma, brain cancer, lung cancer, non-small cell lung carcinoma, colorectal cancer, melanoma and/or pancreatic cancer.



DESCRIPTION

COMPOSITIONS FOR THE TREATMENT OF CANCER AND USES THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application Serial No. 62/183,831, filed June 24, 2015, the disclosure of which is hereby incorporated by reference in its entirety, including all figures, tables and amino acid or nucleic acid sequences.

BACKGROUND OF THE INVENTION

Cancer is the second most prevalent cause of death in the United States and is a complex disease arising after a selection process for cells with acquired functional capabilities, such as limitless proliferative potential and metastatic capabilities. The subject application provides a novel combination therapy that targets cancer at the PI3K/AKT/mTOR pathway, which is constitutively activated in many types of cancers. The disclosed combination therapy has, surprisingly, been found to be effective in the treatment of cancer, particularly breast cancer, prostate cancer, multiple myeloma, hepatocyte carcinoma, lung cancer, non-small cell lung carcinoma, colorectal cancer, melanoma and/or pancreatic cancer.

BRIEF SUMMARY OF THE INVENTION

The subject application provides compositions comprising inhibitors of PI3K, AKT and/or mTOR, one or more 4-quinolinemethanols and a pharmaceutically acceptable excipient. These compositions can contain subtherapeutic amounts of each active ingredient (PI3K, AKT, mTOR, one or more 4-quinolinemethanols and various combinations thereof). The compositions provided by the subject application can be used for the treatment of various forms of cancer, such as breast cancer, prostate cancer, multiple myeloma, hepatocyte carcinoma, brain cancer, lung cancer, non-small cell lung carcinoma, colorectal cancer, melanoma and/or pancreatic cancer.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: Outline of Compound P + Ras Effector Inhibitor Experiments.

Figure 2: Compound P + Everolimus MIA PaCa-2.

Figure 3: Compound P + Everolimus MIA PaCa-2.

Figure 4: Compound P + Everolimus MIA PaCa-2.

Figure 5: Compound P + Everolimus Panc-1.

Figure 6: Compound P + Everolimus Panc-1.

5 Figure 7: Compound P + Everolimus Panc-1.

Figure 8: Compound P + Everolimus (mTOR inhibitor) in Pancreatic Ductal Adenocarcinoma Cell Lines Derived from KRAS/PTEN Mutant Mouse Tumors.

Figure 9: Compound P + MK-2206 MIA PaCa-2.

Figure 10: Compound P + MK-2206 MIA PaCa-2.

10 Figure 11: Compound P + MK-2206 Panc-1.

Figure 12: Compound P + MK-2206 Panc-1.

Figure 13: Compound P + MK-2206 (AKT inhibitor) in Pancreatic Ductal Adenocarcinoma Cell Lines Derived from KRAS/PTEN Mutant Mouse Tumors.

Figure 14: Compound P + BEZ-235 MIA PaCa-2.

15 Figure 15: Compound P + BEZ-235 MIA PaCa-2.

Figure 16: Compound P + BEZ-235 MIA PaCa-2.

Figure 17: Compound P + BEZ-235 Panc-1.

Figure 18: Compound P + BEZ-235 Panc-1.

Figure 19: Compound P + BEZ-235 Panc-1.

20 Figure 20: Compound P + BEZ235 (Dual PI-3K/mTOR Inhibitor) in Pancreatic Ductal Adenocarcinoma Cell Lines Derived from KRAS/PTEN Mutant Mouse Tumors.

Figure 21: Summary Of Ratio Ranges for PDAC Cell Lines.

Figure 22: TS Accelerates KRAS mutant PDAC.

25 BRIEF DESCRIPTION OF THE TABLES

Table 1 provides a list of exemplary 4-quinolinemethanols that can be used in the formulation of compositions disclosed herein. Compound P, as used throughout this application, is mefloquine or a pharmaceutically acceptable salt thereof.

30 **Table 2** provides a list of exemplary PI-3K inhibitors that can be used in the formulation of compositions disclosed herein.

Table 3 provides a list of exemplary AKT inhibitors that can be used in the formulation of compositions disclosed herein.

Table 4 provides a list of exemplary mTOR inhibitors that can be used in the formulation of compositions disclosed herein.

DETAILED DISCLOSURE OF THE INVENTION

As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Furthermore, to the extent that the terms “including”, “includes”, “having”, “has”, “with”, or variants thereof are used in either the detailed description and/or the claims, such terms are intended to be inclusive in a manner similar to the term “comprising”. The transitional terms/phrases (and any grammatical variations thereof) “comprising”, “comprises”, “comprise”, “consisting essentially of”, “consists essentially of”, “consisting” and “consists” can be used interchangeably.

The following abbreviations and terms have the indicated meanings throughout: PI3K = Phosphoinositide-3-kinase; AKT = serine-threonine protein kinase B; mTOR = Mammalian target of rapamycin).

The term “about” or “approximately” means within an acceptable error range for the particular value as determined by one of ordinary skill in the art, which will depend in part on how the value is measured or determined, i.e., the limitations of the measurement system. For example, “about” can mean within 1 or more than 1 standard deviation, per the practice in the art. Alternatively, “about” can mean a range of up to 0-20%, 0 to 10%, 0 to 5%, or up to 1% of a given value. Alternatively, particularly with respect to biological systems or processes, the term can mean within an order of magnitude, preferably within 5-fold, and more preferably within 2-fold, of a value. Where particular values are described in the application and claims, unless otherwise stated the term “about” meaning within an acceptable error range for the particular value should be assumed. In the context of compositions containing amounts of ingredients where the terms “about” or “approximately” are used, these compositions contain the stated amount of the ingredient with a variation (error range) of 0-10% around the value ($X \pm 10\%$).

When ranges are used herein, such as for dose ranges, combinations and subcombinations of ranges (e.g., subranges within the disclosed range), specific embodiments therein are intended to be explicitly included.

“Treatment”, “treating”, “palliating” and “ameliorating” (and grammatical variants of these terms), as used herein, are used interchangeably. These terms refer to an approach for

obtaining beneficial or desired results including but not limited to therapeutic benefit. A therapeutic benefit is achieved with the eradication or amelioration of one or more of the physiological symptoms associated with the underlying disorder such that an improvement is observed in the patient, notwithstanding that the patient may still be afflicted with the underlying disorder.

As used herein, the term “cancer” refers to the presence of cells possessing abnormal growth characteristics, such as uncontrolled proliferation, immortality, metastatic potential, rapid growth and proliferation rate, perturbed oncogenic signaling, and certain characteristic morphological features. This includes but is not limited to the growth of: (1) benign or malignant cells (e.g., tumor cells) that correlates with overexpression of a serine/threonine kinase; or (2) benign or malignant cells (e.g., tumor cells) that correlates with abnormally high levels of serine/threonine kinase activity or lipid kinase activity. Non-limiting serine/threonine kinases implicated in cancer include but are not limited to PI-3K mTOR, and AKT. Exemplary lipid kinases include but are not limited to PI3 kinases such as PBK α , PBK β , PBK δ , and PBK γ .

The term “effective amount” or “therapeutically effective amount” refers to that amount of an inhibitor described herein that is sufficient to effect the intended application including but not limited to disease treatment. The therapeutically effective amount may vary depending upon the intended application (in vitro or in vivo), or the subject and disease condition being treated, e.g., the weight and age of the subject, the severity of the disease condition, the manner of administration and the like, which can readily be determined by one of ordinary skill in the art. The term also applies to a dose that will induce a particular response in target cells, e.g., reduction of proliferation or downregulation of activity of a target protein. The specific dose will vary depending on the particular compounds chosen, the dosing regimen to be followed, whether it is administered in combination with other compounds, timing of administration, the tissue to which it is administered, and the physical delivery system in which it is carried.

A “sub-therapeutic amount” of an agent is an amount less than the effective amount for that agent, but which when combined with an effective or sub-therapeutic amount of another agent or therapy can produce a desired result, due to, for example, synergy in the resulting efficacious effects (e.g., therapeutic benefit) for the patient, or reduced side effects associated with the compounds administered to the patient. Typical therapeutic amounts for an agent, as disclosed herein, can be ascertained from various publicly available sources (e.g.,

drugs.com, The Physician's Desk Reference, or scientific literature). Subtherapeutic amounts of an agent, as provided herein, are amounts less than those reported in the publicly available sources.

In the case of mefloquine, the therapeutic dose is 1000 mg per day. Thus, subtherapeutic doses of mefloquine (per day) are less than 1000 mg and can range from 5 mg to 950 mg, about 5 mg to about 500 mg, about 100 mg to about 500 mg, or about 200 to about 700 mg. For quinine, the therapeutic dose is 648 mg per day. Thus, subtherapeutic doses of quinine (per day) are less than range from 5 mg to 625 mg, about 5 mg to about 500 mg, about 100 mg to about 575 mg, or about 200 to about 500 mg. For idelalisib (CS-101), subtherapeutic doses (per day) are less than 300 mg. Thus, subtherapeutic doses can range from 5 mg to 250 mg, about 5 mg to about 150 mg, about 100 mg to about 125 mg, or about 50 to about 150 mg. For miltefosine, subtherapeutic doses (per day) are less than 150 mg per day for subjects of 45 kg or more or less than 100 mg per day for subjects between 30 and 44 kg. Thus, for subjects weighing more than 45 kg, subtherapeutic doses can range from 5 mg to 125 mg, about 5 mg to about 100 mg, about 100 mg to about 125 mg, or about 25 to about 125 mg. For sirolimus, subtherapeutic doses (per day) are less than 2 mg per day for subjects of 40 kg or more or less than 1 mg/m² (body surface area) per day for subjects less than 40 kg. Thus, for subjects weighing more than 40 kg, subtherapeutic doses (per day) can range from 0.1 mg to 1.95 mg, about 0.5 mg to about 1.75 mg, about 1 mg to about 1.50 mg, or about 0.25 to about 1.50 mg. For subjects weighing less than 40 kg, subtherapeutic doses (per day) can range from 0.1 mg to 0.95 mg, about 0.5 mg to about 0.75 mg, about 0.01 mg to about 0.75 mg, or about 0.25 to about 0.75 mg. For everolimus, subtherapeutic doses (per day) are less than 10 mg per day. Thus, subtherapeutic doses (per day) can range from 0.1 mg to 9.50 mg, about 0.5 mg to about 9.00 mg, about 1 mg to about 7.5 mg, or about 2.50 to about 5.0 mg. For temsirolimus, subtherapeutic doses are about 25 mg/week. Thus, subtherapeutic doses (per week) can range from 1 mg to 24.5 mg, about 0.5 mg to about 22 mg, about 1 mg to about 15 mg, or about 2.50 to about 20 mg.

A “synergistically effective” therapeutic amount or “synergistically effective” amount of an agent is an amount which, when combined with an effective or subtherapeutic amount of another agent or therapy, produces a greater effect than when either of the two agents are used alone. A synergistically effective therapeutic amount of an agent produces a greater effect when used in combination than the additive effects of each of the two agents or therapies when used alone. The term “greater effect” encompasses not only a reduction in

symptoms of the disorder to be treated, but also an improved side effect profile, improved tolerability, improved patient compliance, improved efficacy, or any other improved clinical outcome.

As used herein, “agent” or “agents” refers to an inhibitor of PI3K, AKT and/or mTOR and one or more 4-quinolinemethanols. Exemplary agents are provided in Tables 1-4 of this application.

The terms “antagonist” and “inhibitor” may be used interchangeably, and they refer to a compound having the ability to inhibit a biological function of a target protein, whether by inhibiting the activity or expression of the target protein. Accordingly, the terms “antagonist” and “inhibitor” are defined in the context of the biological role of the target protein. Exemplary “antagonists” and “inhibitors” are provided in Tables 1-4 of this application.

The terms “co-administration,” “administered in combination with,” and their grammatical equivalents encompass administration of two or more agents to a subject so that both agents and/or their metabolites are present in the subject at the same time. Co-administration includes simultaneous administration in separate compositions, administration at different times in separate compositions, or administration in a composition in which both agents are present. Co-administered agents may be in the same formulation. Coadministered agents may also be in different formulations.

A “therapeutic effect,” as used herein, encompasses a therapeutic benefit as described above. This includes delaying the appearance of a disease or condition, delaying the onset of symptoms of a disease or condition, slowing, halting, or reversing the progression of a disease or condition, or any combination thereof.

The term “pharmaceutically acceptable salt” refers to salts derived from a variety of organic and inorganic counter ions well known in the art. Pharmaceutically acceptable acid addition salts can be formed with inorganic acids and organic acids. Inorganic acids from which salts can be derived include, for example, hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid, and the like. Organic acids from which salts can be derived include, for example, acetic acid, propionic acid, glycolic acid, pyruvic acid, oxalic acid, maleic acid, malonic acid, succinic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, p-toluenesulfonic acid, salicylic acid, and the like. Pharmaceutically acceptable base addition salts can be formed with inorganic and organic bases. Inorganic bases from which salts can be derived include, for example, sodium, potassium, lithium, ammonium, calcium,

magnesium, iron, zinc, copper, manganese, aluminum, and the like. Organic bases from which salts can be derived include, for example, primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines, basic ion exchange resins, and the like, specifically such as isopropylamine, trimethylamine, diethylamine, triethylamine, tripropylamine, and ethanolamine. In some embodiments, the pharmaceutically acceptable base addition salt is chosen from ammonium, potassium, sodium, calcium, and magnesium salts.

“Pharmaceutically acceptable carrier” or “pharmaceutically acceptable excipient” includes any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents and the like. The use of such media and agents for pharmaceutically active substances is well known in the art. Except insofar as any conventional media or agent is incompatible with the active ingredient, its use in the therapeutic compositions of the invention is contemplated. Supplementary active ingredients can also be incorporated into the compositions.

“Subject” refers to an animal, such as a mammal, for example a human. The methods described herein can be useful in both pre-clinical human therapeutics and veterinary applications. In some embodiments, the subject is a mammal (such as an animal model of disease), and in some embodiments, the subject is human. The terms “subject” and “patient” can be used interchangeably.

The terms “simultaneous” or “simultaneously” as applied to administering agents to a subject refer to administering one or more agents at the same time, or at two different time points that are separated by no more than 1 hour. The term “sequentially” refers to administering more than one agent at two different time points that are separated by more than 1 hour, e.g., about 2 hours, about 5 hours, 8 hours, 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days or even longer.

The subject application provides methods of treating cancer comprising the administration or co-administration of a composition comprising one or more 4-quinolinemethanols and: a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K); b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT); c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR. In certain embodiments, the 4-quinolinemethanol is selected from Table 1, the PI-3K inhibitor is selected from Table 2, the AKT inhibitor is selected from

Table 3 and the mTOR inhibitor is selected from Table 4. In various embodiments, one or more 4-quinolinemethanols and one or more PI-3K inhibitors are administered simultaneously or sequentially. Other embodiments provide for the one or more 4-quinolinemethanols and one or more PI-3K inhibitors to be co-administered as a single composition. Yet other embodiments provide for one or more 4-quinolinemethanols and one or more AKT inhibitors to co-administered or administered simultaneously or sequentially. Yet another embodiment provides for one or more 4-quinolinemethanols and one or more AKT inhibitors to be co-administered as a single composition. Similarly, the disclosed method can comprise the administration or co-administration of more 4-quinolinemethanols and one or more mTOR inhibitors. As discussed herein, one or more 4-quinolinemethanols and one or more AKT inhibitors can be administered simultaneously or sequentially or as a single composition.

In various embodiments, subtherapeutic amounts of one or more 4-quinolinemethanols (4QM) and: a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K); b) one or more agents that inhibit the activity of serine-threonine protein kinase B (AKT); c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR can be administered or co-administered. The subtherapeutic amounts of these agents are preferably provided in synergistically effective amounts. Alternatively, the agents can be administered in subtherapeutic amounts in the following ratios:

one or more 4-quinolinemethanols (4QM) and one or more PI-3K inhibitors at a ratio (4QM:PI-3K) of between 600:1 and 17.5:1;

one or more 4-quinolinemethanols (4QM) and one or more AKT inhibitors (AKTI) at a ratio (4QM:AKTI) of between 0.33:1 and 3:1;

one or more 4-quinolinemethanols (4QM) and one or more mTOR inhibitors (mTORI) at a ratio (4QM:mTORI) of between 1000:1 and 17.5:1; or

various ratios falling within the ranges provided herein.

Cancers suitable for treatment according to the disclosed methods include, but are not limited to: Acanthoma, Acinic cell carcinoma, Acoustic neuroma, Acral lentiginous melanoma, Acrospiroma, Acute eosinophilic leukemia, Acute lymphoblastic leukemia, Acute megakaryoblastic leukemia, Acute monocytic leukemia, Acute myeloblastic leukemia with maturation, Acute myeloid dendritic cell leukemia, Acute myeloid leukemia, Acute

promyelocytic leukemia, Adamantinoma, Adenocarcinoma, Adenoid cystic carcinoma, Adenoma, Adenomatoid odontogenic tumor, Adrenocortical carcinoma, Adult T-cell leukemia, Aggressive NK-cell leukemia, AIDS-related cancers, AIDS-related lymphoma, Alveolar soft part sarcoma, Ameloblastic fibroma, Anal cancer, Anaplastic large cell lymphoma, Anaplastic thyroid cancer, Angioimmunoblastic T-cell lymphoma, Angiomyolipoma, Angiosarcoma, Appendix cancer, Astrocytoma, Atypical teratoid rhabdoid tumor, Basal cell carcinoma, Basal-like carcinoma, B-cell leukemia, B-cell lymphoma, Bellini duct carcinoma, Biliary tract cancer, Bladder cancer, Blastoma, Bone cancer, Bone tumor, Brain stem glioma, Brain tumor, Breast cancer, Brenner tumor, Bronchial tumor, Bronchioloalveolar carcinoma, Brown tumor, Burkitt's lymphoma, Cancer of unknown primary site, Carcinoid Tumor, Carcinoma, Carcinoma in situ, Carcinoma of the penis, Carcinoma of unknown primary site, Carcinosarcoma, Castleman's Disease, Central nervous system embryonal tumor, Cerebellar astrocytoma, Cerebral astrocytoma, Cervical cancer, Cholangiocarcinoma, Chondroma, Chondrosarcoma, Chordoma, Choriocarcinoma, Choroid plexus papilloma, Chronic lymphocytic leukemia, Chronic monocytic leukemia, Chronic myelogenous leukemia, Chronic myeloproliferative disorder, Chronic neutrophilic leukemia, Clear-cell tumor, Colon cancer, Colorectal cancer, Craniopharyngioma, Cutaneous T-cell lymphoma, Degos disease, Dermatofibrosarcoma protuberans, Dermoid cyst, Desmoplastic small round cell tumor, Diffuse large B cell lymphoma, Dysembryoplastic neuroepithelial tumor, Embryonal carcinoma, Endodermal sinus tumor, Endometrial cancer, Endometrial uterine cancer, Endometrioid tumor, Enteropathy-associated T-cell lymphoma, Ependymblastoma, Ependymoma, Epithelioid sarcoma, Erythroleukemia, Esophageal cancer, Esthesioneuroblastoma, Ewing family of tumor, Ewing family sarcoma, Ewing's sarcoma, Extracranial germ cell tumor, Extragonadal germ cell tumor, Extrahepatic bile duct cancer, Extramammary Paget's disease, Fallopian tube cancer, Fetus in fetu, Fibroma, Fibrosarcoma, Follicular lymphoma, Follicular thyroid cancer, Gallbladder Cancer, Gallbladder cancer, Ganglioglioma, Ganglioneuroma, Gastric cancer, Gastric lymphoma, Gastrointestinal cancer, Gastrointestinal carcinoid tumor, Gastrointestinal stromal tumor, Gastrointestinal stromal tumor, Germ cell tumor, Germinoma, Gestational choriocarcinoma, Gestational trophoblastic tumor, Giant cell tumor of bone, Glioblastoma multiforme, Glioma, Gliomatosis cerebri, Glomus tumor, Glucagonoma, Gonadoblastoma, Granulosa cell tumor, Hairy Cell Leukemia, Hairy cell leukemia, Head and neck cancer, Heart cancer, Hemangioblastoma, Hemangiopericytoma, Hemangiosarcoma, Hematological malignancy,

Hepatocellular carcinoma, Hepatosplenic T-cell lymphoma, Hereditary breast-ovarian cancer syndrome, Hodgkin's lymphoma, Hypopharyngeal cancer, Hypothalamic glioma, Inflammatory breast cancer, Intraocular melanoma, Islet cell carcinoma, Islet cell tumor, Juvenile myelomonocytic leukemia, Sarcoma, Kaposi's sarcoma, Kidney cancer, Klatskin tumor, Krukenberg tumor, Laryngeal cancer, Lentigo maligna melanoma, Leukemia, Leukemia, Lip and oral cavity cancer, Liposarcoma, Lung cancer, Luteoma, Lymphangioma, Lymphangiosarcoma, Lymphoepithelioma, Lymphoid leukemia, Lymphoma, Macroglobulinemia, Malignant fibrous histiocytoma, Malignant fibrous histiocytoma of bone, Malignant glioma, Malignant mesothelioma, Malignant peripheral nerve sheath tumor, Malignant rhabdoid tumor, Malignant triton tumor, MALT lymphoma, Mantle cell lymphoma, Mast cell leukemia, Mediastinal germ cell tumor, Mediastinal tumor, Medullary thyroid cancer, Medulloblastoma, Medulloepithelioma, Melanoma, Melanoma, Meningioma, Merkel Cell Carcinoma, Mesothelioma, Metastatic squamous neck cancer with occult primary, Metastatic urothelial carcinoma, Mixed mullerian tumor, Monocytic leukemia, Mouth cancer, Mucinous tumor, Multiple endocrine neoplasia syndrome, Multiple myeloma, Mycosis fungoides, Myelodysplasia disease, Myelodysplasia syndromes, Myeloid leukemia, Myeloid sarcoma, Myeloproliferative disease, Myxoma, nasal cavity cancer, Nasopharyngeal cancer, Nasopharyngeal carcinoma, Neoplasm, Neurinoma, Neuroblastoma, Neuroblastoma, Neurofibroma, Neuroma, Nodular melanoma, Non-Hodgkin's lymphoma, Nonmelanoma skin cancer, Non-small cell lung cancer, Ocular oncology, Oligoastrocytoma, Oligodendroglioma, Oncocytoma, Optic nerve sheath meningioma, Oral cancer, Oropharyngeal cancer, Osteosarcoma, Osteosarcoma, Ovarian cancer, Ovarian epithelial cancer, Ovarian germ cell tumor, Ovarian low malignant potential tumor, Paget's disease of the breast, Pancoast tumor, Pancreatic cancer, Papillary thyroid cancer, Papillomatosis, Paraganglioma, Paranasal sinus cancer, Parathyroid cancer, Penile cancer, Perivascular epithelioid cell tumor, Pharyngeal cancer, Pheochromocytoma, Pineal parenchymal tumor of intermediate differentiation, Pineoblastoma, Pituicytoma, Pituitary adenoma, Pituitary tumor, Plasma cell neoplasm, Pleuropulmonary blastoma, Polyembryoma, precursor T-lymphoblastic lymphoma, Primary central nervous system lymphoma, Primary effusion lymphoma, Primary hepatocellular cancer, Primary liver cancer, Primary peritoneal cancer, Primitive neuroectodermal tumor, Prostate cancer, Pseudomyxoma peritonei, Rectal cancer, Renal cell carcinoma, Respiratory tract carcinoma involving the NUT gene on chromosome 15, Retinoblastoma, Rhabdomyoma, Rhabdomyosarcoma, Richter's transformation,

Sacrococcygeal teratoma, Salivary gland cancer, Sarcoma, Schwannomatosis, Sebaceous gland carcinoma, Secondary neoplasm, Seminoma, Serous tumor, Sertoli-Leydig cell tumor, Sex cord-stromal tumor, Sezary Syndrome, Signet ring cell carcinoma, Skin cancer, Small blue round cell tumor, Small cell carcinoma, Small cell lung cancer, Small cell lymphoma, Small intestine cancer, Soft tissue sarcoma, Somatostatinoma, Soot wart, Spinal cord tumor, Spinal tumor, Splenic marginal zone lymphoma, Squamous cell carcinoma, Stomach cancer, Superficial spreading melanoma, Supratentorial primitive neuroectodermal Tumor, Surface epithelial-stromal tumor, Synovial sarcoma, T-cell acute lymphoblastic leukemia, T-cell large granular lymphocyte leukemia, T-cell leukemia, T-cell lymphoma, T-cell prolymphocytic leukemia, Teratoma, Terminal lymphatic cancer, Testicular cancer, Thecoma, Throat cancer, Thymic carcinoma, Thymoma, Thyroid cancer, Transitional Cell Cancer of renal pelvis and ureter, Transitional cell carcinoma, Urachal cancer, Urethral cancer, Urogenital neoplasm, Uterine sarcoma, Uveal melanoma, Vaginal cancer, Verner-Morrison syndrome, Verrucous carcinoma, Visual pathway glioma, Vulvar cancer, Waldenstrom's macroglobulinemia, Warthin's tumor, Wilms' tumor, or any combinations thereof.

