COMBINATION COMPRISING PALBOCICLIB AND 6-(2,4-DICHLOROPHENYL)-5-[4-[(3S)-1-(3-FLUOROPROPYL)PYRROLIDIN-3-YL]OXYPHENYL]-8,9-DIHYDRO-7H-BENZO[7] ANNULENE-2-CARBOXYLIC ACID AND ITS USE FOR THE TREATMENT OF CANCER

Herein are provided a combination of palbociclib and of 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid, a pharmaceutical composition containing such a combination, and the therapeutic uses of such combination and pharmaceutical composition, in particular for the treatment of cancer.

The estrogen receptor α (ESR1) is expressed in the majority of breast tumors, enabling them to respond to the mitogenic actions of estrogens.

6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid, hereafter designated as "compound (1)", is a selective estrogen receptor degrader (SERD) which has complete estrogen receptor antagonist properties and accelerates the proteasomal degradation of the estrogen receptor. This compound is disclosed in the patent application PCT/EP2017/053282, published as WO 2017/140669.

Palbociclib, also known as 6-acetyl-8-cyclopentyl-5-methyl-2-[5-(1-piperazinyl)pyridine-2-ylamino]pyrido[2,3-d]pyrimidin-7(8H)-one, is an inhibitor of cyclin-dependent kinase (CDK) 4 and 6. Palbociclib is marketed under the tradename Ibrance® and is indicated for the treatment of hormone receptor (HR)-positive, human epidermal growth factor receptor 2 (HER2)-negative locally advanced or metastatic breast cancer, in combination with an aromatase inhibitor, or in combination with fulvestrant in women who have received prior endocrine therapy. In pre- or perimenopausal women, the endocrine therapy should be combined with a luteinizing hormone-releasing hormone (LHRH) agonist.

There is always a need to find new antitumoral treatments. Now, it has been shown that a combination of compound (1) with palbociclib is well tolerated, demonstrates strong anti-tumor efficacy and induces tumor regression, with a synergistic effect compared to each of the active ingredient alone.

Herein is provided a combination comprising compound (1) and palbociclib.

In the combination provided herein, compound (1) may exist not only in the form of a zwitterion (i.e. a globally neutral molecule having an acid group and a basic group), but also in the form of addition salts with acids or bases. Such addition salts may be used in the

above combination. Hence, herein is provided a combination comprising compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib.

In an embodiment, the combination of compound (1), or a pharmaceutically acceptable salt thereof, with palbociclib shows therapeutic synergy. A combination demonstrates therapeutic synergy if its therapeutic effect is superior compared to the cumulative effect of either active agent of the combination alone.

In another embodiment, compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib are administered by the oral route.

Provided herein is also a combination of compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib for its use as a medicament.

Provided herein is also a pharmaceutical composition comprising compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib, as well as at least one pharmaceutically acceptable excipient.

The excipients are selected from the customary excipients which are known to a person skilled in the art. More particularly, the excipients are selected from those useful for oral administration in whatever form (liquid solution, dispersion or suspension, tablets, capsules or the like).

In another embodiment, compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib may be administered simultaneously, separately, or spaced out over a period of time (sequential administration). Therefore, the combination provided herein is not exclusively limited to the one which is obtained by physical association of the constituents in a single pharmaceutical composition, but also to those which allow a separate administration, which can be simultaneous or spaced out (or “spread out”) over time.

Herein is also provided a pharmaceutical kit which comprises:

(i) a first pharmaceutical composition comprising compound (1), or a pharmaceutically acceptable salt thereof, and at least one pharmaceutically acceptable excipient;

(ii) a second pharmaceutical composition comprising palbociclib, and at least one pharmaceutically acceptable excipient;

both pharmaceutical compositions (i) and (ii) being in separate compartments and being intended to be independently administered, each administration with regards to the other one being simultaneous, separated or spread out (sequential) over time.

In the combinations, pharmaceutical compositions and pharmaceutical kit described above, the compound (1) or pharmaceutically acceptable salt thereof and palbociclib are advantageously present at effective doses, adapted considering the treated pathology and the condition of the patient to which it is administered. In particular for palbociclib, the recommended starting dose for cancer treatment for adult patients is 125 mg once daily for 21 days followed by 7 days off treatment, along with dosing interruption and/or dose reductions based on individual safety and tolerability.