In some embodiments, the cancer selected from the group consisting of non-small cell lung cancer, small cell lung cancer, head and neck squamous cell carcinoma, pancreatic cancer, breast cancer, ovarian cancer, renal cell carcinoma, prostate cancer, neuroendocrine cancer, gastric cancer, bladder cancer, a brain cancer (glioma, astrocytoma, glioblastoma multiforme, etc.), colon cancer and endometrial cancer.

The subject application also provides compositions comprising one or more 4-quinolinemethanols (4QM) and: a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K); b) one or more agents that inhibit the activity of serine-threonine protein kinase B (AKT); c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR. In various embodiments, subtherapeutic amounts of 4Qm and the other agents are provided within the composition. Some embodiments provide compositions containing subtherapeutic amounts of the agents disclosed herein in the following ratios:

one or more 4-quinolinemethanols (4QM) and one or more PI-3K inhibitors at a ratio (4QM:PI-3K) of between 600:1 and 17.5:1;

one or more 4-quinolinemethanols (4QM) and one or more AKT inhibitors (AKTI) at a ratio (4QM:AKTI) of between 0.33:1 and 3:1;

one or more 4-quinolinemethanols (4QM) and one or more mTOR inhibitors (mTORI) at a ratio (4QM:mTORI) of between 1000:1 and 17.5:1; or various ratios falling within the ranges provided herein.

Other embodiments provide compositions comprising 4QM and various agents in subtherapeutic amounts. For example, subtherapeutic doses of mefloquine (per day) are less than 1000 mg and can range from 5 mg to 950 mg, about 5 mg to about 500 mg, about 100 mg to about 500 mg, or about 200 to about 700 mg. For quinine, the therapeutic dose is 648 mg per day. Thus, subtherapeutic doses of quinine (per day) can range from 5 mg to 625 mg, about 5 mg to about 500 mg, about 100 mg to about 575 mg, or about 200 to about 500 mg. For idelalisib (CS-101), subtherapeutic doses (per day) are less than 300 mg. Thus, subtherapeutic doses can range from 5 mg to 250 mg, about 5 mg to about 150 mg, about 100 mg to about 125 mg, or about 50 to about 150 mg. For miltefosine, subtherapeutic doses (per day) are less than 150 mg per day for subjects of 45 kg or more or less than 100 mg per day for subjects between 30 and 44 kg. Thus, for subjects weighing more than 45 kg, subtherapeutic doses can range from 5 mg to 125 mg, about 5 mg to about 100 mg, about 100 mg to about 125 mg, or about 25 to about 125 mg. For sirolimus, subtherapeutic doses (per day) are less than 2 mg per day for subjects of 40 kg or more or less than 1 mg/m² (body surface area) per day for subjects less than 40 kg. Thus, for subjects weighing more than 40 kg, subtherapeutic doses (per day) can range from 0.1 mg to 1.95 mg, about 0.5 mg to about 1.75 mg, about 1 mg to about 1.50 mg, or about 0.25 to about 1.50 mg. For subjects weighing less than 40 kg, subtherapeutic doses (per day) can range from 0.1 mg to 0.95 mg, about 0.5 mg to about 0.75 mg, about 0.01 mg to about 0.75 mg, or about 0.25 to about 0.75 mg. For everolimus, subtherapeutic doses (per day) are less than 10 mg per day. Thus, subtherapeutic doses (per day) can range from 0.1 mg to 9.50 mg, about 0.5 mg to about 9.00 mg, about 1 mg to about 7.5 mg, or about 2.50 to about 5.0 mg. For temsirolimus, subtherapeutic doses are about 25 mg/week. Thus, subtherapeutic doses (per week) can range from 1 mg to 24.5 mg, about 0.5 mg to about 22 mg, about 1 mg to about 15 mg, or about 2.50 to about 20 mg. In some embodiments, compositions containing subtherapeutic amounts of the other agents disclosed in Tables 1-4 can be readily ascertained from the literature and correspond to amounts that are between 5% and 95%, between 5% and 90%, between 5% and 80% or between 5% and 75% of the amounts reported to be therapeutically effective for any compound identified in Tables 1-4.

Other embodiments provide for a composition comprising one or more 4-quinolinemethanols (4QM) and: a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K); b) one or more agents that inhibit the activity of serine-threonine protein kinase B (AKT); c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR. Subtherapeutic amounts of these components of the composition correspond to amounts that are between 5% and 95%, between 5% and 90%, between 5% and 80% or between 5% and 75% of the amounts reported to be therapeutically effective for a given 4-quinolinemethanol (4QM) agent that inhibits the activity of Phosphoinositide-3-kinase (PI-3K), an agent that inhibits the activity of serine-threonine protein kinase B (AKT), or an agent that inhibit the activity of mammalian target of rapamycin (mTOR).

All patents, patent applications, provisional applications, and publications referred to or cited herein are incorporated by reference in their entirety, including all figures and tables, to the extent they are not inconsistent with the explicit teachings of this specification.

Following are examples which illustrate procedures for practicing the invention. These examples should not be construed as limiting. All percentages are by weight and all solvent mixture proportions are by volume unless otherwise noted.

Example 1.

In the present study, we show that human TS (hTS) significantly accelerates PDAC progression and metastases and decreases overall survival of *Pdx1-Cre/LSL-Kras^{G12D/+}* mice (*Kras^{G12D/+}* mice) and that dual targeting of TS and the Ras/PI-3K/AKT/mTOR pathway results in synergistic growth inhibition of PDAC in vitro and in vivo. Specifically, we demonstrate that a widely-used anti-parasitic agent (referred to as Compound P or mefloquine), which inhibits the enzymatic activity of human TS in a partial mixed-type manner, synergizes with inhibitors of the KRAS/PI-3K/AKT/mTOR pathway to inhibit PDAC in vitro and in vivo. In summary, we demonstrate that the oncogenes KRAS and TS cooperate to accelerate the progression of PDAC, and propose that combination therapies targeting these two oncogenic pathways should be evaluated in PDAC patients (see Figure 22). Because our data demonstrate that Thymidylate Synthase and mutant Kras oncogenically cooperate to promote pancreatic cancer progression and metastasis, we next investigated whether targeting of either of these two oncogenic signals could inhibit pancreatic cancer growth in KRAS mutant cells. To accomplish this, we evaluated the effect of a novel partial

mixed-type inhibitor of TS, compound P (mefloquine), or several KRAS effector inhibitors on the viability of 4 KRAS mutant PDAC cell lines (two human PDAC cell lines, MIA PaCa-2 and Panc-1, and two murine cell lines: T182, derived from a KrasG12D/+Pten-/+ murine PDAC, and E549, derived from a hTS/KrasG12D/+Pten-/+ mouse murine PDAC).

5 We treated each cell line with the mTOR inhibitor Everolimus, the AKT inhibitor MK-2206, the dual PI-3K/mTOR inhibitor BEZ235, and the MEK inhibitor Selumetinib, or Compound P (mefloquine), prior to viability assessment at 72 hours via MTT assay. We found that while the novel TS inhibitor Compound P was cytotoxic in all cell lines tested, the KRAS effector inhibitors varied in their growth inhibition effects: the mTOR inhibitor
10 Everolimus was potently cytostatic, while the AKT inhibitor MK-2206 and the dual PI-3K/mTOR inhibitor BEZ235 were both fully cytotoxic in 3 out of 4 cell lines. However, none of the KRAS effector inhibitors were fully cytotoxic in Panc-1 cells. We found that the MEK inhibitor Selumetinib had little effect in the 4 PDAC cell lines (data not shown).

To determine optimal doses for combination, we first analyzed the viability dose-response curves for each drug. For the TS allosteric inhibitor (Compound P) we chose 12 μ M
15 as the optimal dose for combination in all cell lines, in order to capture the steep slope observed in the viability dose-response curve. For everolimus, we chose 0.1 μ M as the optimal dose for combination in all cell lines, because the dose-response effect appeared to be cytostatic across 5 orders of magnitude (from 0.001 μ M to 10 μ M) and 0.1 μ M is the
20 midpoint order of magnitude in this range. For MK-2206, and BEZ-235, we chose doses which would capture the cytotoxicity of the dose-response viability curves: 8.0 μ M for MK-2206, and 0.2 μ M for BEZ235. The optimal dose for each drug was then serially diluted by one-half from the chosen optimal dose to 1/32nd of the chosen optimal dose, such that six
25 combination points could be analyzed. Because the ratio of each drug in each experiment remained constant in all serial dilutions, we refer to this method as the “fixed molar ratio method”.

To determine the effect of combination treatment on cell viability, we treated the 4 PDAC cell lines with the TS inhibitor compound P combined with each of the KRAS effector inhibitors using the fixed molar ratio method, and analyzed individual drug curves and
30 combination points using CalcuSyn software to assess for synergy. We found that simultaneous targeting of TS (by partial mixed-type inhibition of the homodimeric enzyme) and oncogenic KRAS (via targeting of the KRAS/PI3K/AKT/mTOR effector pathway) results in synergistic antitumor activity which is greater than that observed with either drug

alone. Specifically, we found that the novel TS inhibitor Compound P synergized with the mTOR inhibitor Everolimus, the dual PI3K/mTOR inhibitor BEZ235, and the AKT inhibitor MK-2206 in four KRAS mutant pancreatic cancer cell lines when combined in a constant ratio method. Interestingly, synergy was not observed with the combination of the TS inhibitor compound P and the MEK inhibitor Selumetinib (data not shown).

Table 1. List of Exemplary 4-Quinolinemethanols

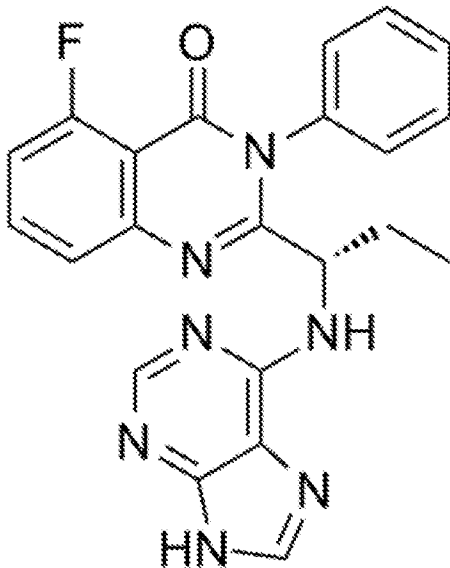
WR-142490 (Compound P; mefloquine)	[2,8-bis(trifluoromethyl)quinolin-4-yl]-piperidin-2-ylmethanol
Quinine	(R)-[(2S,4S,5R)-5-ethenyl-1-azabicyclo[2.2.2]octan-2-yl]-(6-methoxyquinolin-4-yl)methanol
Qunidine	(S)-[(2R,4S,5R)-5-ethenyl-1-azabicyclo[2.2.2]octan-2-yl]-(6-methoxyquinolin-4-yl)methanol
SN-10275	(6,8-dichloro-2-phenylquinolin-4-yl)-piperidin-2-ylmethanol
WR-30090	2-(dibutylamino)-1-[6,8-dichloro-2-(3,4-dichlorophenyl)quinolin-4-yl]ethanol
WR-176990	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(dibutylamino)ethanol
WR-177000	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(butylamino)ethanol
WR-177973	Identified in Table 1 of US 2011/0092488.
WR-183544	1-[2,8-Bis(trifluoromethyl)-4-quinolinyl]-2-(propylamino)ethanol
WR-183545	1-[2,8-Bis(trifluoromethyl)-4-quinolinyl]-2-(methylamino)ethanol
WR-184806	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-3-(tert-butylamino)propan-1-ol
WR-194965	4-tert-butyl-2-[(tert-butylamino)methyl]-6-(4-chlorophenyl)phenol
WR-211679	Identified in Table 1 of US 2011/0092488.
WR-211925	Identified in Table 1 of US 2011/0092488.
WR-226253	(S)-[6,8-dichloro-2-(trifluoromethyl)quinolin-4-yl]-[(2S)-piperidin-2-yl]methanol;methanesulfonic acid
WR-308245	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(methylamino)ethanol
WR-308246	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(dimethylamino)ethanol
WR-308247	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-fluoroethylamino)ethanol
WR-308251	2-anilino-1-[2,8-bis(trifluoromethyl)quinolin-4-yl]ethanol
WR-308252	2-(benzylamino)-1-[2,8-bis(trifluoromethyl)quinolin-4-

	yl]ethanol
WR-308253	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-phenylethylamino)ethanol
WR-308254	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(diethylamino)ethanol
WR-308257	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(propan-2-ylamino)ethanol
WR-308258	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-hydroxyethylamino)ethanol
WR-308277	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(dipropylamino)ethanol
WR-308278	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(3-methylsulfanylpropylamino)ethanol
WR-308314	2-amino-1-[2,8-bis(trifluoromethyl)quinolin-4-yl]ethanol
WR-308396	2-[2-(benzylamino)ethylamino]-1-[2,8-bis(trifluoromethyl)quinolin-4-yl]ethanol
WR-308411	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2,2,2-trifluoroethylamino)ethanol
WR-308412	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-methoxyethylamino)ethanol
WR-308413	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(4-methylpentan-2-ylamino)ethanol
WR-308437	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-ethyl-4-methylimidazol-1-yl)ethanol
WR-308442	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(hexylamino)ethanol
WR-308446	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-[(4,6,6-trimethyl-3-bicyclo[3.1.1]heptanyl)amino]ethanol
WR-308607	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-methylpropylamino)ethanol
WR-308621	[2,8-bis(trifluoromethyl)quinolin-4-yl]-[[(2R)-pyrrolidin-2-yl]methylamino]methanol
WR-308622	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(3-methoxypropylamino)ethanol
WR-308623	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-propylimidazol-1-yl)ethanol
WR-308626	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-propan-2-ylimidazol-1-yl)ethanol
WR-308632	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-butylsulfanylethanol
WR-308633	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-butoxyethanol
WR-308653	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]heptan-1-ol

WR-308763	1-[2,8-bis(trifluoromethyl)quinolin-4-yl]-2-(2-methylbenzimidazol-1-yl)ethanol
WR-308764	2-(benzimidazol-1-yl)-1-[2,8-bis(trifluoromethyl)quinolin-4-yl]ethanol
WR-319535	[[[(1S,4R)-2-azabicyclo[2.2.1]heptan-4-yl]methylamino]-[2,8-bis(trifluoromethyl)quinolin-4-yl]methanol
WR-319581	2-[[[(1R,4S)-2-azabicyclo[2.2.1]heptan-4-yl]methylamino]-1-[2,8-bis(trifluoromethyl)quinolin-4-yl]ethanol

Table 2. Exemplary PI-3K Inhibitors

GDC-0941	4-[2-(1H-indazol-4-yl)-6-[(4-methylsulfonylpiperazin-1-yl)methyl]thieno[3,2-d]pyrimidin-4-yl]morpholine
NVP-BKM120	5-(2,6-dimorpholin-4-ylpyrimidin-4-yl)-4-(trifluoromethyl)pyridin-2-amine
PX-866	[(3aR,6E,9S,9aR,10R,11aS)-6-[[bis(prop-2-enyl)amino]methylidene]-5-hydroxy-9-(methoxymethyl)-9a,11a-dimethyl-1,4,7-trioxo-2,3,3a,9,10,11-hexahydroindeno[4,5-h]isochromen-10-yl] acetate
GDC-0032	2-methyl-2-[4-[2-(5-methyl-2-propan-2-yl-1,2,4-triazol-3-yl)-5,6-dihydroimidazo[1,2-d][1,4]benzoxazepin-9-yl]pyrazol-1-yl]propanamide
GSK2636771	2-methyl-1-[[2-methyl-3-(trifluoromethyl)phenyl]methyl]-6-morpholin-4-ylbenzimidazole-4-carboxylic acid
IPI-145	8-chloro-2-phenyl-3-[(1S)-1-(7H-purin-6-ylamino)ethyl]isoquinolin-1-one
CAL-101 (GS-1101)	5-fluoro-3-phenyl-2-[(1S)-1-(7H-purin-6-ylamino)propyl]quinazolin-4-one
LY294002	2-morpholin-4-yl-8-phenylchromen-4-one
Wortmannin	(1S,6bR,9aS,11R,11bR)-9a,11b-dimethyl-1-[(methyloxy)methyl]-3,6,9-trioxo-1,6,6b,7,8,9,9a,10,11,11b-decahydro-3H-furo[4,3,2-de]indeno[4,5-h]isochromen-11-yl acetate
Demethoxyviridin	(1R,11bR)-1-Hydroxy-11b-methyl-1,7,8,11b-tetrahydrocyclopenta[7,8]phenanthro[10,1-bc]furan-3,6,9(2H)-trione

XL-147	2-amino-N-[3-[[3-(2-chloro-5-methoxyanilino)quinoxalin-2-yl]sulfamoyl]phenyl]-2-methylpropanamide
BAY80-6946	2-amino-N-[7-methoxy-8-(3-morpholin-4-ylpropoxy)-2,3-dihydroimidazo[1,2-c]quinazolin-5-yl]pyrimidine-5-carboxamide
ZSTK474	4-[4-[2-(difluoromethyl)benzimidazol-1-yl]-6-morpholin-4-yl-1,3,5-triazin-2-yl]morpholine
BYL719	(2S)-1-N-[4-methyl-5-[2-(1,1,1-trifluoro-2-methylpropan-2-yl)pyridin-4-yl]-1,3-thiazol-2-yl]pyrrolidine-1,2-dicarboxamide
MLN01117 (INK-1117)	
SAR260301	(S)-2-(2-(2-methylindolin-1-yl)-2-oxoethyl)-6-morpholinopyrimidin-4(3H)-one
AMG319	(S)-N-(1-(7-Fluoro-2-(pyridin-2-yl)quinolin-3-yl)ethyl)-9H-purin-6-amine
TGR-1202 (RP6530)	
IC87114	2-[(6-aminopurin-9-yl)methyl]-5-methyl-3-(2-methylphenyl)quinazolin-4-one
TG-100-115	3-[2,4-diamino-7-(3-hydroxyphenyl)pteridin-6-yl]phenol
CUDC-907	N-hydroxy-2-[[2-(6-methoxypyridin-3-yl)-4-morpholin-4-yl]thieno[3,2-d]pyrimidin-6-yl]methyl-

	methylamino]pyrimidine-5-carboxamide
AEZS-136	
NVP-BAG956	2-methyl-2-[4-[2-methyl-8-(2-pyridin-3-ylethynyl)imidazo[4,5-c]quinolin-1-yl]phenyl]propanenitrile
PIK-75	N-[(E)-(6-bromoimidazo[1,2-a]pyridin-3-yl)methylideneamino]-N,2-dimethyl-5-nitrobenzenesulfonamide;hydrochloride
PIK-90	N-(7,8-dimethoxy-2,3-dihydroimidazo[1,2-c]quinazolin-5-yl)pyridine-3-carboxamide
TGX-221	9-(1-anilinoethyl)-7-methyl-2-morpholin-4-ylpyrido[1,2-a]pyrimidin-4-one
AS-252424	5-[5-(4-fluoro-2-hydroxy-phenyl)-furan-2-ylmethylene]-thiazolidine-2,4-dione
D-106669	1-ethyl-3-[3-(4-methylanilino)pyrido[2,3-b]pyrazin-6-yl]urea
A-66	(2S)-N1-[2-(1,1-Dimethylethyl)-4'-methyl[4,5'-bithiazol]-2'-yl]-1,2-pyrrolidinedicarboxamide
BN108	The solution containing 0.5 mg/mL of dried extract of <i>Anemarrhena asphodeloides</i> Bunge is also referred to herein as BN108. Active ingredient in BN108 is Timosaponin A3
Timosaponin A3	(2S,3R,4S,5S,6R)-2-[(2R,3R,4S,5R,6R)-4,5-dihydroxy-6-(hydroxymethyl)-2-[(1'R,2'S,3R,4'S,7'S,8'R,9'S,12'S,13'S,16'S,18'R)-6,7',9',13'-tetramethyl-5'-oxaspiro[oxane-3,6'-pentacyclo[10.8.0.0 ^{2,9} .0 ^{4,8} .0 ^{13,18}]icosane]oxy]oxan-3-yl]oxy}-6-(hydroxymethyl)oxane-3,4,5-triol

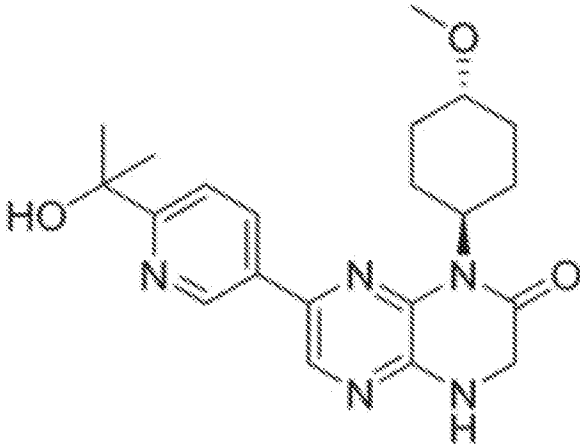
Table 3. Exemplary AKT inhibitors

MK-2206	8-[4-(1-aminocyclobutyl)phenyl]-9-phenyl-2H-[1,2,4]triazolo[3,4-f][1,6]naphthyridin-3-one; dihydrochloride
Triciribine	(2R,3R,4S,5R)-2-(3-amino-5-methyl-1,4,5,6,8-pentaazaacenaphthylen-1(5H)-yl)-5-(hydroxymethyl)tetrahydrofuran-3,4-diol.
Triciribine-Phosphate	1-(5-O-Phosphono-β-D-ribofuranosyl)-5-methyl-1,5-dihydro-1,4,5,6,8-pentaazaacenaphthylene-3-

	amine; 1,4,5,6,8-Pentaazaacenaphthylene-3-amino-1,5-dihydro-5-methyl-1-beta-D-ribofuranosyl 5'-monophosphate
Miltefosine	2-(hexadecoxy-oxido-phosphoryl)oxyethyl-trimethyl-azanium
Perifosine (KRX-0401)	(1,1-dimethylpiperidin-1-ium-4-yl) octadecyl phosphate
RX-0201	This is an antisense oligonucleotide having the following sequence: 5' gctgcatgatctccttgcg 3'
Erucylphosphocholine	[(Z)-docos-13-enyl] 2-(trimethylazaniumyl)ethyl phosphate
PBI-05204	[(3S,5R,8R,9S,10S,13R,14S,16S,17R)-14-hydroxy-3-[(2R,4S,5S,6S)-5-hydroxy-4-methoxy-6-methyloxan-2-yl]oxy-10,13-dimethyl-17-(5-oxo-2H-furan-3-yl)-1,2,3,4,5,6,7,8,9,11,12,15,16,17-tetradecahydrocyclopenta[a]phenanthren-16-yl] acetate
GSK690693	4-[2-(4-amino-1,2,5-oxadiazol-3-yl)-1-ethyl-7-[[[(3S)-piperidin-3-yl]methoxy]imidazo[4,5-c]pyridin-4-yl]-2-methylbut-3-yn-2-ol
XL-418	1-[3-[4-(3-bromo-2H-pyrazolo[3,4-d]pyrimidin-4-yl)piperazin-1-yl]-4-methyl-5-(2-pyrrolidin-1-ylethylamino)phenyl]-4,4,4-trifluorobutan-1-one
GDC-0068	(2S)-2-(4-chlorophenyl)-1-[4-[(5R,7R)-7-hydroxy-5-methyl-6,7-dihydro-5H-cyclopenta[d]pyrimidin-4-yl]piperazin-1-yl]-3-(propan-2-ylamino)propan-1-one
GSK2110183	N-[(2S)-1-amino-3-(3,4-difluorophenyl)propan-2-yl]-5-chloro-4-(4-chloro-2-methylpyrazol-3-yl)thiophene-2-carboxamide
GSK2141795	N-[(2S)-1-amino-3-(3,4-difluorophenyl)propan-2-yl]-5-chloro-4-(4-chloro-2-methylpyrazol-3-yl)furan-2-carboxamide
ARQ-092	
AZD5363	(S)-4-amino-N-(1-(4-chlorophenyl)-3-hydroxypropyl)-1-(7H-pyrrolo[2,3-d]pyrimidin-4-yl)piperidine-4-carboxamide

Table 4. mTOR Inhibitors

Sirolimus (Rapamycin)	(1R,9S,12S,15R,16E,18R,19R,21R,23S,24E,26E,28E,30S,32S,35R)-1,18-dihydroxy-12-[(2S)-1-[(1S,3R,4R)-4-hydroxy-3-methoxycyclohexyl]propan-2-yl]-19,30-dimethoxy-15,17,21,23,29,35-hexamethyl-11,36-dioxo-4-azatricyclo[30.3.1.0 ^{4,9}]hexatriaconta-16,24,26,28-tetraene-2,3,10,14,20-pentone
Everolimus	(1S,9R,15R,16E,18R,19R,21S,23R,24E,26E,28E,30S,32R,35S)-1,18-dihydroxy-12-[(2S)-1-[(1S,3R,4R)-4-(2-hydroxyethoxy)-3-methoxycyclohexyl]propan-2-yl]-19,30-dimethoxy-15,17,21,23,29,35-hexamethyl-11,36-dioxo-4-azatricyclo[30.3.1.0 ^{4,9}]hexatriaconta-16,24,26,28-tetraene-2,3,10,14,20-pentone
Tacrolimus	(1R,9S,12S,13R,14S,17R,18E,21S,23S,24R,25S,27R)-1,14-dihydroxy-12-[(1E)-1-[(1R,3R,4R)-4-hydroxy-3-methoxycyclohexyl]prop-1-en-2-yl]-23,25-dimethoxy-13,19,21,27-tetramethyl-17-(prop-2-en-1-yl)-11,28-dioxo-4-azatricyclo[22.3.1.0 ^{4,9}]octacos-18-ene-2,3,10,16-tetrone
Temsirolimus	(1R,2R,4S)-4-[(2R)-2-[(1R,9S,12S,15R,16E,18R,19R,21R,23S,24E,26E,28E,30S,32S,35R)-1,18-dihydroxy-19,30-dimethoxy-15,17,21,23,29,35-hexamethyl-2,3,10,14,20-pentaoxo-11,36-dioxo-4-azatricyclo[30.3.1.0 ^{4,9}]hexatriaconta-16,24,26,28-tetraen-12-yl]propyl]-2-methoxycyclohexyl 3-hydroxy-2-(hydroxymethyl)-2-methylpropanoate
Deforolimus or Ridaforolimus	(1R,2R,4S)-4-[(2R)-2-[(1R,9S,12S,15R,16E,18R,19R,21R,23S,24E,26E,28Z,30S,32S,35R)-1,18-dihydroxy-19,30-dimethoxy-15,17,21,23,29,35-hexamethyl-2,3,10,14,20-pentaoxo-11,36-dioxo-4-azatricyclo[30.3.1.0 ^{4,9}]hexatriaconta-16,24,26,28-tetraen-12-yl]propyl]-2-methoxycyclohexyl dimethylphosphinate
AZD2014	3-[2,4-bis[(3S)-3-methylmorpholin-4-yl]pyrido[2,3-d]pyrimidin-7-yl]-N-methylbenzamide
MLN-0128 (INK-128)	5-(4-amino-1-propan-2-ylpyrazolo[3,4-d]pyrimidin-3-yl)-1,3-benzoxazol-2-amine

CC-223	
Palomid 529	8-(1-hydroxyethyl)-2-methoxy-3-((4-methoxybenzyl)oxy)-6H-benzo[c]chromen-6-one
KU-0063794	[5-[2-[(2R,6S)-2,6-dimethylmorpholin-4-yl]-4-morpholin-4-ylpyrido[2,3-d]pyrimidin-7-yl]-2-methoxyphenyl]methanol
Torin-1	1-[4-(4-propanoylpiperazin-1-yl)-3-(trifluoromethyl)phenyl]-9-quinolin-3-ylbenzo[h][1,6]naphthyridin-2-one
Torin-2	9-(6-aminopyridin-3-yl)-1-[3-(trifluoromethyl)phenyl]benzo[h][1,6]naphthyridin-2-one
DUAL PI-3K/mTOR Inhibitors	
NVP-BEZ235	2-methyl-2-[4-(3-methyl-2-oxo-8-quinolin-3-ylimidazo[4,5-c]quinolin-1-yl)phenyl]propanenitrile
NVP-BBD130	2-methyl-2-(4-(3-methyl-2-oxo-8-(2-(pyridin-3-yl)ethynyl)-2,3-dihydroimidazo[4,5-c]quinolin-1-yl)phenyl)propanenitrile
NVP-BGT226	(Z)-but-2-enedioic acid;8-(6-methoxypyridin-3-yl)-3-methyl-1-[4-piperazin-1-yl]-3-(trifluoromethyl)phenyl]imidazo[4,5-c]quinolin-2-one
LY3023414	Identified in US20140377258 without providing structure or IUPAC name.
GDC-0890	

PF-05212384 (PKI-587)	1-[4-[4-(dimethylamino)piperidine-1-carbonyl]phenyl]-3-[4-(4,6-dimorpholin-4-yl-1,3,5-triazin-2-yl)phenyl]urea
XL-765	N-[4-[[3-(3,5-dimethoxyanilino)quinoxalin-2-yl]sulfamoyl]phenyl]-3-methoxy-4-methylbenzamide
GSK2126458	2,4-difluoro-N-[2-methoxy-5-(4-pyridazin-4-ylquinolin-6-yl)pyridin-3-yl]benzenesulfonamide
PWT33597 (VCD-597)	
PI-103	3-(4-morpholin-4-ylpyrido[2,3]furo[2,4-b]pyrimidin-2-yl)phenol
GNE-477	5-[7-methyl-6-[(4-methylsulfonylpiperazin-1-yl)methyl]-4-morpholin-4-ylthieno[3,2-d]pyrimidin-2-yl]pyrimidin-2-amine
SF-1126	L-Serine, N2-(1,4-dioxo-4-((4-(4-oxo-8-phenyl-4H-1-benzopyran-2-yl)morpholinium-4-yl)methoxy)butyl)-L-arginylglycyl-L-alpha-aspartyl-, inner salt
GSK1059615	(5Z)-5-[(4-pyridin-4-ylquinolin-6-yl)methylidene]-1,3-thiazolidine-2,4-dione
PF-04691502	2-amino-8-[4-(2-hydroxyethoxy)cyclohexyl]-6-(6-methoxypyridin-3-yl)-4-methylpyrido[2,3-d]pyrimidin-7-one

It should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and the scope of the appended claims. In addition, any elements or limitations of any invention or embodiment thereof disclosed herein can be combined with any and/or all other elements or limitations (individually or in any combination) or any other invention or embodiment thereof disclosed herein, and all such combinations are contemplated within the scope of the invention without limitation thereto.

CLAIMS

We claim:

1. A method of treating cancer comprising the administration of a composition comprising one or more 4-quinolinemethanols and:
 - a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
 - b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);
 - c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTORMTOR); or
 - d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTORMTOR.
2. The method according to claim 1, wherein said 4-quinolinemethanol is selected from Table 1, said PI-3K inhibitor is selected from Table 2, said AKT inhibitor is selected from Table 3 and said mTOR inhibitor is selected from Table 4.
3. The method according to any one of claims 1-2, wherein one or more 4-quinolinemethanols and one or more PI-3K inhibitors are co-administered.
4. The method according to claim 3, wherein one or more 4-quinolinemethanols and one or more PI-3K inhibitors are administered simultaneously or sequentially.
5. The method according to claim 3, wherein one or more 4-quinolinemethanols and one or more PI-3K inhibitors are co-administered as a single composition.
6. The method according to any one of claims 1-2, wherein one or more 4-quinolinemethanols and one or more AKT inhibitors are co-administered.
7. The method according to claim 6, wherein one or more 4-quinolinemethanols and one or more AKT inhibitors are administered simultaneously or sequentially.

8. The method according to claim 6, wherein one or more 4-quinolinemethanols and one or more AKT inhibitors are co-administered as a single composition.

9. The method according to any one of claims 1-2, wherein one or more 4-quinolinemethanols and one or more mTOR inhibitors are co-administered.

10. The method according to claim 9, wherein one or more 4-quinolinemethanols and one or more AKT inhibitors are administered simultaneously or sequentially.

11. The method according to claim 9, wherein one or more 4-quinolinemethanols and one or more AKT inhibitors are co-administered as a single composition.

12. The method according to claims 1-5, wherein one or more 4-quinolinemethanols (4QM) and one or more PI-3K inhibitors are administered at a ratio (4QM:PI-K3I) of between 600:1 and 17.5:1.

13. The method according to claims 1-2 or 6-8, wherein one or more 4-quinolinemethanols (4QM) and one or more AKT inhibitors (AKTI) are administered at a ratio (4QM:AKTI) of between 0.33:1 and 3:1.

14. The method according to claims 1-2 or 9-11, wherein wherein one or more 4-quinolinemethanols (4QM) and one or more mTOR inhibitors (mTORI) are administered at a ratio (4QM:mTORI) of between 1000:1 and 17.5:1.

15. The method according to claims 1-11, said method comprising the co-administration of a synergistically effective amount of one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine-threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or

d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR.

16. The method according to claim 15, wherein said synergistically effective amount being subtherapeutic levels of one or more 4-quinolinemethanols and:

a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);

b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);

c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or

d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR.

17. The method according to any one of claims 1-16, wherein said cancer is selected from: Cancers suitable for treatment according to the disclosed methods include, but are not limited to: Acanthoma, Acinic cell carcinoma, Acoustic neuroma, Acral lentiginous melanoma, Acrospiroma, Acute eosinophilic leukemia, Acute lymphoblastic leukemia, Acute megakaryoblastic leukemia, Acute monocytic leukemia, Acute myeloblastic leukemia with maturation, Acute myeloid dendritic cell leukemia, Acute myeloid leukemia, Acute promyelocytic leukemia, Adamantinoma, Adenocarcinoma, Adenoid cystic carcinoma, Adenoma, Adenomatoid odontogenic tumor, Adrenocortical carcinoma, Adult T-cell leukemia, Aggressive NK-cell leukemia, AIDS-related cancers, AIDS-related lymphoma, Alveolar soft part sarcoma, Ameloblastic fibroma, Anal cancer, Anaplastic large cell lymphoma, Anaplastic thyroid cancer, Angioimmunoblastic T-cell lymphoma, Angiomyolipoma, Angiosarcoma, Appendix cancer, Astrocytoma, Atypical teratoid rhabdoid tumor, Basal cell carcinoma, Basal-like carcinoma, B-cell leukemia, B-cell lymphoma, Bellini duct carcinoma, Biliary tract cancer, Bladder cancer, Blastoma, Bone cancer, Bone tumor, Brain stem lioma, Brain tumor, Breast cancer, Brenner tumor, Bronchial tumor, Bronchioloalveolar carcinoma, Brown tumor, Burkitt's lymphoma, Cancer of unknown primary site, Carcinoid Tumor, Carcinoma, Carcinoma in situ, Carcinoma of the penis, Carcinoma of unknown primary site, Carcinosarcoma, Castleman's Disease, Central nervous system embryonal tumor, Cerebellar astrocytoma, Cerebral astrocytoma, Cervical cancer,

Cholangiocarcinoma, Chondroma, Chondrosarcoma, Chordoma, Choriocarcinoma, Choroid plexus papilloma, Chronic lymphocytic leukemia, Chronic monocytic leukemia, Chronic myelogenous leukemia, Chronic myeloproliferative disorder, Chronic neutrophilic leukemia, Clear-cell tumor, Colon cancer, Colorectal cancer, Craniopharyngioma, Cutaneous T-cell lymphoma, Degos disease, Dermatofibrosarcoma protuberans, Dermoid cyst, Desmoplastic small round cell tumor, Diffuse large B cell lymphoma, Dysembryoplastic neuroepithelial tumor, Embryonal carcinoma, Endodermal sinus tumor, Endometrial cancer, Endometrial uterine cancer, Endometrioid tumor, Enteropathy-associated T-cell lymphoma, Ependymblastoma, Ependymoma, Epithelioid sarcoma, Erythroleukemia, Esophageal cancer, Esthesioneuroblastoma, Ewing family of tumor, Ewing family sarcoma, Ewing's sarcoma, Extracranial germ cell tumor, Extragonadal germ cell tumor, Extrahepatic bile duct cancer, Extramammary Paget's disease, Fallopian tube cancer, Fetus in fetu, Fibroma, Fibrosarcoma, Follicular lymphoma, Follicular thyroid cancer, Gallbladder Cancer, Gallbladder cancer, Ganglioglioma, Ganglioneuroma, Gastric cancer, Gastric lymphoma, Gastrointestinal cancer, Gastrointestinal carcinoid tumor, Gastrointestinal stromal tumor, Gastrointestinal stromal tumor, Germ cell tumor, Germinoma, Gestational choriocarcinoma, Gestational trophoblastic tumor, Giant cell tumor of bone, Glioblastoma multiforme, Glioma, Gliomatosis cerebri, Glomus tumor, Glucagonoma, Gonadoblastoma, Granulosa cell tumor, Hairy Cell Leukemia, Hairy cell leukemia, Head and neck cancer, Heart cancer, Hemangioblastoma, Hemangiopericytoma, Hemangiosarcoma, Hematological malignancy, Hepatocellular carcinoma, Hepatosplenic T-cell lymphoma, Hereditary breast-ovarian cancer syndrome, Hodgkin's lymphoma, Hypopharyngeal cancer, Hypothalamic glioma, Inflammatory breast cancer, Intraocular melanoma, Islet cell carcinoma, Islet cell tumor, Juvenile myelomonocytic leukemia, Sarcoma, Kaposi's sarcoma, Kidney cancer, Klatskin tumor, Krukenberg tumor, Laryngeal cancer, Lentigo maligna melanoma, Leukemia, Leukemia, Lip and oral cavity cancer, Liposarcoma, Lung cancer, Luteoma, Lymphangioma, Lymphangiosarcoma, Lymphoepithelioma, Lymphoid leukemia, Lymphoma, Macroglobulinemia, Malignant fibrous histiocytoma, Malignant fibrous histiocytoma of bone, Malignant glioma, Malignant mesothelioma, Malignant peripheral nerve sheath tumor, Malignant rhabdoid tumor, Malignant triton tumor, MALT lymphoma, Mantle cell lymphoma, Mast cell leukemia, Mediastinal germ cell tumor, Mediastinal tumor, Medullary thyroid cancer, Medulloblastoma, Medulloepithelioma, Melanoma, Melanoma, Meningioma, Merkel Cell Carcinoma, Mesothelioma, Metastatic squamous neck cancer with occult

primary, Metastatic urothelial carcinoma, Mixed mullerian tumor, Monocytic leukemia, Mouth cancer, Mucinous tumor, Multiple endocrine neoplasia syndrome, Multiple myeloma, Mycosis fungoides, Myelodysplasia disease, Myelodysplasia syndromes, Myeloid leukemia, Myeloid sarcoma, Myeloproliferative disease, Myxoma, nasal cavity cancer, Nasopharyngeal cancer, Nasopharyngeal carcinoma, Neoplasm, Neurinoma, Neuroblastoma, Neuroblastoma, Neurofibroma, Neuroma, Nodular melanoma, Non-Hodgkin's lymphoma, Nonmelanoma skin cancer, Non-small cell lung cancer, Ocular oncology, Oligoastrocytoma, Oligodendroglioma, Oncocytoma, Optic nerve sheath meningioma, Oral cancer, Oropharyngeal cancer, Osteosarcoma, Osteosarcoma, Ovarian cancer, Ovarian epithelial cancer, Ovarian germ cell tumor, Ovarian low malignant potential tumor, Paget's disease of the breast, Pancoast tumor, Pancreatic cancer, Papillary thyroid cancer, Papillomatosis, Paraganglioma, Paranasal sinus cancer, Parathyroid cancer, Penile cancer, Perivascular epithelioid cell tumor, Pharyngeal cancer, Pheochromocytoma, Pineal parenchymal tumor of intermediate differentiation, Pineoblastoma, Pituicytoma, Pituitary adenoma, Pituitary tumor, Plasma cell neoplasm, Pleuropulmonary blastoma, Polyembryoma, precursor T-lymphoblastic lymphoma, Primary central nervous system lymphoma, Primary effusion lymphoma, Primary hepatocellular cancer, Primary liver cancer, Primary peritoneal cancer, Primitive neuroectodermal tumor, Prostate cancer, Pseudomyxoma peritonei, Rectal cancer, Renal cell carcinoma, Respiratory tract carcinoma involving the NUT gene on chromosome 15, Retinoblastoma, Rhabdomyoma, Rhabdomyosarcoma, Richter's transformation, Sacrococcygeal teratoma, Salivary gland cancer, Sarcoma, Schwannomatosis, Sebaceous gland carcinoma, Secondary neoplasm, Seminoma, Serous tumor, Sertoli-Leydig cell tumor, Sex cord-stromal tumor, Sezary Syndrome, Signet ring cell carcinoma, Skin cancer, Small blue round cell tumor, Small cell carcinoma, Small cell lung cancer, Small cell lymphoma, Small intestine cancer, Soft tissue sarcoma, Somatostatinoma, Soot wart, Spinal cord tumor, Spinal tumor, Splenic marginal zone lymphoma, Squamous cell carcinoma, Stomach cancer, Superficial spreading melanoma, Supratentorial primitive neuroectodermal Tumor, Surface epithelial-stromal tumor, Synovial sarcoma, T-cell acute lymphoblastic leukemia, T-cell large granular lymphocyte leukemia, T-cell leukemia, T-cell lymphoma, T-cell prolymphocytic leukemia, Teratoma, Terminal lymphatic cancer, Testicular cancer, Thecoma, Throat cancer, Thymic carcinoma, Thymoma, Thyroid cancer, Transitional Cell Cancer of renal pelvis and ureter, Transitional cell carcinoma, Urachal cancer, Urethral cancer, Urogenital neoplasm, Uterine sarcoma, Uveal melanoma, Vaginal cancer, Verner-Morrison syndrome, Verrucous

carcinoma, Visual pathway glioma, Vulvar cancer, Waldenstrom's macroglobulinemia, Warthin's tumor, Wilms' tumor, or any combinations thereof.

18. The method according to claim 17, wherein said cancer is selected from the group consisting of non-small cell lung cancer, small cell lung cancer, head and neck squamous cell carcinoma, pancreatic cancer, breast cancer, ovarian cancer, renal cell carcinoma, prostate cancer, neuroendocrine cancer, gastric cancer, bladder cancer, glioma, astrocytoma, glioblastoma multiforme, colon cancer and endometrial cancer.

19. A composition comprising one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine-threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or
- d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR.

20. The composition according to claim 19, wherein one or more 4-quinolinemethanols (4QM) and one or more PI-3K inhibitors are administered at a ratio (4QM:PI-3K) of between 600:1 and 17.5:1.

21. The composition according to claim 19, wherein wherein one or more 4-quinolinemethanols (4QM) and one or more AKT inhibitors (AKTI) are administered at a ratio (4QM:AKTI) of between 0.33:1 and 3:1.

22. The composition according to claim 19, wherein wherein one or more 4-quinolinemethanols (4QM) and one or more mTOR inhibitors (mTORI) are administered at a ratio (4QM:mTORI) of between 1000:1 and 17.5:1.

23. The composition according to claims 19-22, said composition comprising subtherapeutic amounts of one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or
- d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR.

24. The composition according to claim 23, wherein said one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or
- d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR are compounds selected from Tables 1-4.

25. The composition according to claim 24, wherein said composition comprises mefloquine and everolimus, mefloquine and MK-2206, or mefloquine and BEZ-235.

26. The method according to any one of claims 1-18, wherein said one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or
- d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR are compounds selected from Tables 1-4.

27. The method according to claim 26, wherein said composition comprises mefloquine and everolimus, mefloquine and MK-2206, or mefloquine and BEZ-235.

28. The method according to claim 1, said method comprising the co-administration of a synergistically effective amount of one or more 4-quinolinemethanols and:

- a) one or more agents that inhibit the activity of Phosphoinositide-3-kinase (PI-3K);
- b) one or more agents that inhibit the activity of serine–threonine protein kinase B (AKT);
- c) one or more agents that inhibit the activity of mammalian target of rapamycin (mTOR); or
- d) any combination of one or more agents that inhibit the activity of PI-3K, AKT and mTOR.