Herein is also provided a combination comprising compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib, as well as a pharmaceutical composition and kit as described above, for use in the treatment of cancer.

Herein is also provided compound (1) or a pharmaceutically acceptable salt thereof for use in the treatment of cancer by co-administration with palbociclib.

Herein is also provided palbociclib for use in the treatment of cancer by co-administration with compound (1) or a pharmaceutically acceptable salt thereof.

In another embodiment, the cancer is a hormone dependent cancer.

In another embodiment, the cancer is an estrogen receptor dependent cancer, particularly the cancer is an estrogen receptor α dependent cancer.

In another embodiment, the cancer is resistant to anti-hormonal treatment.

In another embodiment, the cancer is a cancer with wild type estrogen receptors.

In another embodiment, the cancer is a cancer with deregulated function of estrogen receptors related to, but not limited to, at least one epigenetic and genetic alteration of estrogen receptors such us mutation, amplification, splice variant.

In another embodiment, the cancer is a cancer with mutated estrogen receptors.

In another embodiment, the mutations of estrogen receptors can include, but not limited to, new or known mutations such as Leu536Arg, Tyr537Ser, Tyr537Asn, or Asp538Gly.

In another embodiment, the cancer is an estrogen-sensitive cancer.

In another embodiment, the cancer is breast cancer, more particularly an estrogen receptor positive breast cancer (ERα positive breast cancer), or a metastasis thereof, such as a cerebral metastasis.

Herein is also provided a method of treating the pathological conditions indicated above, particularly breast cancer, comprising administering to a subject in need thereof a therapeutically effective amount of compound (1), or a pharmaceutically acceptable salt thereof, and a therapeutically effective amount of palbociclib.

Herein is also provided a method of treating the pathological conditions indicated above, particularly breast cancer, comprising administering to a subject in need thereof a pharmaceutical composition as described above.

Herein is also provided a method of treating the pathological conditions indicated above, particularly breast cancer, comprising administering to a subject in need thereof a combination as described above.

Herein is also provided a method of treating the pathological conditions indicated above, particularly breast cancer, comprising co-administering to a subject in need thereof compound (1) or a pharmaceutically acceptable salt thereof and palbociclib.

Herein is also provided a method of treating the pathological conditions indicated above, particularly breast cancer, comprising co-administering to a subject in need thereof palbociclib and compound (1) or a pharmaceutically acceptable salt thereof.

In an embodiment of the methods described above, the subject is a human.

Herein is also provided a combination comprising compound (1), or a pharmaceutically acceptable salt thereof, and palbociclib for the manufacture of a medicament useful in treating the pathological conditions indicated above, particularly breast cancer.

Herein is also provided the use of compound (1), or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament useful in treating the pathological conditions indicated above, particularly breast cancer, by co-administration with palbociclib.

Herein is also provided the use of palbociclib in the manufacture of a medicament useful in treating the pathological conditions indicated above, particularly breast cancer, by co-administration with compound (1) or a pharmaceutically acceptable salt thereof.

Herein is also provided an article of manufacture, a packaging, or an administration unit, comprising:

- a packaging material;
- the above defined combination, pharmaceutical composition or pharmaceutical kit; and
- a label or package insert contained within said packaging material, indicating that said combination, pharmaceutical composition or pharmaceutical kit is administered to a patient for the treatment of cancer.

The examples below show how to synthesize compound (1), and the pharmacological results obtained with compound (1), palbociclib and their combination against a breast cancer cell line xenograft in mice.

1 - <u>Synthesis of 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl) pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid</u>

The experimental protocol for synthesizing 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid (compound (1)), described in the patent application WO 2017/140669, is reproduced below, along with its analytical data. The synthetic scheme for the synthesis of compound (1) is found in Figure 1.

The 1H NMR spectra were performed on a Bruker Avance DRX-400 spectrometer, with the chemical shifts (δ in ppm) in the solvent dimethyl sulfoxide-d6 (d6-DMSO) referenced at 2.5 ppm at a temperature of 303 K. Coupling constants (J) are given in Hertz.