I. Compound P + Everolimus (mTOR inhibitor)	II. Compound P + MK-2206 (AKT inhibitor)	III. Compound P + BEZ235 (Dual PI-3K/mTOR inhibitor)
1. MiaPaCa-2 a. Ratio M 12μM P: 0.1μM E b. Ratio A 7.7μM P: 0.1μM E c. Ratio B 3.5μM P: 0.1μM E	1. MiaPaCa-2 a. Ratio M 12μM P: 8μM MK b. Ratio A 3.5μM P: 4μM MK 2. Panc-1 a. Ratio M 12μM P: 8μM MK b. Ratio A 3.0μM P: 9μM MK 3. T182 a. Ratio M 12μM P: 8μM MK 4. E549 a. Ratio M 12μM P: 8μM MK	1. MiaPaCa-2 a. Ratio M 12μM P: 0.2 BEZ b. Ratio A 3.5μM P: 0.02 BEZ c. Ratio B 3.5μM P: 0.2 BEZ 2. Panc-1 a. Ratio M 12μM P: 0.2 BEZ b. Ratio A 4.6μM P: 0.06 BEZ c. Ratio B 4.6 μM P: 0.2 BEZ 3. T182 a. Ratio M 12μM P: 0.2 BEZ 4. E549 a. Ratio M 12μM P: 0.2 BEZ

Figure 1

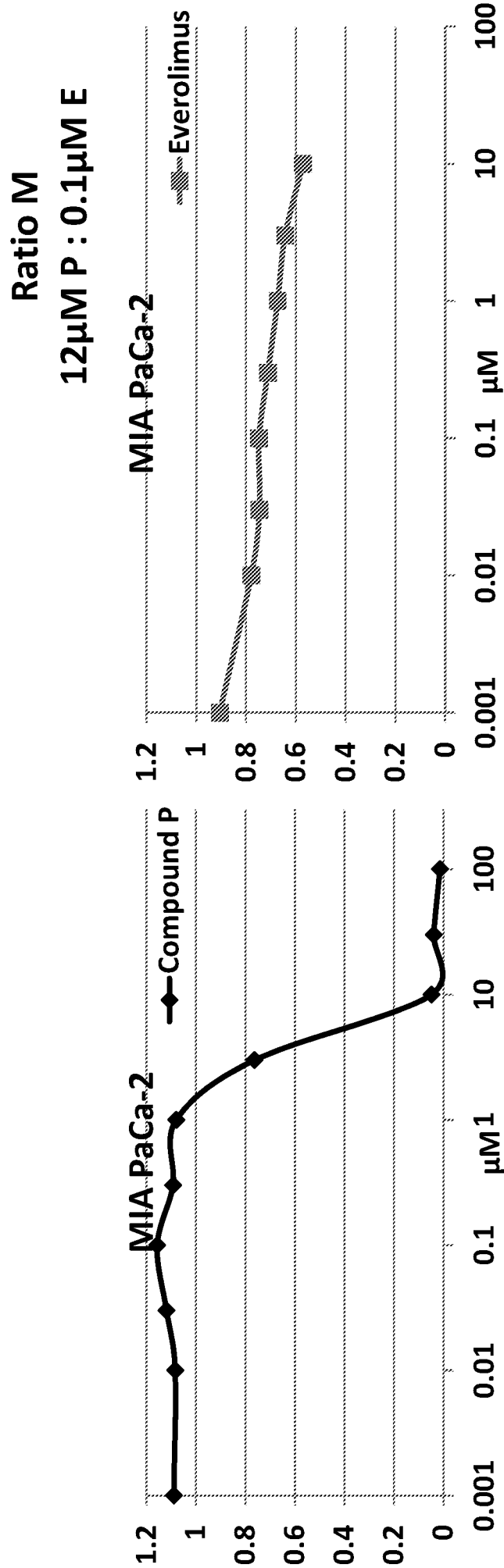


Figure 2

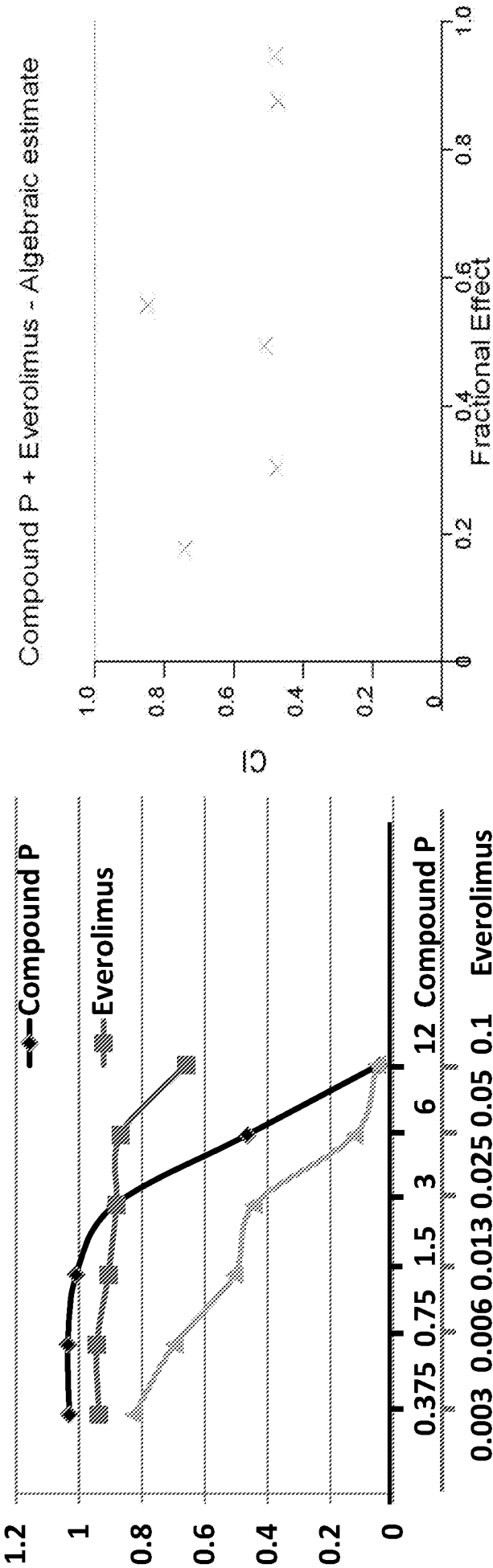


Figure 2 (continued)

Ratio A
7.7μM P : 0.1μM E

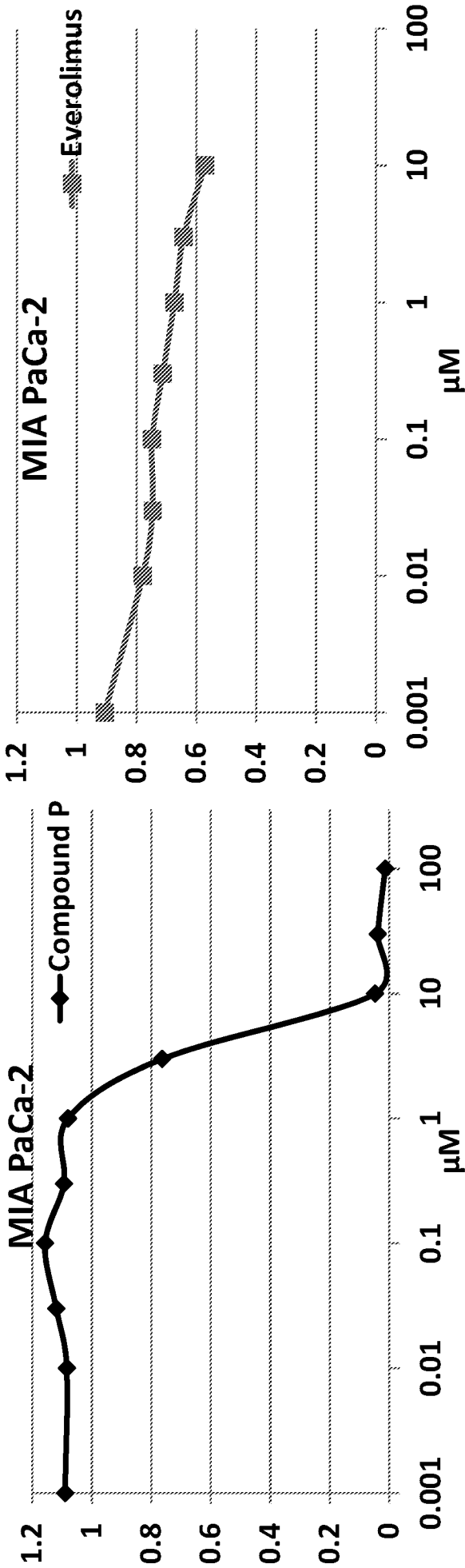


Figure 3

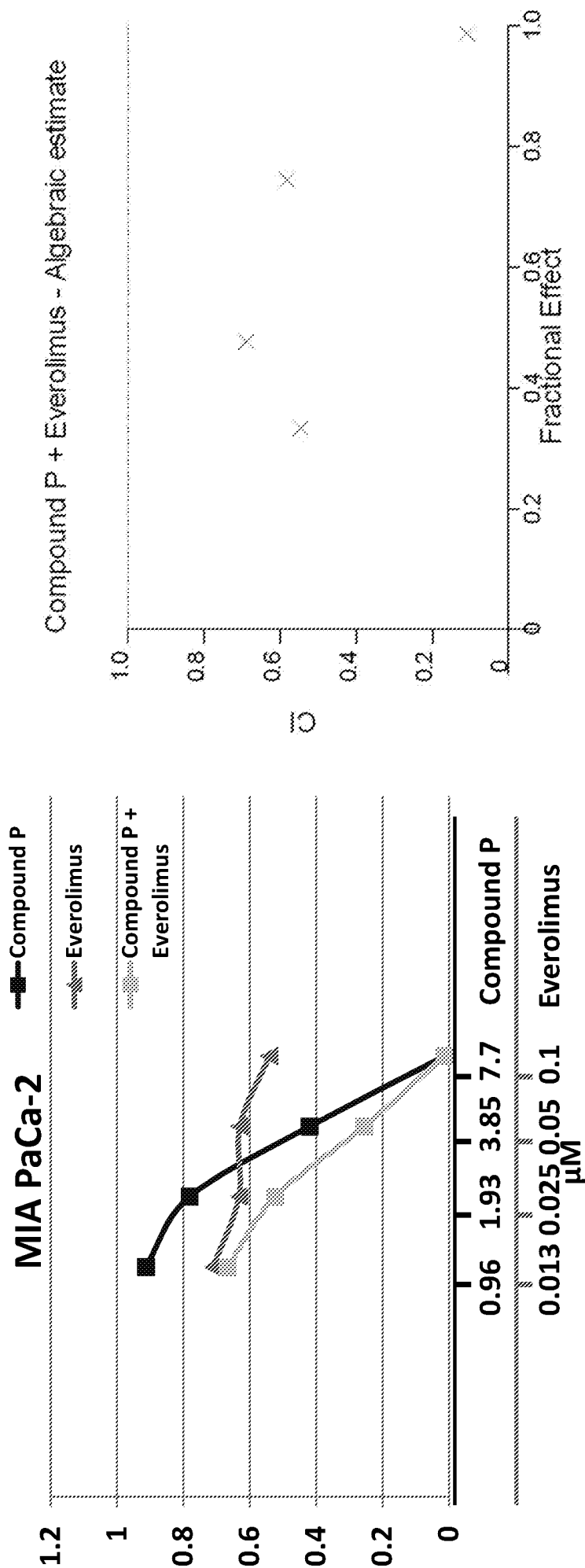


Figure 3 (continued)

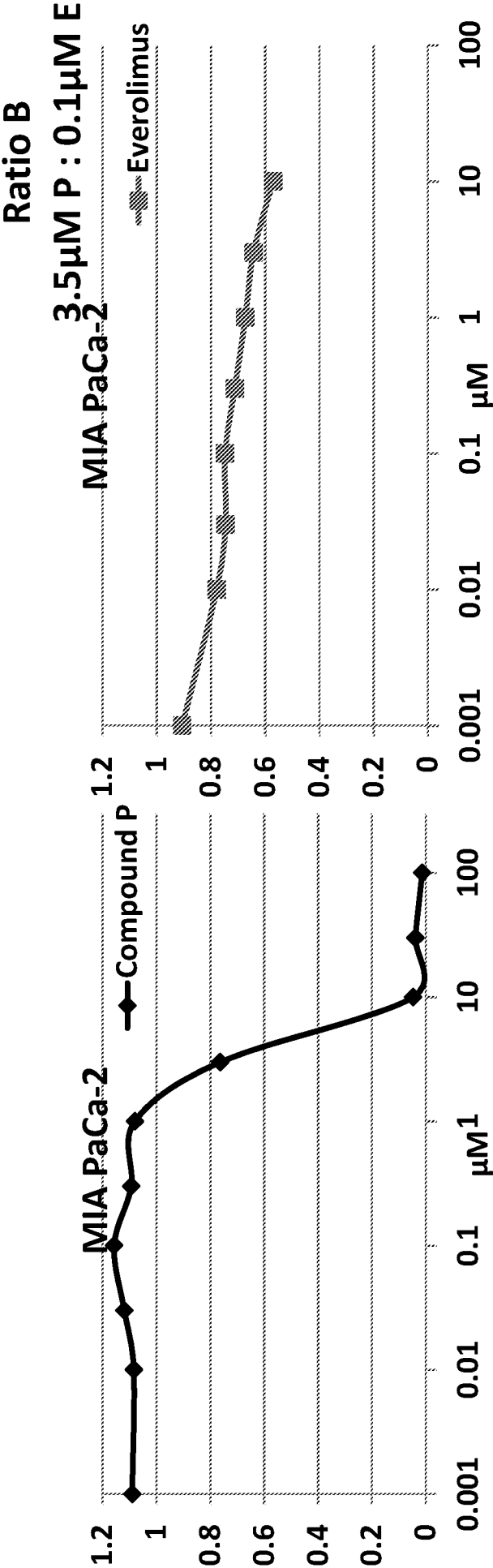


Figure 4

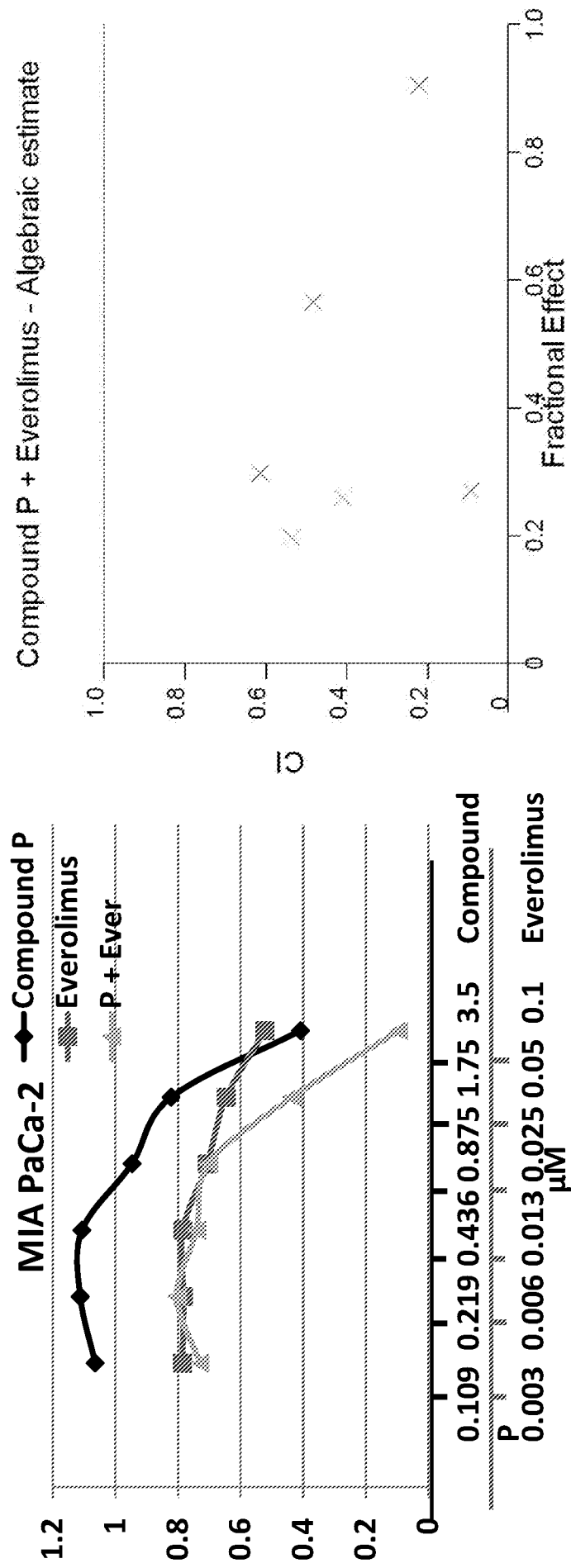


Figure 4 (continued)

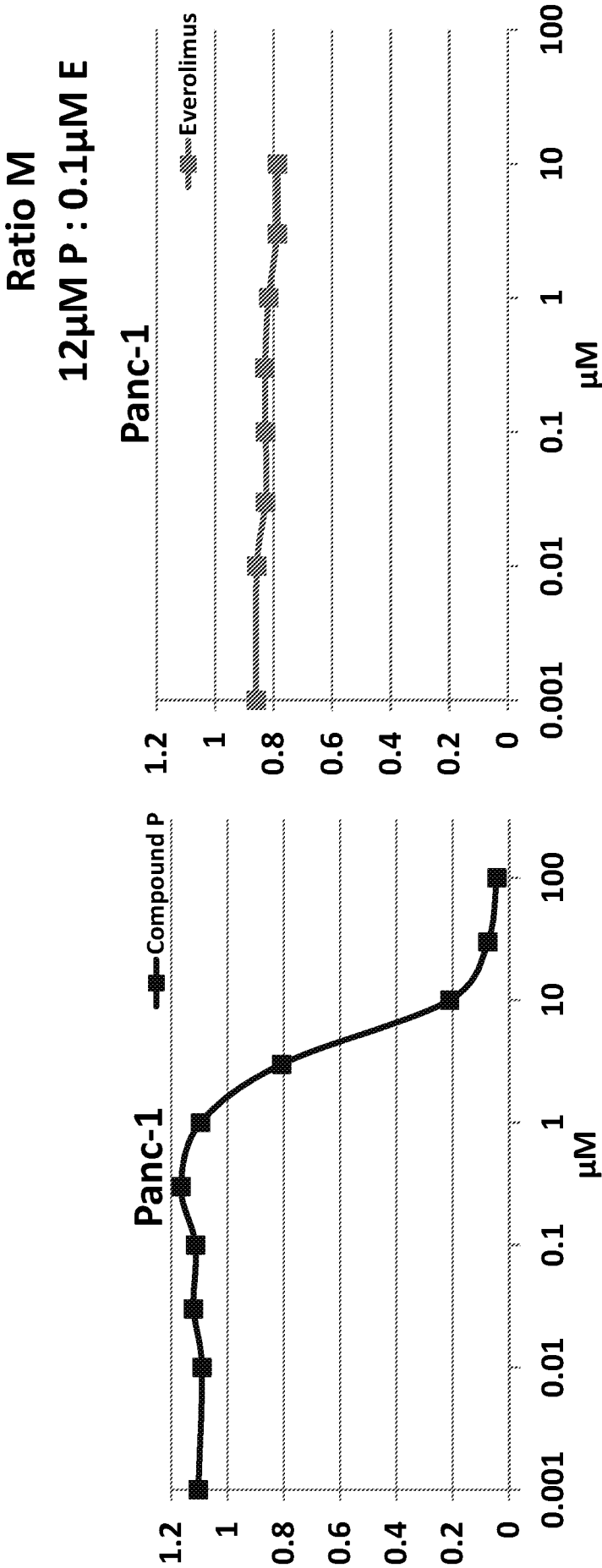


Figure 5

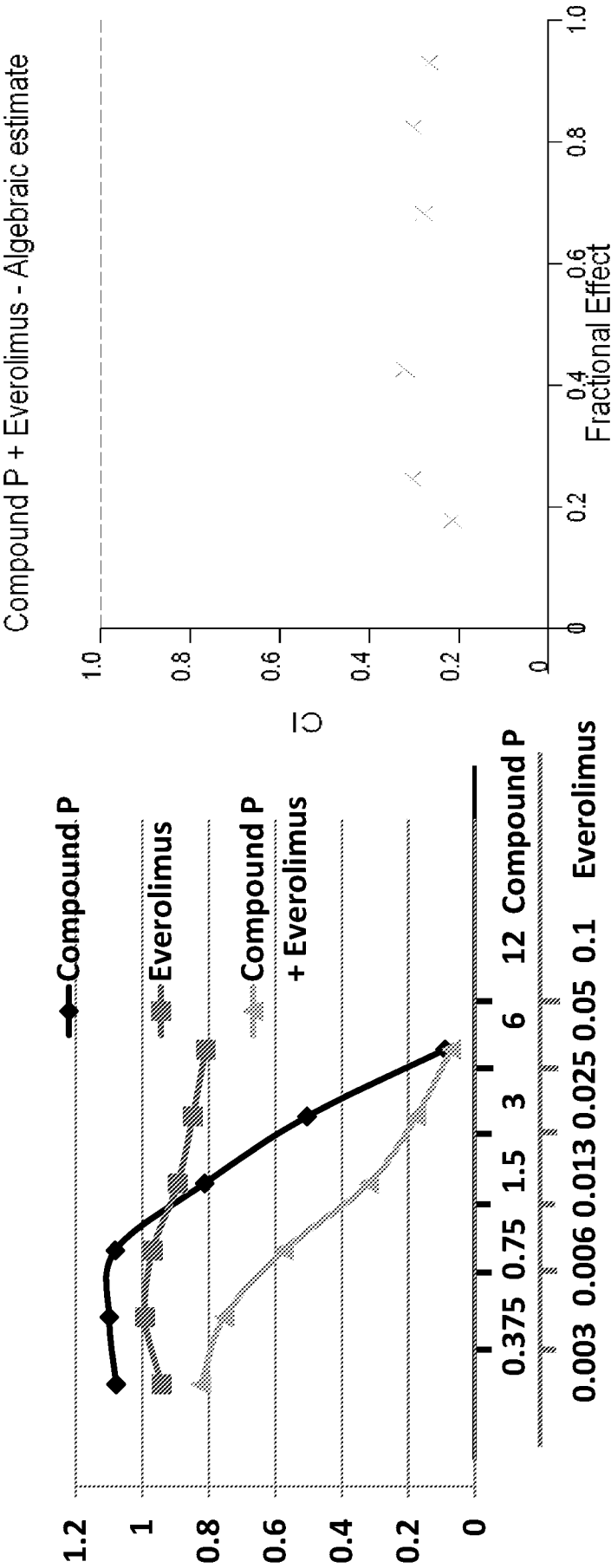


Figure 5 (continued)

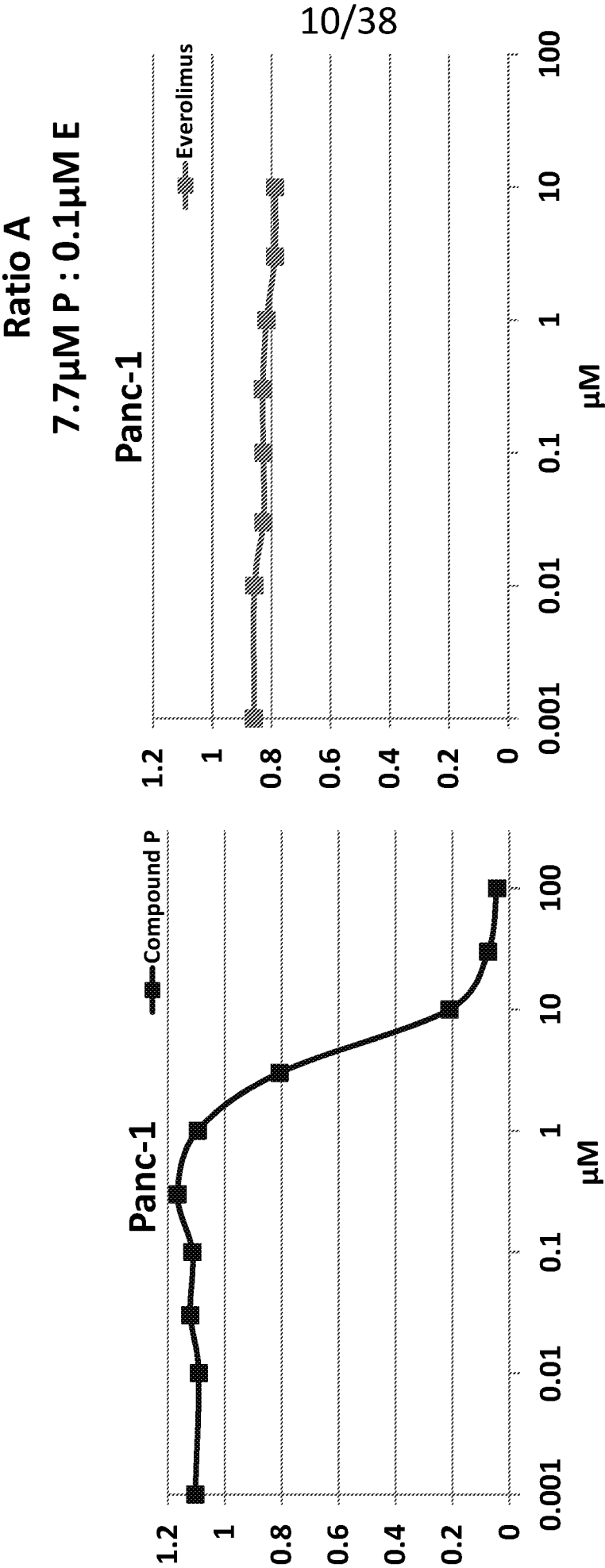


Figure 6

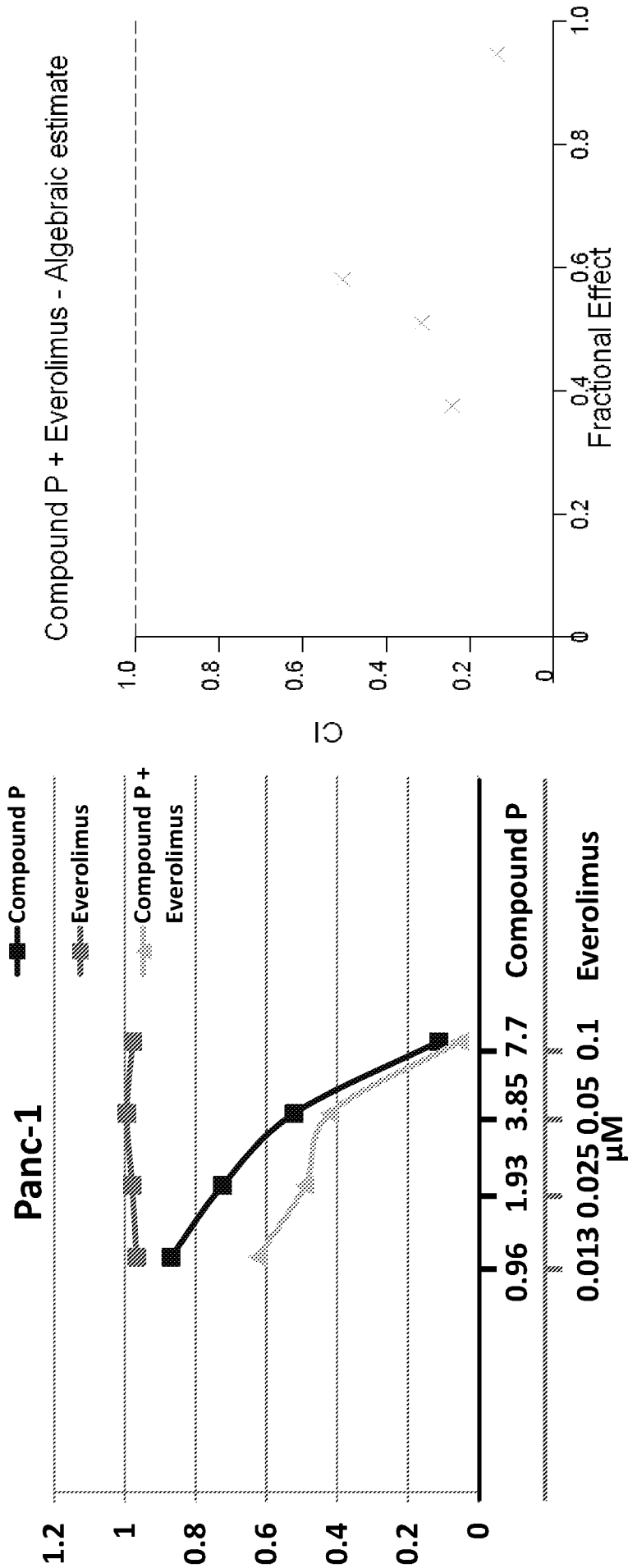


Figure 6 (continued)

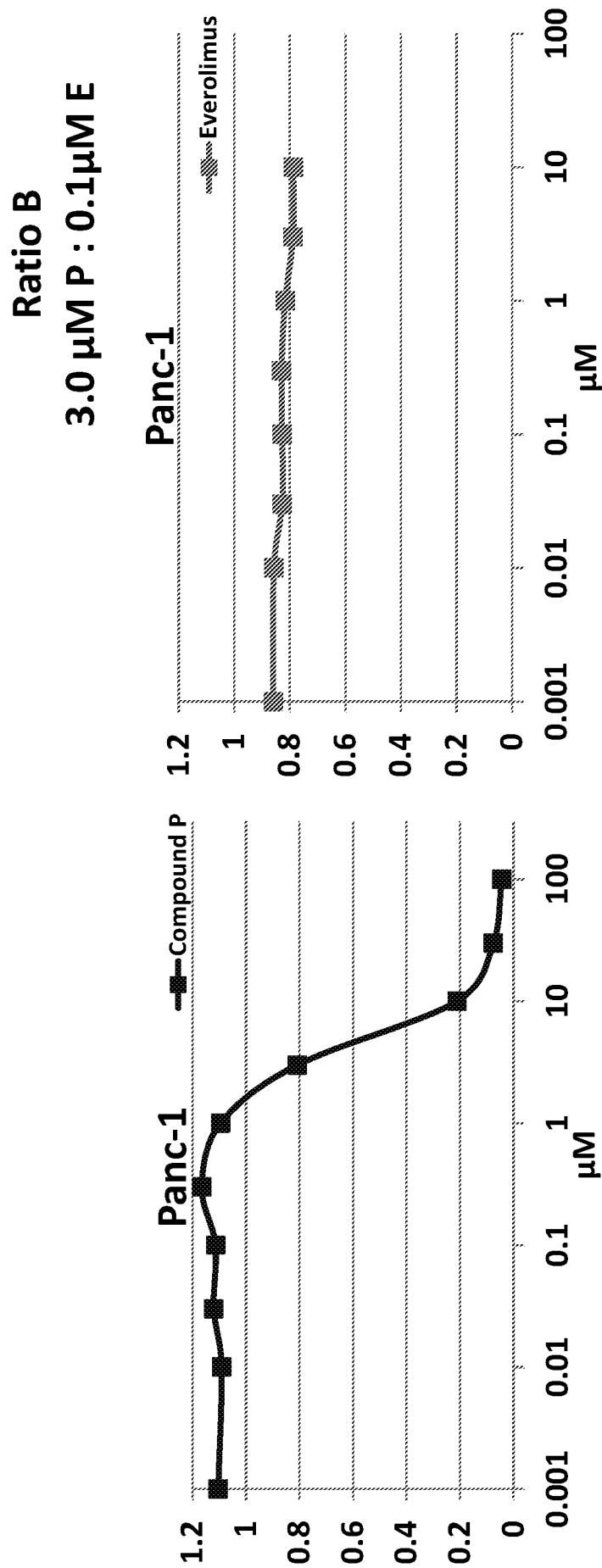


Figure 7

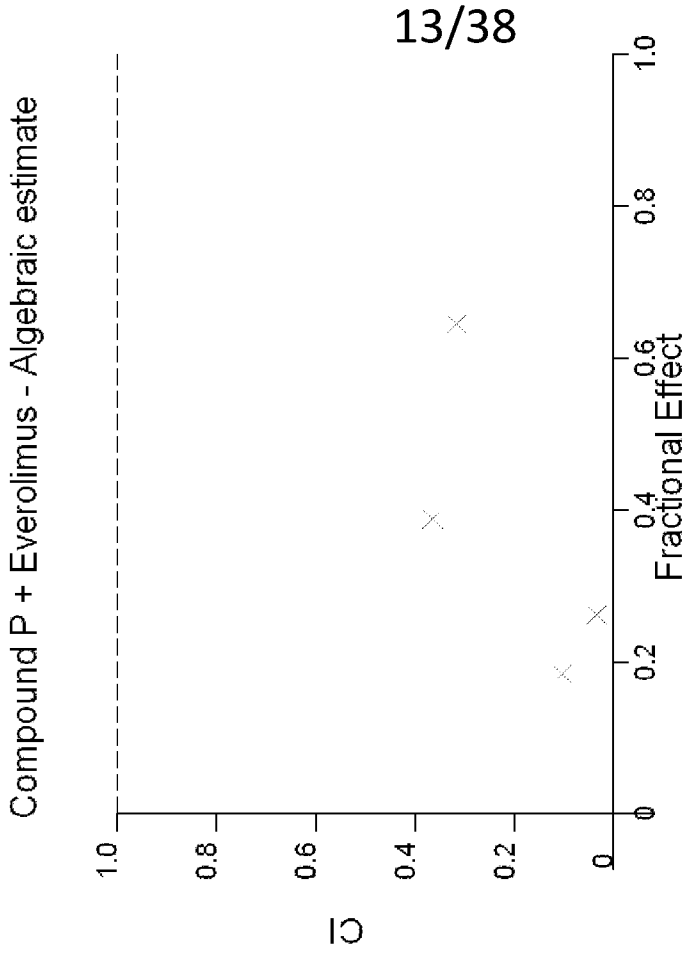
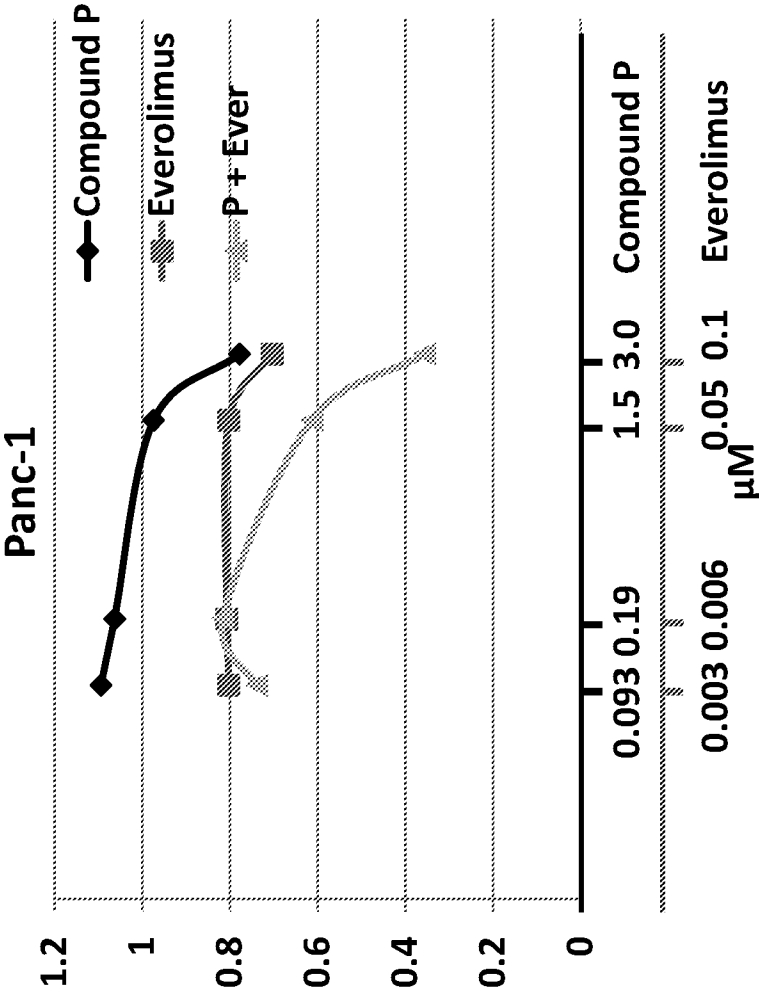


Figure 7 (continued)

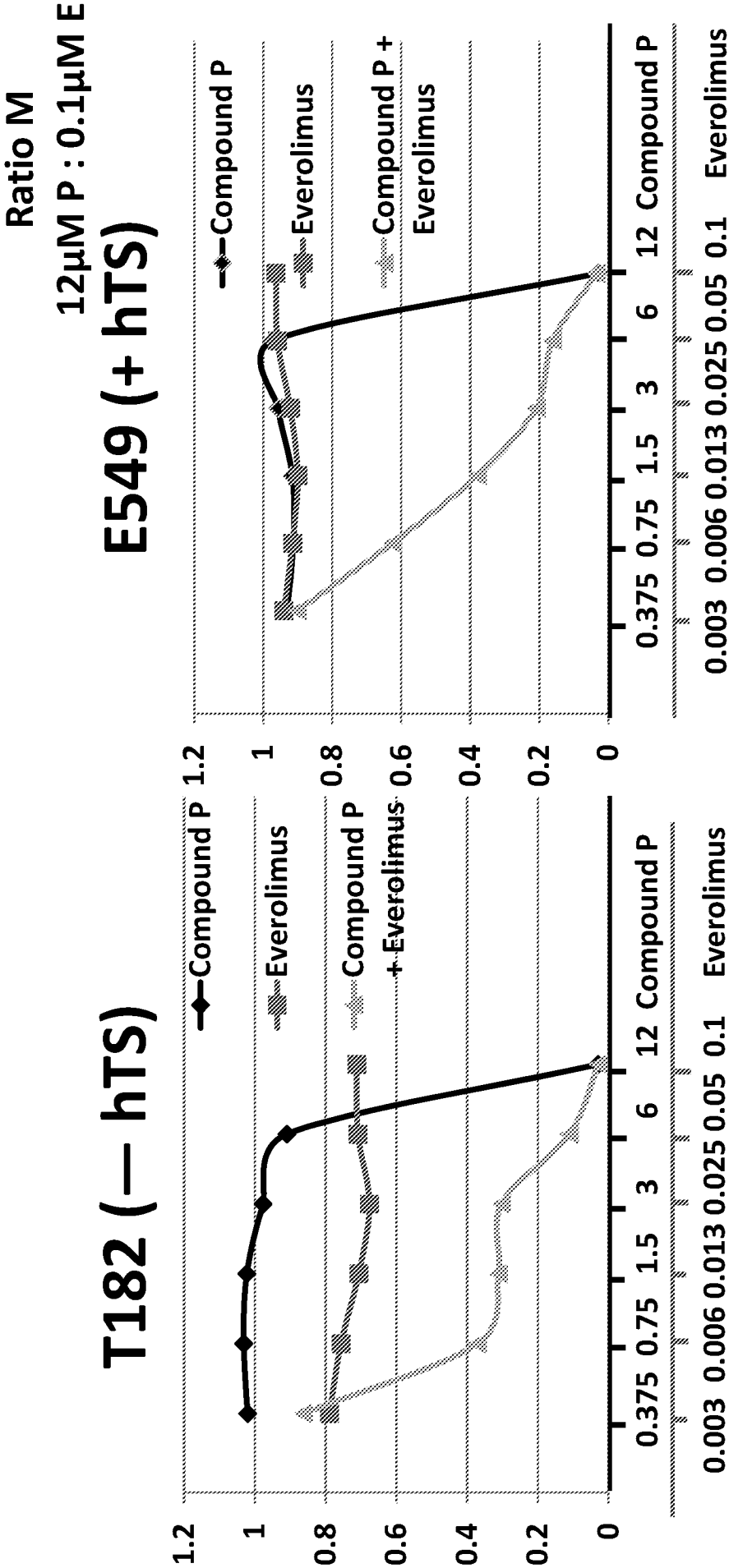


Figure 8

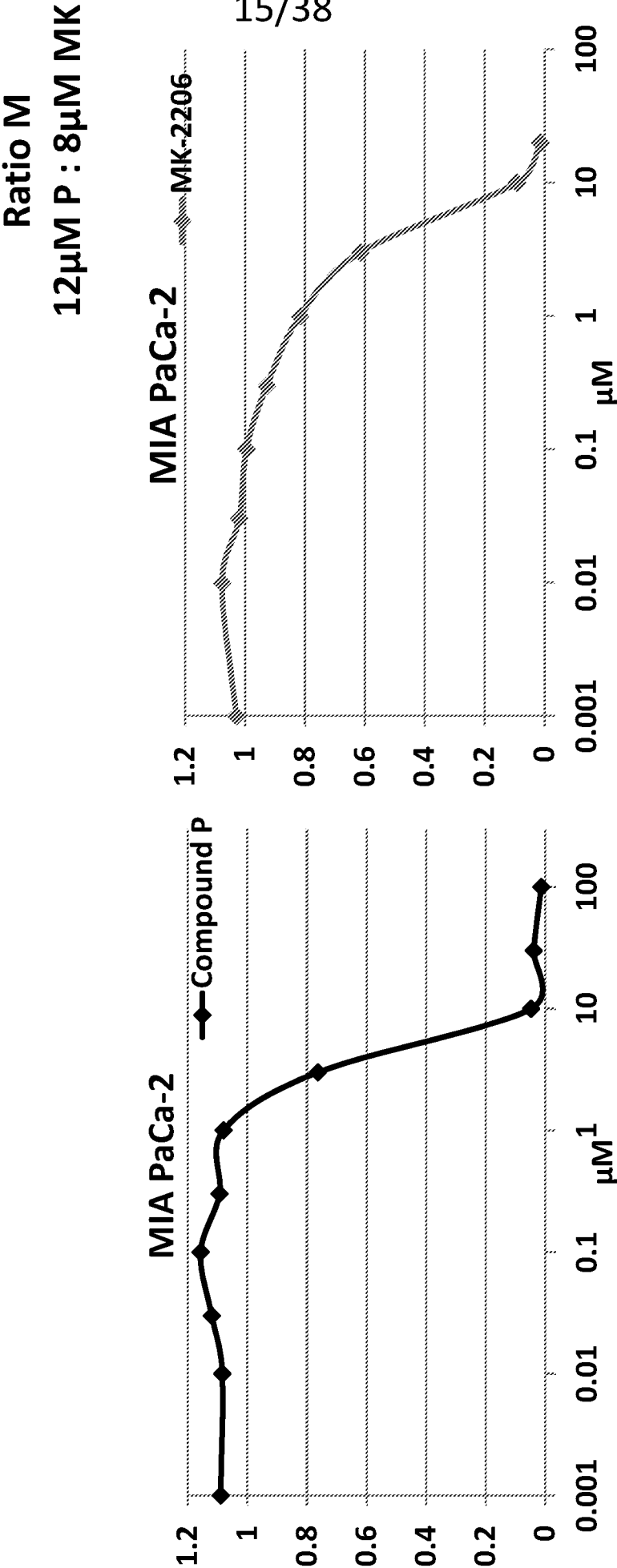


Figure 9

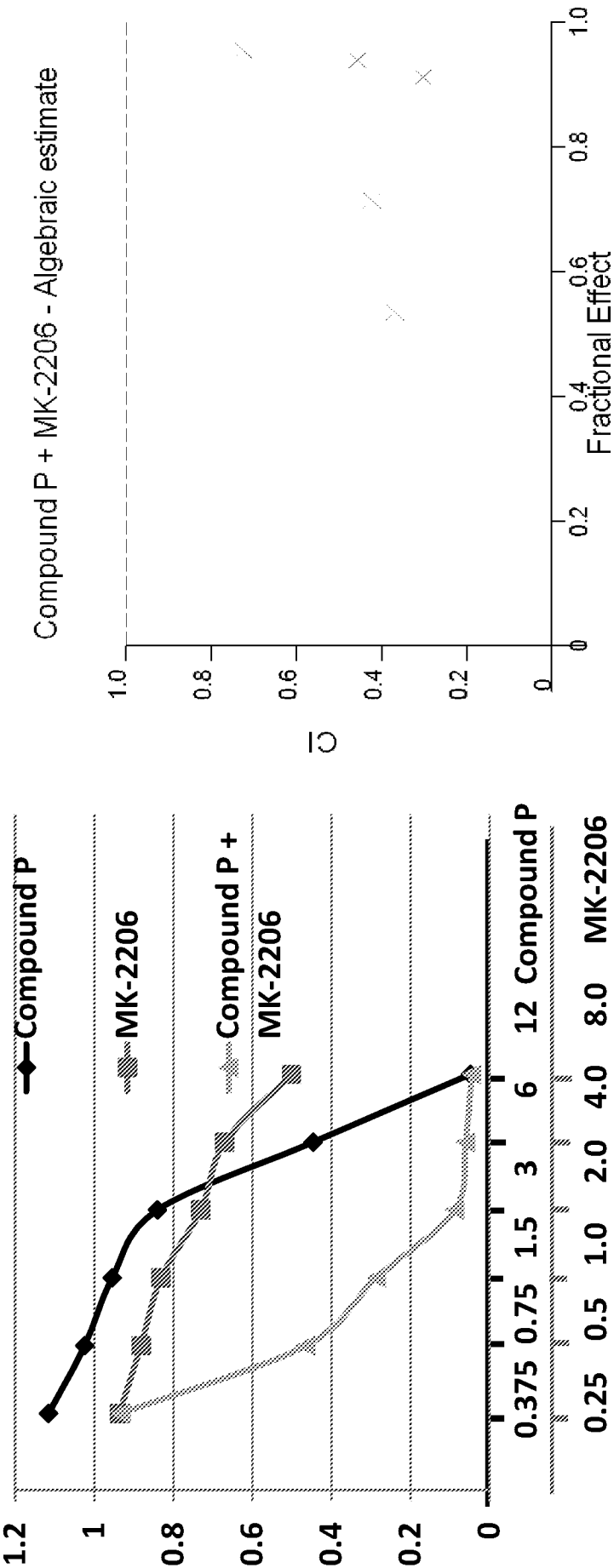


Figure 9 (continued)