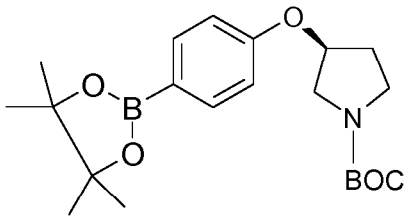
The liquid chromatography/mass spectra (LC/MS) were obtained on a UPLC Acquity Waters instrument, light scattering detector Sedere and SQD Waters mass spectrometer using UV detection DAD 210<l<400 nm and column Acquity UPLC CSH C18 1.7 µm, dimension 2.1x30 mm, mobile phase H_2O + 0,1% HCO_2H / CH_3CN + 0,1% HCO_2H.

The following abbreviations and empirical formulae are used:

AcOEt	ethyl acetate
$AlCl_3$	aluminium trichloride
Cs_2CO_3	cesium carbonate
DCM	dichloromethane
DMF	*N,N*-dimethylformamide
DMSO	dimethyl sulfoxide

HCl	hydrogen chloride
K_2CO_3	potassium carbonate
LC/MS	liquid chromatography/mass spectrometry
MeOH	methanol
$MgSO_4$	magnesium sulfate
$NaHCO_3$	sodium bicarbonate
NaOH	sodium hydroxyde
$Pd(dppf)Cl_2$	1,1′bis(diphenylphosphino)ferrocene] dichloropalladium(II)
Ph_3P or $P(Ph)_3$	triphenylphosphine
$Ph_3P=O$	triphenylphosphine oxide
°C	degrees Celsius
ml	millilitre(s)
mmol	millimole(s)
µmol	micromole(s)
µM	micromolar
nM	nanomolar
ppm	parts per million

Intermediate (c). Tert-butyl (3S)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2yl)phenoxy]pyrrolidine-1-carboxylate

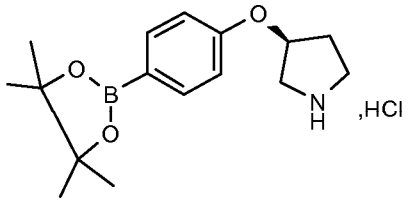


To a solution of commercially available 4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenol (**a**) (82.7 g, 364.51 mmol) in THF (2 L) was added under argon (R)-1-N-Boc-3-hydroxypyrrolidine (**b**) (84.43 g, 437.41 mmol) followed by N,N,N',N'-tetramethylazodicarboxamide (99.1 g, 546.77 mmol). The clear reaction mixture turned orange and triphenylphosphine (143.41 g, 546.77 mmol) was added. The reaction mixture was stirred at room temperature for 24 hours, meanwhile a precipitate of triphenylphosphine oxide formed ($Ph_3P=O$). The reaction mixture was poured in water (1.5 L) and extracted with ethyl acetate (AcOEt) (3x1.5 L). Gathered organic phases were dried over magnesium sulfate ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was taken up into diisopropylether (1.5 L) and the solid formed ($Ph_3P=O$) was filtered. The solvent was

concentrated under reduced pressure and the residue purified by column chromatography eluting with a mixture of heptane with AcOEt (90/10; v/v) to give 145 g (100%) of tert-butyl (3S)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy]pyrrolidine-1-carboxylate (**c**) as a colorless oil.

^{1}H NMR (400 MHz, DMSO-d6, δ ppm): 1.27 (s : 12H); 1.39 (s : 9H); 2.05 (m : 1H); 2.14 (m : 1H); 3.37 (3H); 3.55 (m : 1H); 5.05 (s : 1H); 6.94 (d, J = 8.4 Hz : 2H); 7.61 (d, J = 8.4 Hz : 2H)

Intermediate (d). (3S)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2yl)phenoxy]pyrrolidine, hydrochloride



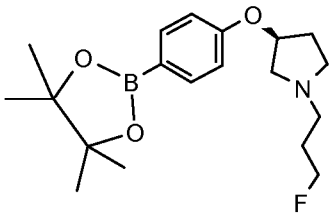
To a solution of (S)-tert-butyl 3-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy)pyrrolidine-1-carboxylate (**c**) (80 g, 195.23 mmol) in MeOH (450 ml) was added slowly HCl 4N in dioxane (250 ml).