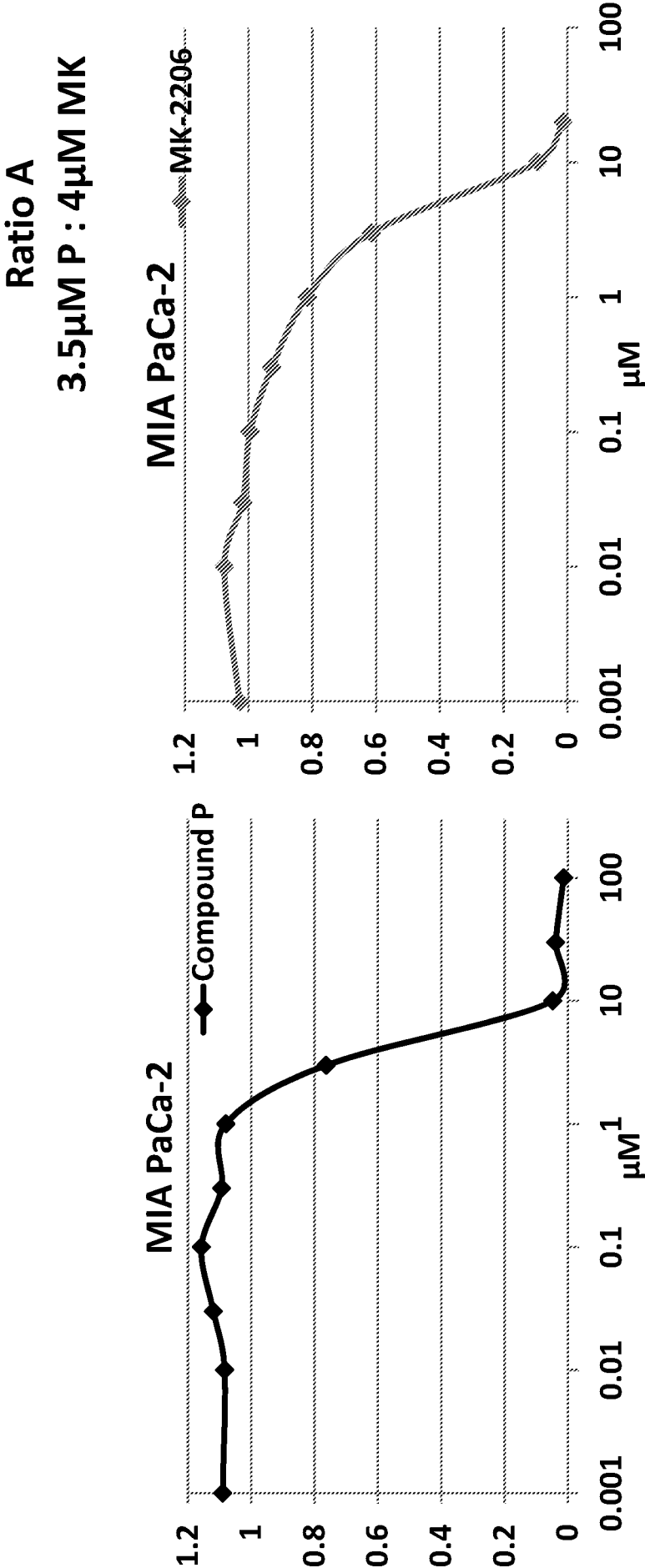
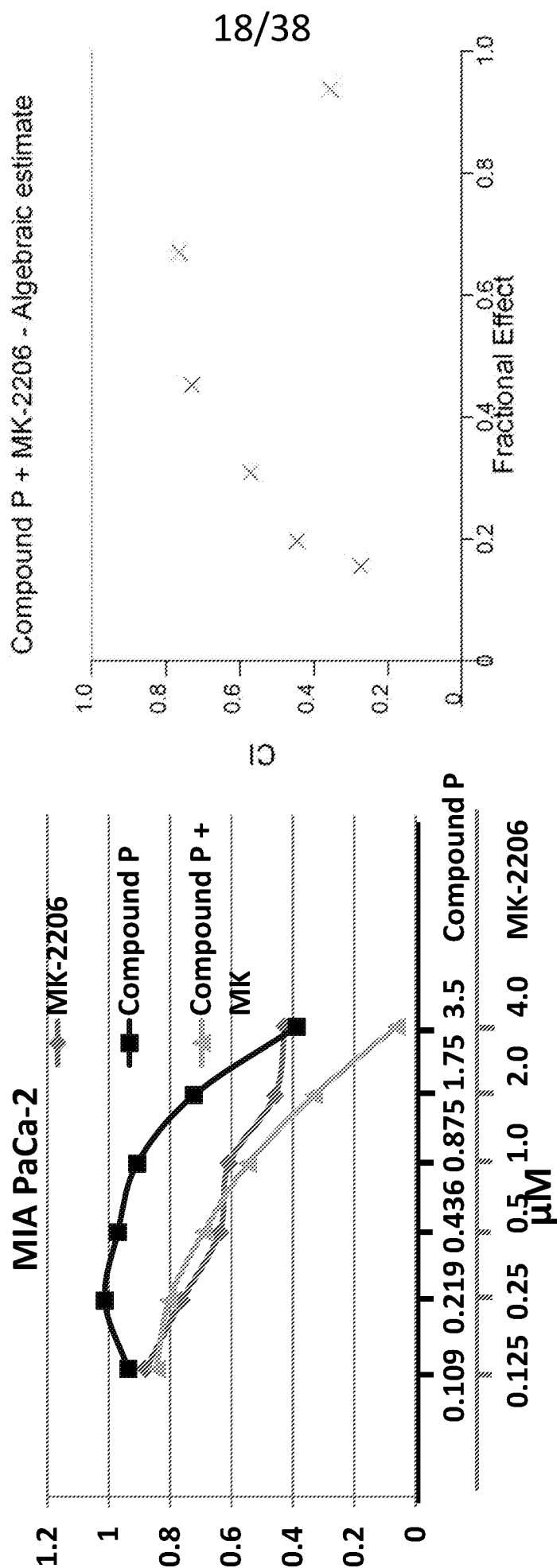


Figure 10



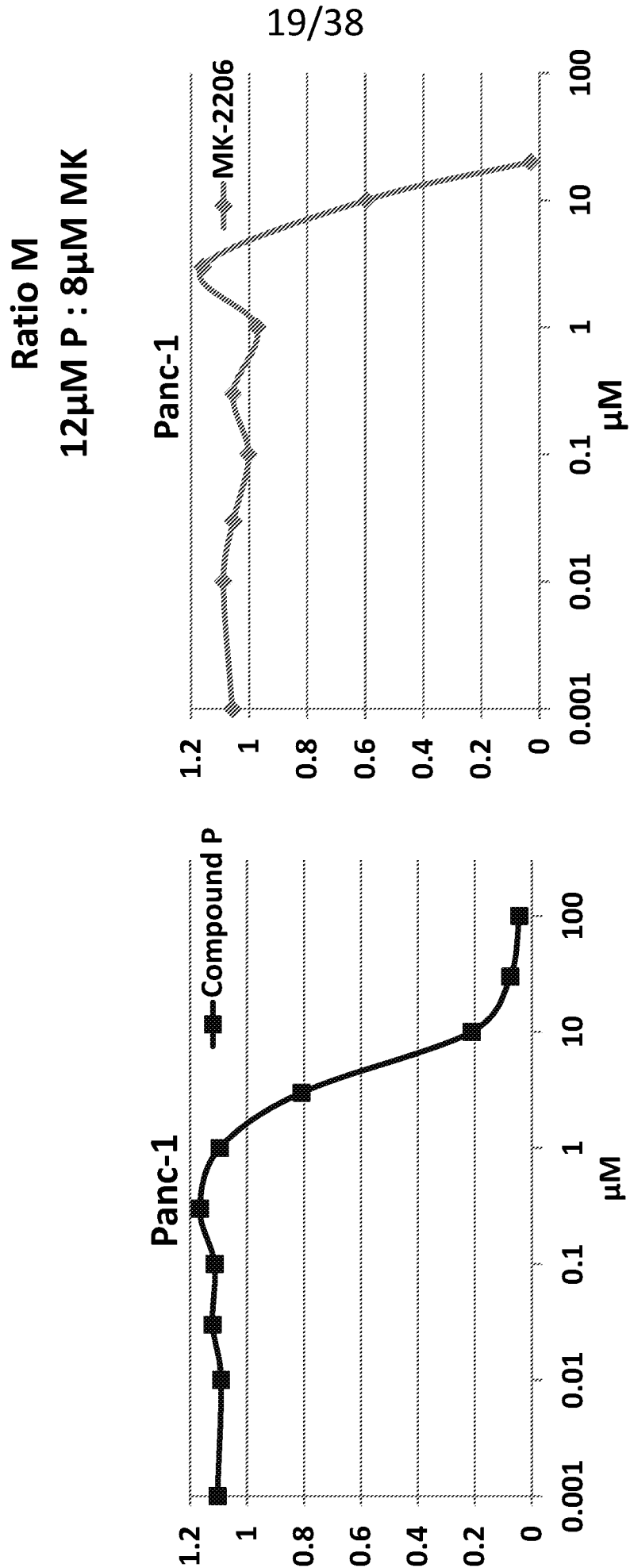


Figure 11

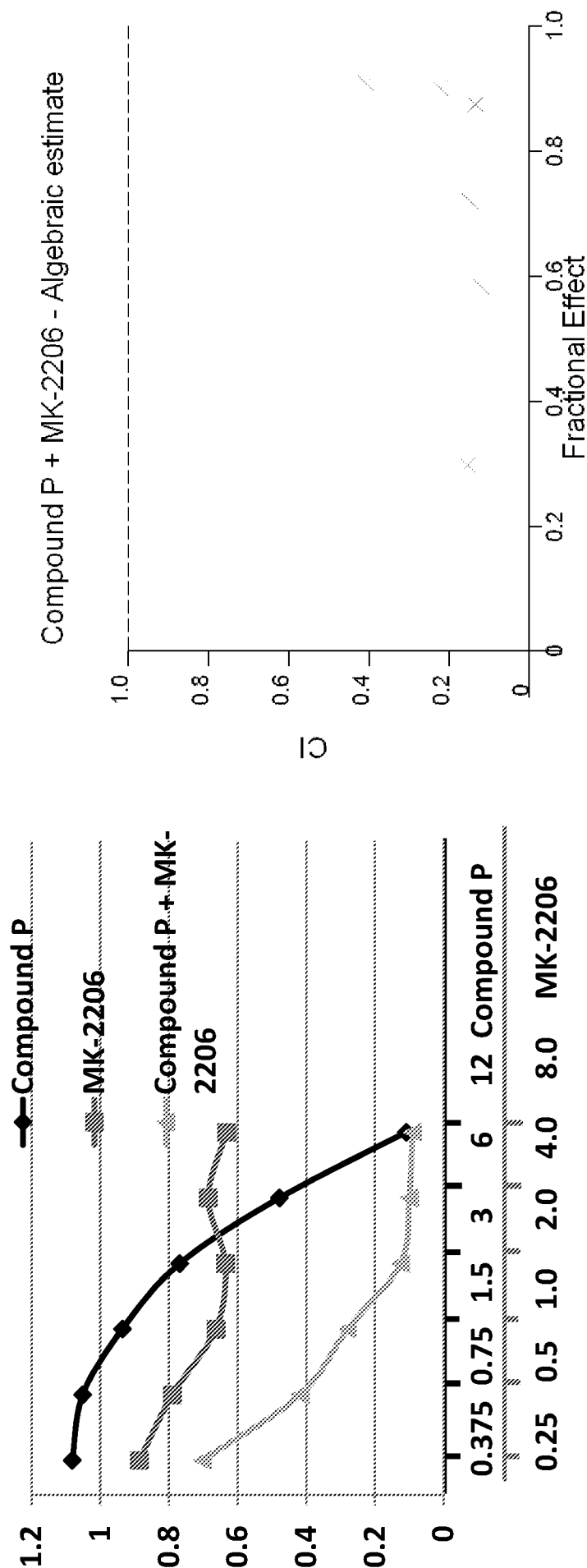


Figure 11 (continued)

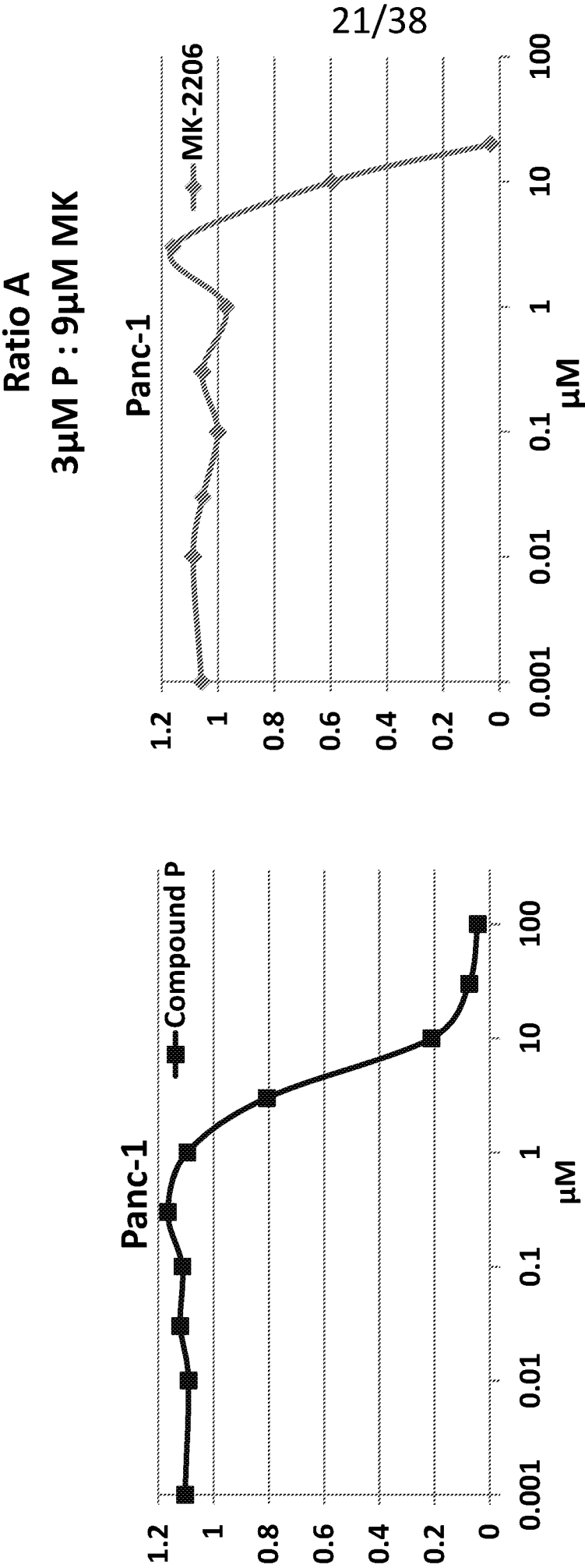


Figure 12

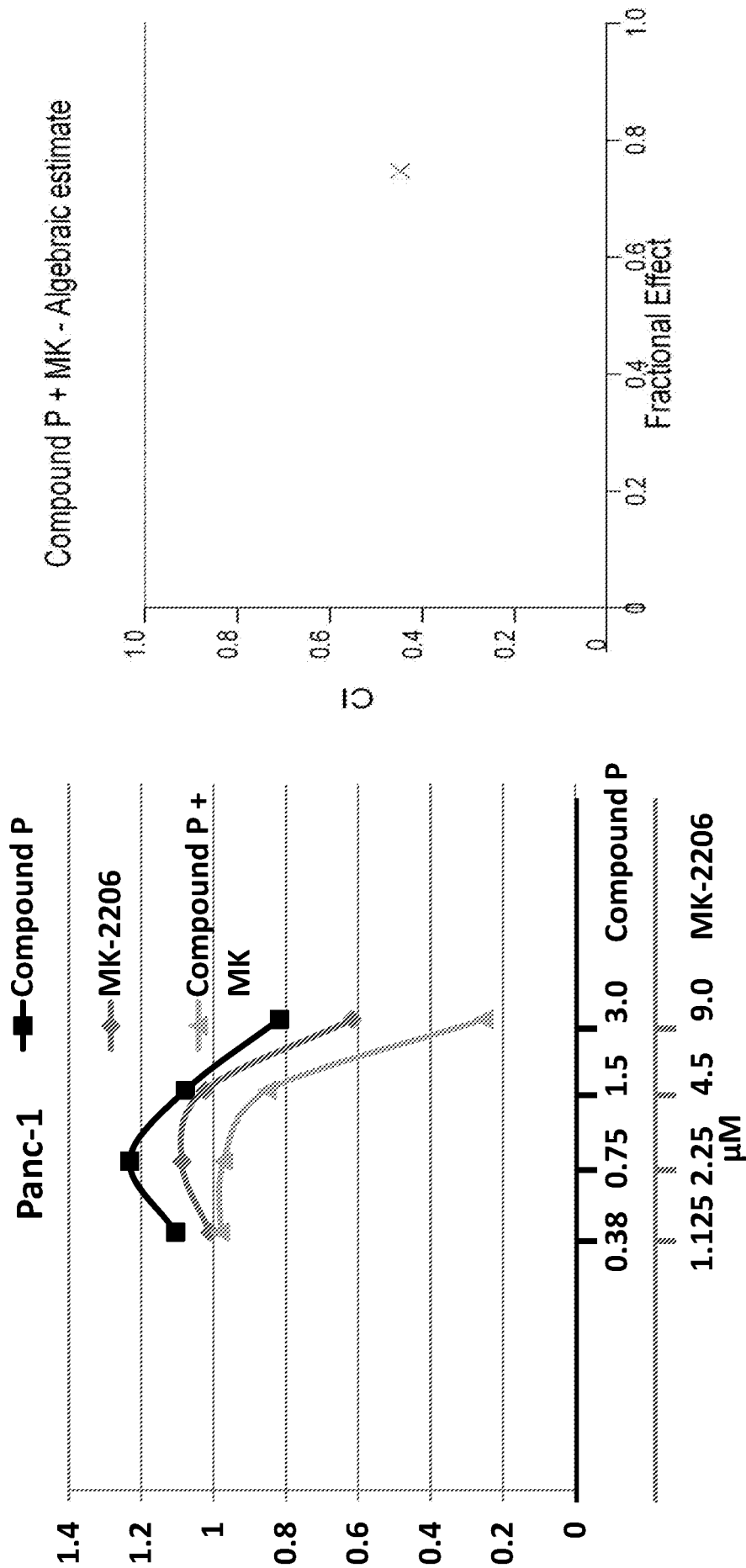


Figure 12 (continued)

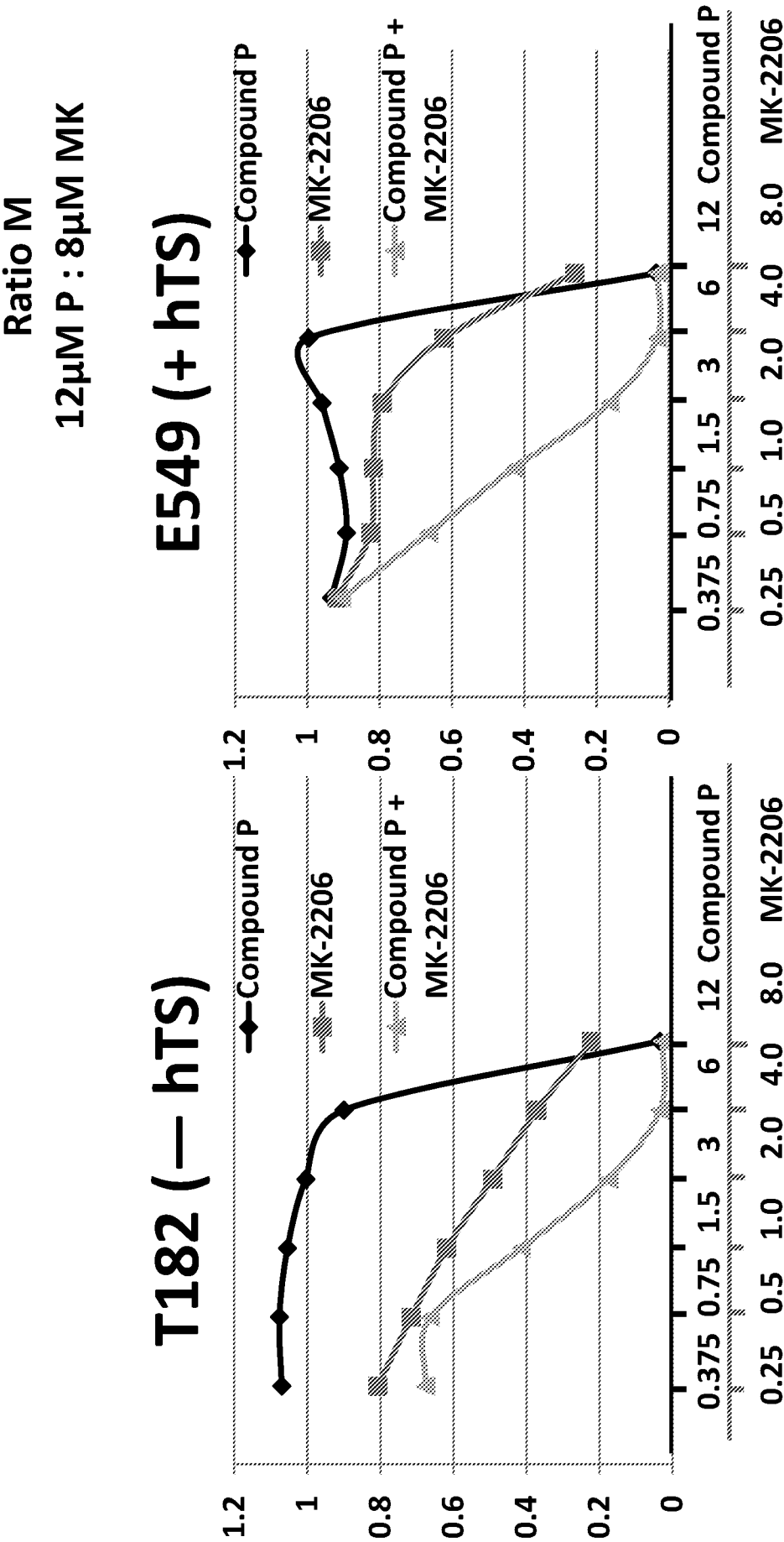


Figure 13

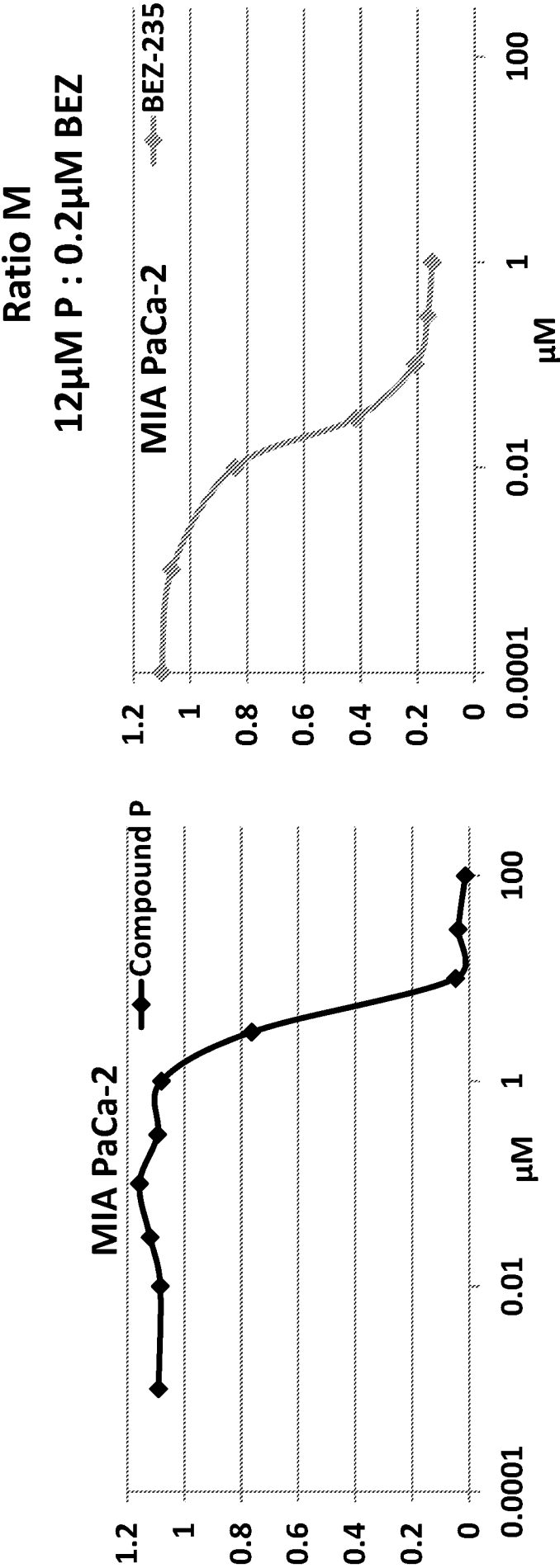


Figure 14

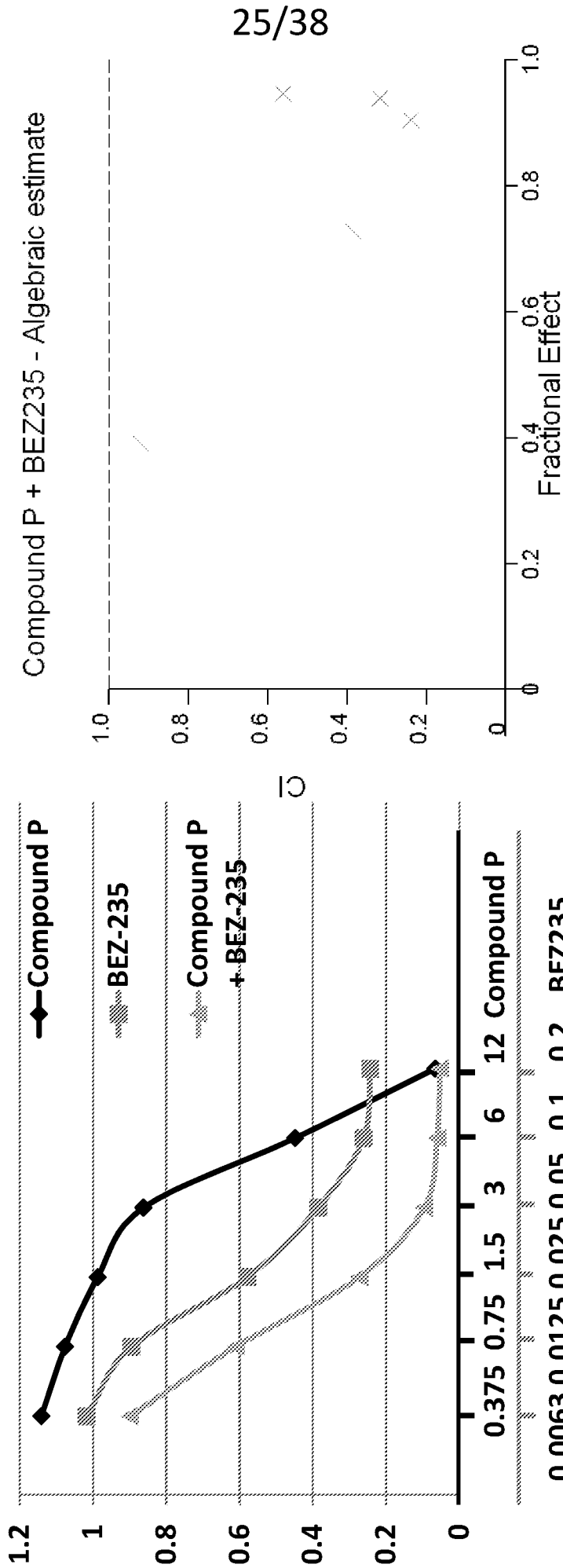


Figure 14 (continued)

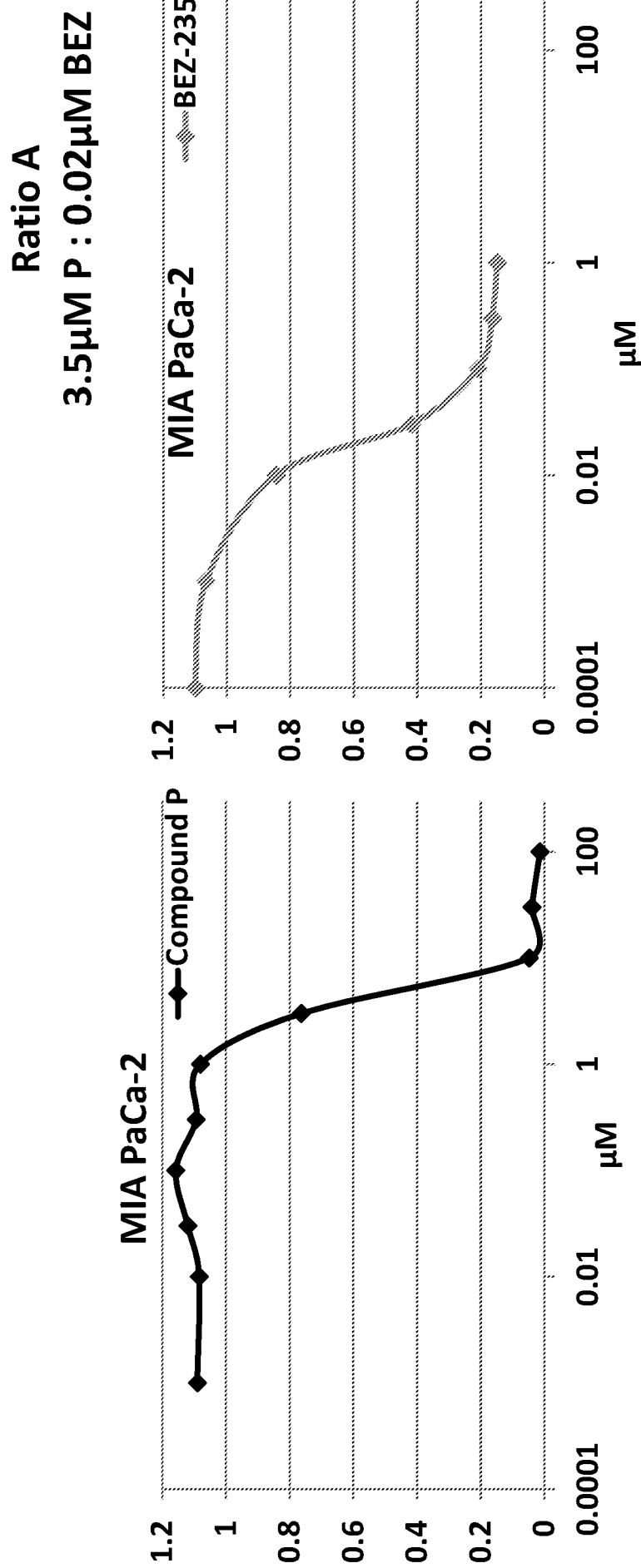


Figure 15

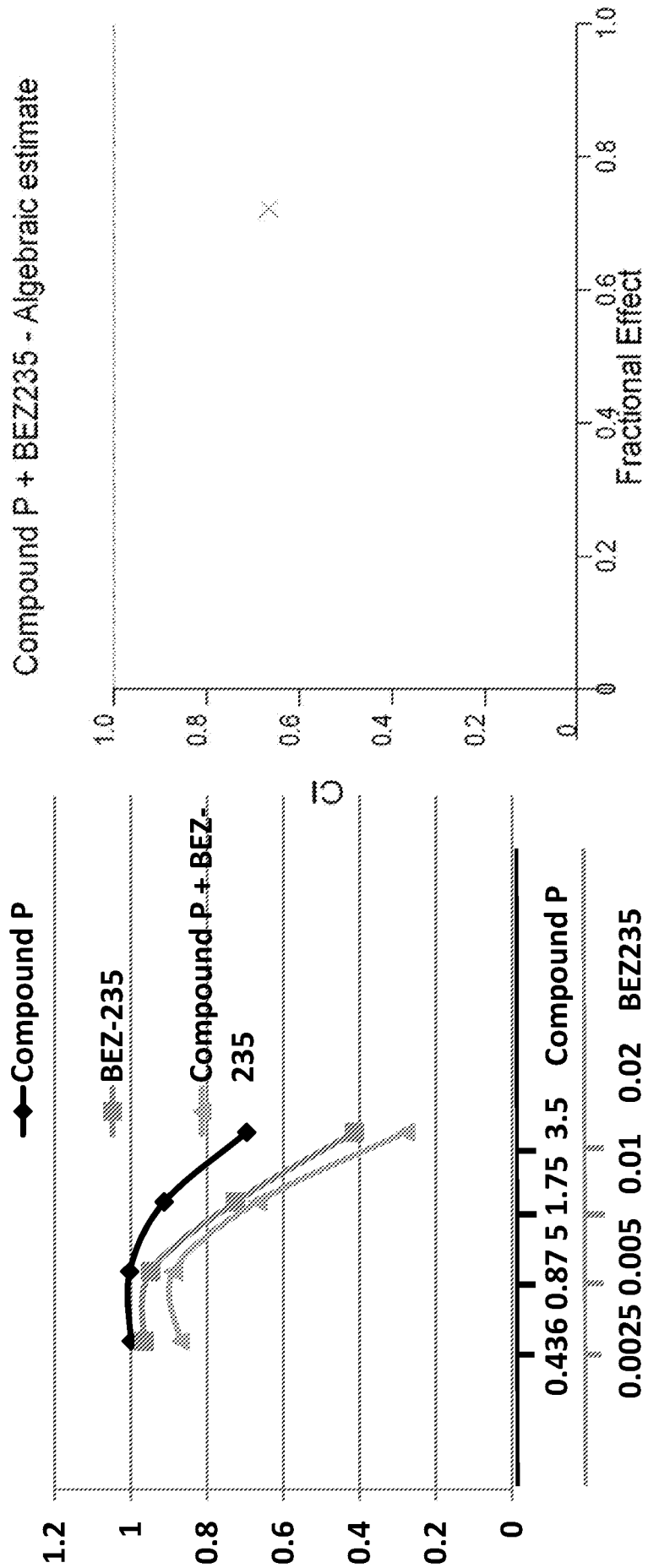


Figure 15 (continued)

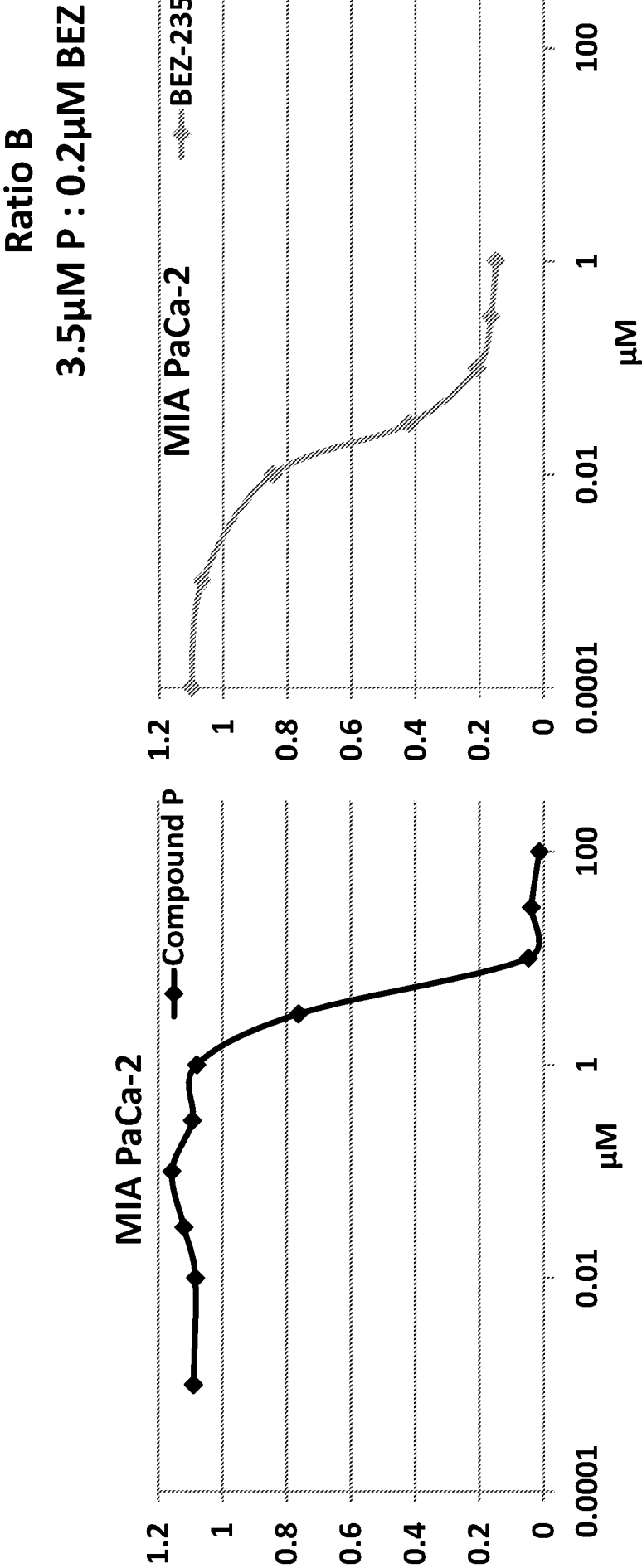


Figure 16

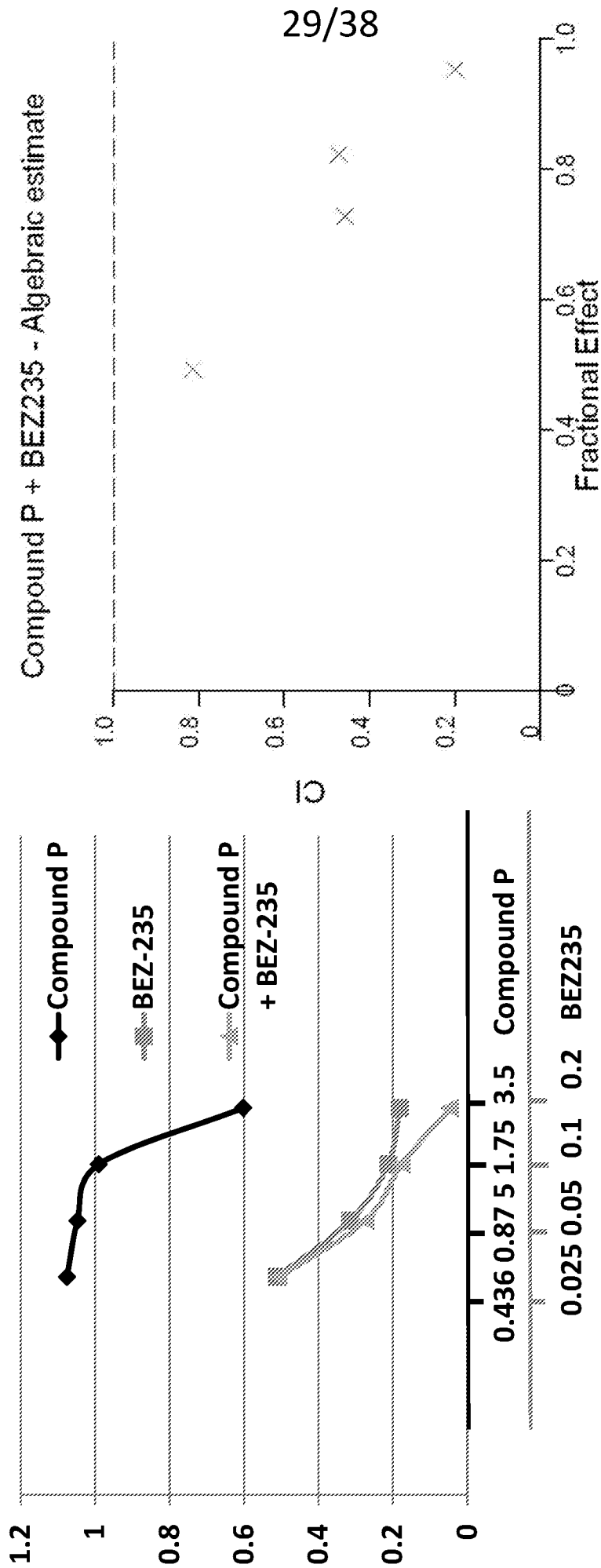


Figure 16 (continued)

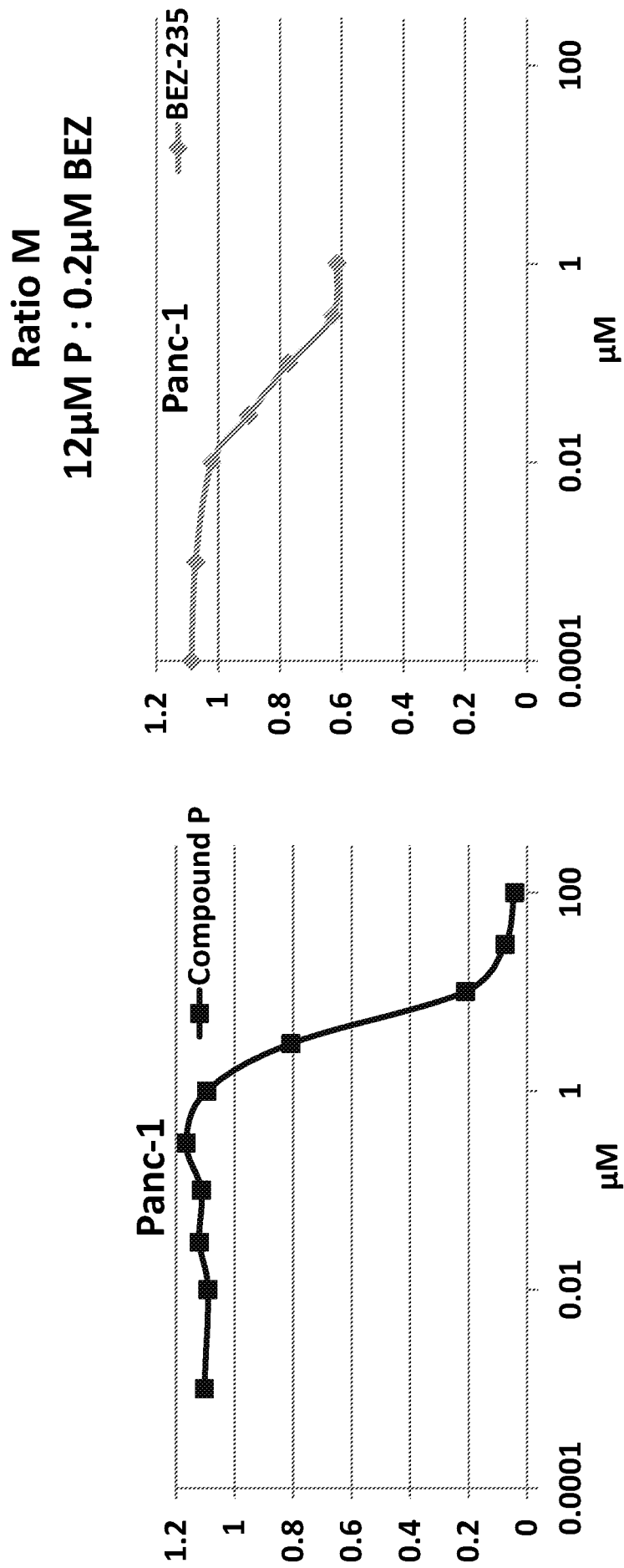


Figure 17

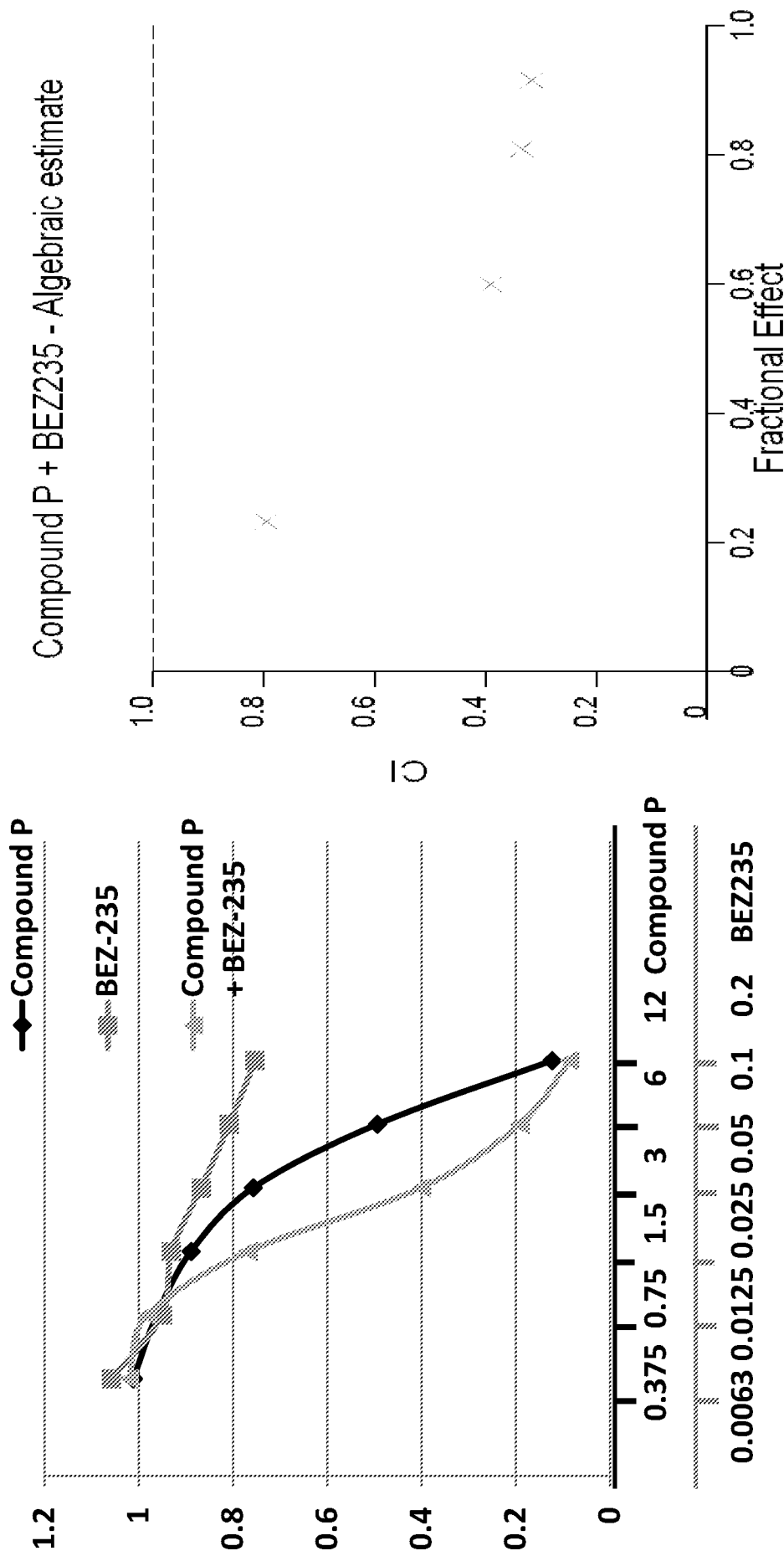


Figure 17 (continued)