After 1.5 hours, the reaction mixture was concentrated under reduced pressure and the residue was taken up into Et_2O with stirring to give a solid which then was filtered and dried under vacuum to give 61.8 g (95%) of (3S)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2yl)phenoxy]pyrrolidine, hydrochloride (**d**) as a white powder.

^{1}H NMR (400 MHz, DMSO-d6, δ ppm): 1.28 (s : 12H); 2.10 (m : 1H); 2.21 (m : 1H); 3.31 (3H); 3.48 (m : 1H); 5.19 (m : 1H); 6.97 (d, J = 8.4 Hz : 2H); 7.63 (d, J = 8.4 Hz : 2H); 9.48 (s : 1H); 9.71 (s : 1H).

LC/MS (m/z, MH^+): 290

Intermediate (e). (3S)-1-(3-fluoropropyl)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy]pyrrolidine



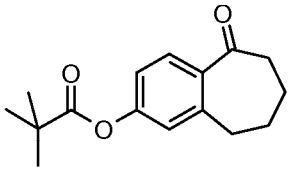
To a suspension of (S)-3-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy)pyrrolidine hydrochloride (**d**) (20 g, 61.42 mmol) in acetonitrile (100 ml), was added K_2CO_3 (21.22 g, 153.54 mmol) and 1-iodo-3-fluoropropane (12.15 g, 61.42 mmol), under argon. The reaction

mixture was stirred at 40°C for 24 hours. After cooling to room temperature, the reaction mixture was filtered and washed with acetonitrile. The filtrate was concentrated under reduced pressure and the residue was taken up in DCM and the solid formed was filtered and washed with DCM. The filtrate was concentrated to give 21.5 g (100%) of (3S)-1-(3-fluoropropyl)-3-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy]pyrrolidine (**e**) as a yellow foam.

^{1}H NMR (400 MHz, DMSO-d6, δ ppm): 1.27 (s : 12H); 1.77 (m : 2H); 1.84 (m : 1H); 2.27 (m : 1H); 2.41 (m : 1H); 2.49 (2H); 2.62 (dd, J = 2.6 and 10.4Hz : 1H); 2.69 (m : 1H); 2.83 (dd, J = 6.2 and 10.4Hz : 1H); 4.47 (td, J = 6.2 and 47Hz : 2H) ; 4.99 (m : 1H); 6.77 (d , J = 8.4 Hz : 2H); 7.58 (d, J = 8.4 Hz : 2H).

LC/MS (m/z, MH^+): 350

Intermediate (B). 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yl 2,2-dimethylpropanoate

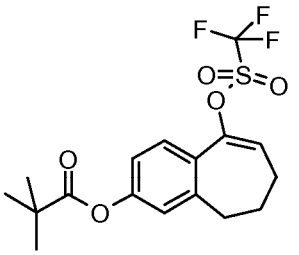


To a solution of 2-hydroxy-6,7,8,9-tetrahydro-5H-benzo[7]annulen-5-one (**A**) (1.52 g, 8.63 mmol), in acetone (60 ml), was added K_2CO_3 (1.19 g, 8.63 mmol) and pivaloyl chloride (1.06 ml, 8.63 mmol). The reaction mixture was stirred at room temperature for 16 hours, filtered and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of heptane in AcOEt (100/0 to 85/15, v/v) to give 1.55 g (69%) of 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yl 2,2-dimethylpropanoate (**B**) as a colorless oil.

^{1}H NMR (400 MHz, DMSO-d6, δ ppm): 7.65 (d, 1H); 7.10-7.04 (m, 2H); 2.95 (t, 2H); 2.68 (t, 2H); 1.85-1.65 (m, 4H).