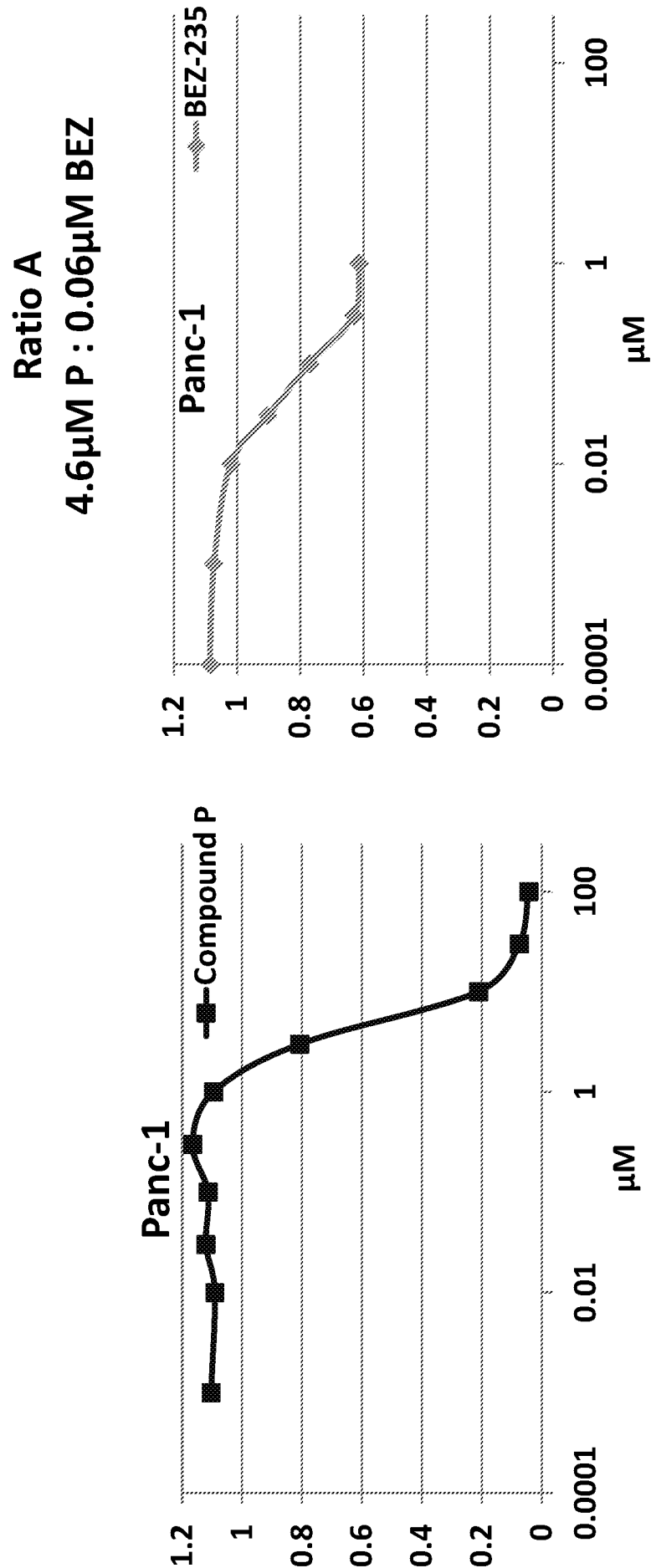


Figure 18

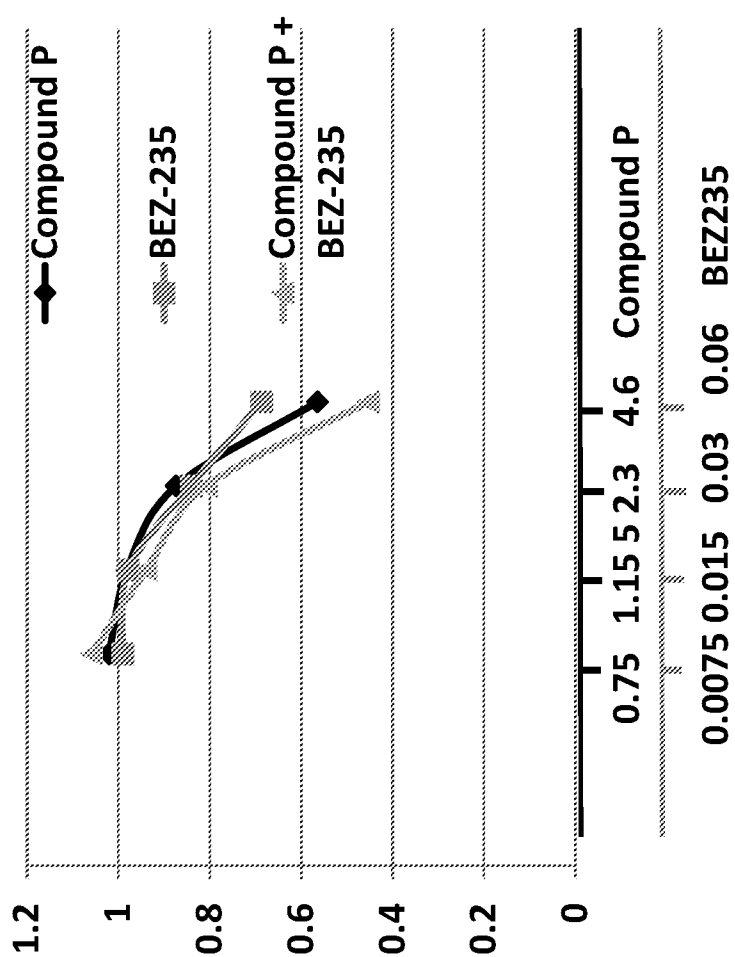
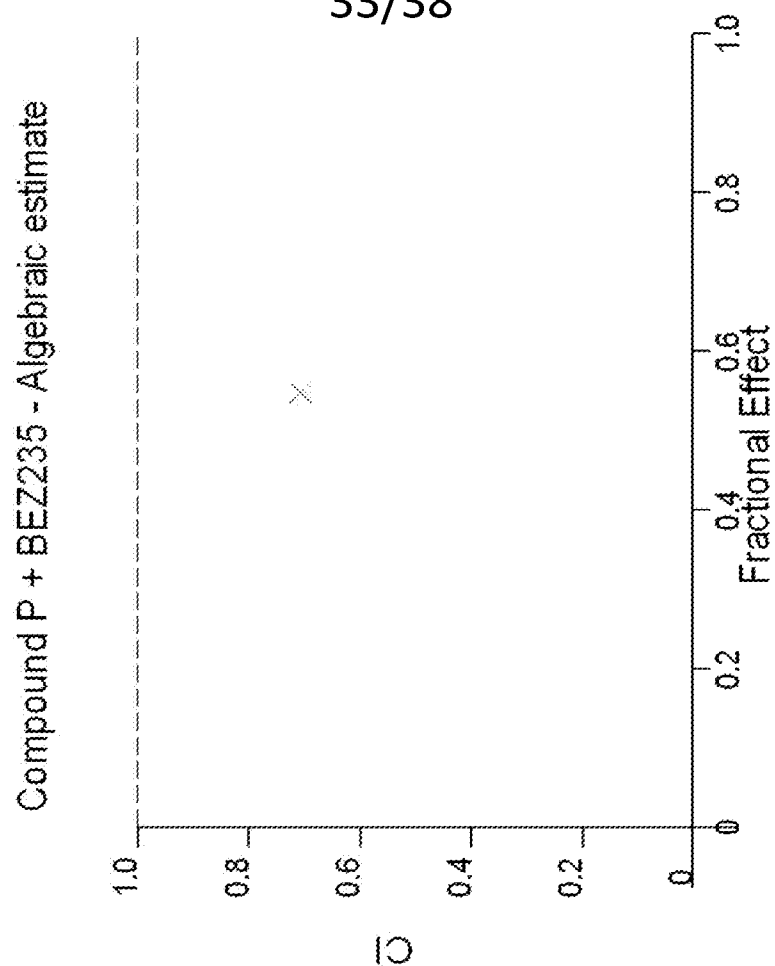


Figure 18 (continued)

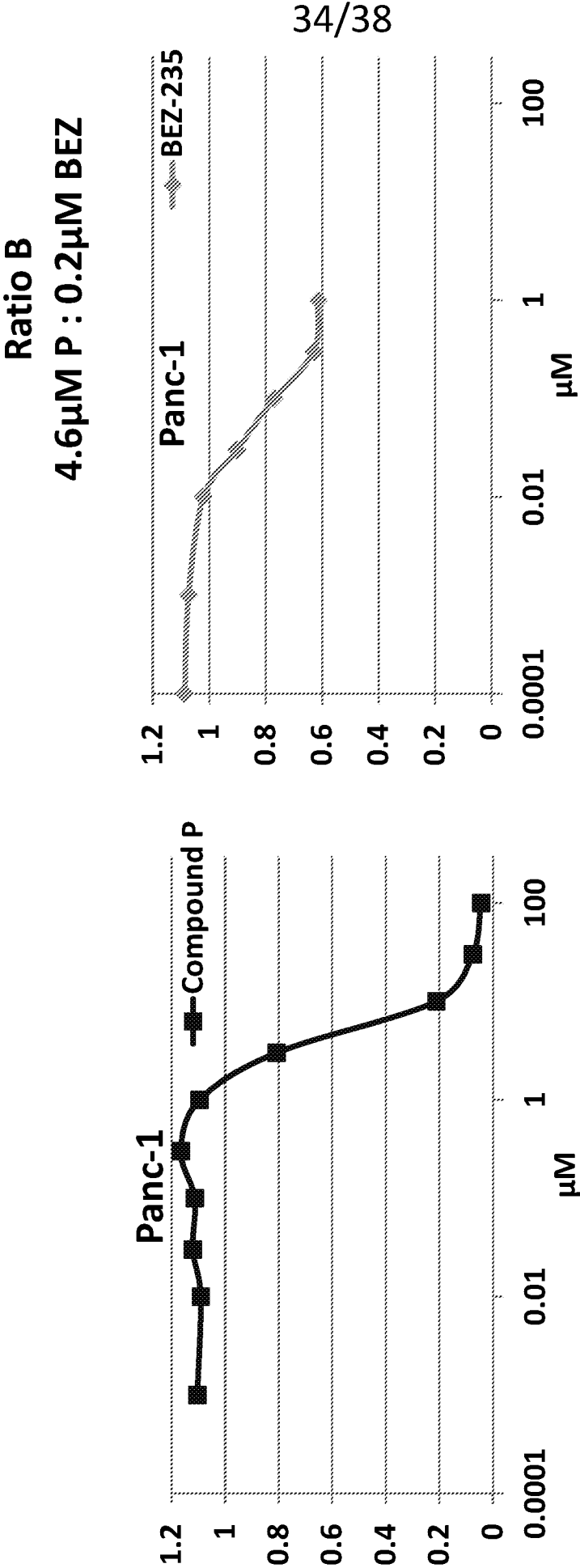


Figure 19

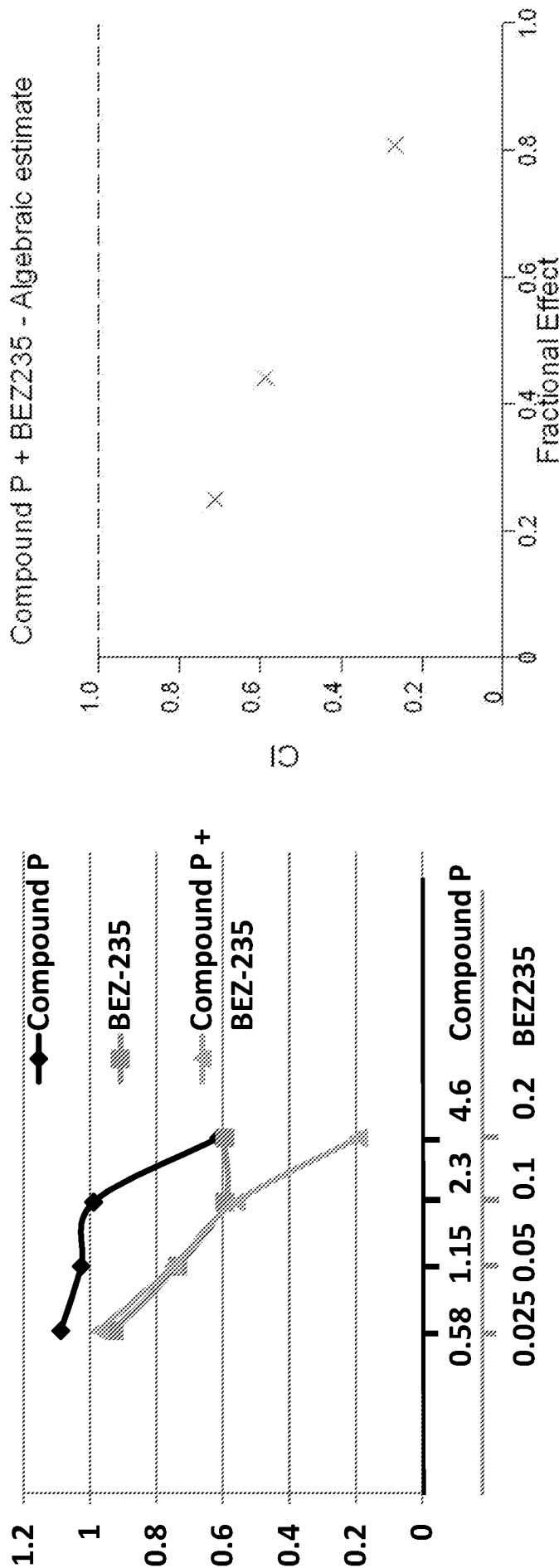


Figure 19 (continued)

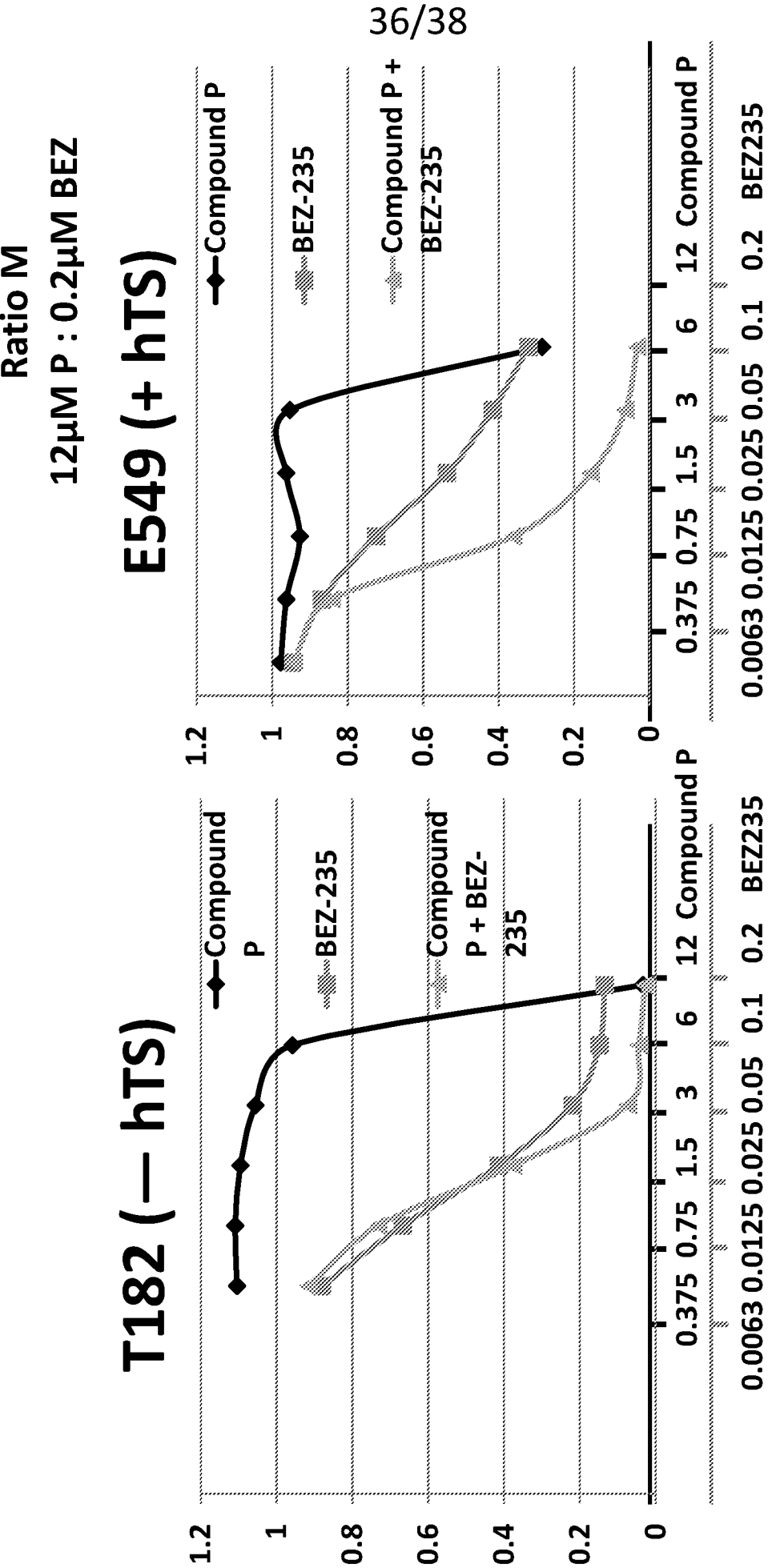


Figure 20

Compound P + Everolimus	Compound P + MK-2206	Compound P + BEZ-235
0.1µM Everolimus :	4µM - 9µM MK-2206:	0.02µM - 0.2µM BEZ235:
3.0µM - 12 µM Compound P	3.0µM - 12 µM Compound P	3.5µM - 12 µM Compound P

37/38

Figure 21

38/38

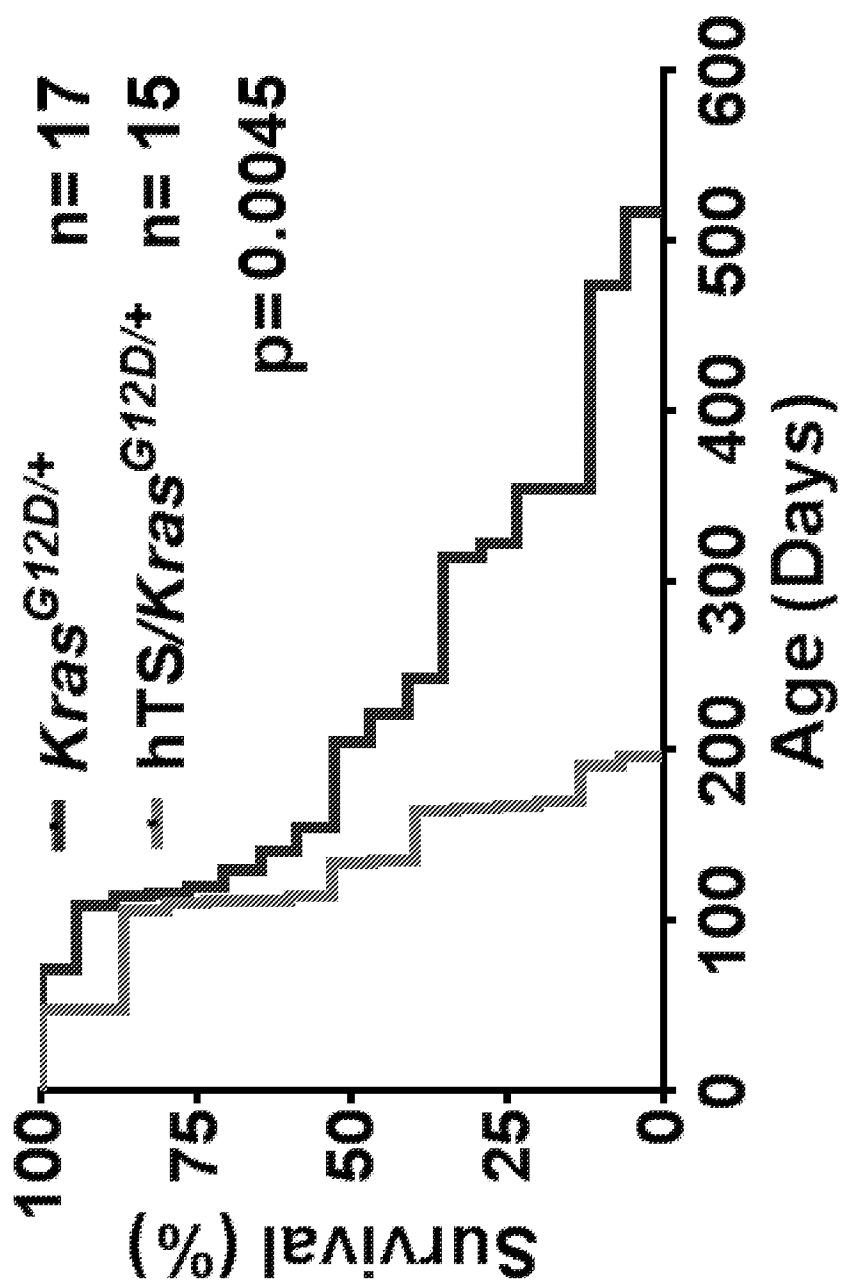


Figure 22

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US2016/037731**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 1-18,26-28
because they relate to subject matter not required to be searched by this Authority, namely:
Claims 1-18 and 26-28 pertain to methods for treatment of the human body by therapy, and thus relate to a subject matter which this International Searching Authority is not required, under PCT Article 17(2)(a)(i) and PCT Rule 39.1(iv), to search.
2. ☒ Claims Nos.: 16,18,24,25,27
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 16, 18, 24, 25 and 27 are unclear, since they refer to one of claims which are not drafted in accordance with PCT Rule 6.4(a) (PCT Article 6).
3. ☒ Claims Nos.: 12-15,17,23,26
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/037731**A. CLASSIFICATION OF SUBJECT MATTER****A61K 31/47(2006.01)i, A61K 31/4709(2006.01)i, A61K 31/436(2006.01)i, A61K 45/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61K 31/47; A61K 31/4709; A61K 31/44; A61K 31/4745; A61K 31/436; A61K 45/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: 4-quinolinemethanol, PI3K, AKT, mTOR, inhibitor, cancer, combination

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003-0216426 A1 (CARSON, D. A. et al.) 20 November 2003 See abstract; paragraphs [0025], [0058], [0065]; and figure 4A.	19-22
Y	MORGAN, T. M. et al., 'Target therapy for advanced prostate cancer: Inhibition of the PI3K/Akt/mTOR pathway' Current Cancer Drug Targets, 2009, Vol. 9, No. 2, pp. 237-249, NIH-PA Author Manuscript version (Internal pages 1-24) See abstract; and pages 5-8.	19-22
X	US 2013-0183289 A1 (GORELIK, L. et al.) 18 July 2013 See abstract; paragraphs [0098]-[0102]; and claim 34.	19, 22
A	YAN, K.-H. et al., 'Mefloquine exerts anticancer activity in prostate cancer cells via ROS-mediated modulation of Akt, ERK, JNK and AMPK signaling' Oncology Letters, 2013, Vol. 5, pp. 1541-1545 See the whole document.	19-22



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 October 2016 (19.10.2016)

Date of mailing of the international search report

19 October 2016 (19.10.2016)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2016/037731

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CHANG, L. et al., 'PI3K/Akt/mTOR pathway inhibitors enhance radiosensitivity in radioresistant prostate cancer cells through inducing apoptosis, reducing autophagy, suppressing NHEJ and HR repair pathways' Cell Death and Disease, 2014, Vol. 5, Article No. e.1437, Internal pages 1-10 See the whole document.	19-22

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/037731

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003-0216426 A1	20/11/2003	AU 2003-231803 A1 AU 2003-231803 A8 US 2005-0154010 A1 WO 03-096992 A2 WO 03-096992 A3	02/12/2003 02/12/2003 14/07/2005 27/11/2003 24/12/2003
US 2013-0183289 A1	18/07/2013	EP 2200611 A1 EP 2200611 A4 EP 3025714 A1 US 2014-0199291 A9 US 2016-0151390 A1 US 9233107 B2 WO 2009-038684 A1	30/06/2010 22/09/2010 01/06/2016 17/07/2014 02/06/2016 12/01/2016 26/03/2009