LC/MS (m/z, MH^+): 261

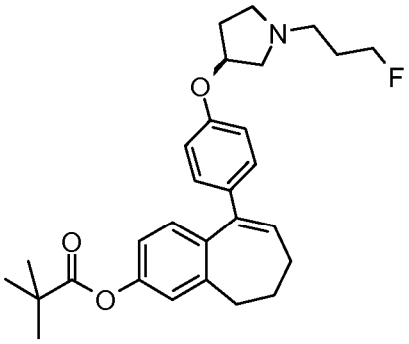
Intermediate (C). 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulen-3-yl 2,2-dimethylpropanoate



To a solution of 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yl 2,2-dimethylpropanoate (**B**) (15 g, 57.62 mmol) in DCM (500 ml) was added dropwise under argon pyridine (7.28 ml, 86.43 mmol) and trifluoromethanesulfonic anhydride (19.58 ml, 115.24 mmol). The reaction mixture was stirred at room temperature for 2 hours and ice (200 g) was added. The phases were separated, the aqueous phase was washed with DCM and the gathered organic phases were dried over $MgSO_4$, filtered and evaporated under reduced pressure to give 22 g (97%) of 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulen-3-yl 2,2-dimethylpropanoate (**C**) as a white solid.

LC/MS (m/z, MH^-): 391

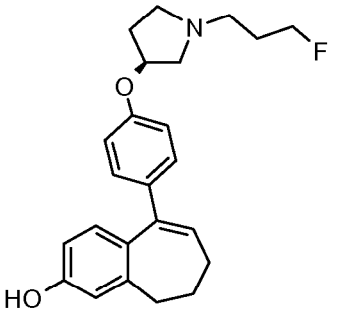
Intermediate (D). 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl-2,2-dimethylpropanoate



To a solution of 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulen-3-yl-2,2-dimethylpropanoate (**C**) (22 g, 56.07 mmol) and (3S)-1-(3-fluoropropyl)-3-[4-(tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy]pyrrolidine (**e**) (20.56 g, 58.87 mmol) in dioxane (420 ml) and water (120 ml) was added under argon $Pd(dppf)Cl_2$ (2.75 g, 3.36 mmol) and Cs_2CO_3 (36.57 g, 112.13 mmol). The reaction mixture was stirred for 1 hour at room temperature and was partitioned between water and DCM. The aqueous phase was washed with DCM and the gathered organic phases dried over $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by column chromatography eluting with a gradient of MeOH in DCM (0 to 5%; V/V) to give 31 g (100 %) of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl-2,2-dimethylpropanoate (**D**).

LC/MS (m/z, MH^+): 466

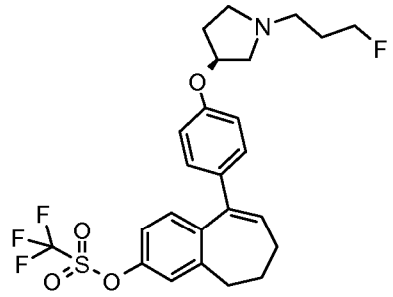
Intermediate (E). 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-ol



To a solution under argon of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl-2,2-dimethylpropanoate (**D**) (24.8 g, 53.26 mmol) in MeOH (300 ml), was added NaOH 5M (23 ml, 115.00 mmol). The reaction mixture was stirred for 2 hours at room temperature. pH was then adjusted to 7 by addition of 6N aqueous HCl solution. The MeOH was concentrated under reduced pressure, then DCM was added. The organic phase was dried over $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of DCM/ MeOH from 100/0 to 95/05 to give 18.8 g (93%) of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-ol (**E**) as a beige solid.

LC/MS (m/z, MH^+): 382

Intermediate (F). 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl trifluoromethanesulfonate

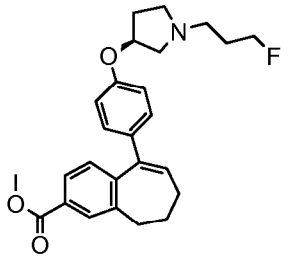


To a solution of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-ol (**E**) (20.6 g, 54.00 mmol) in DCM (200 ml) and pyridine (6.55 ml, 81.00 mmol), cooled to 5°C (ice bath), was added dropwise trifluoromethanesulfonic anhydride (18.93 ml, 108.00 mmol) under argon, and the reaction temperature was maintained <15°C. The ice bath was removed, and the brown suspension was stirred at room temperature for 2 hours. Ice (200 g) and DCM (200 ml) were added and the phases separated. The organic phase was dried over $MgSO_4$, and concentrated under reduced pressure. The residue was

purified by flash chromatography eluting with a gradient of DCM/MeOH from 100/0 to 95/05 to give 24.7 g (89.1%) of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl trifluoromethanesulfonate (**F**) as a brown oil.

LC/MS (m/z, MH^+): 514

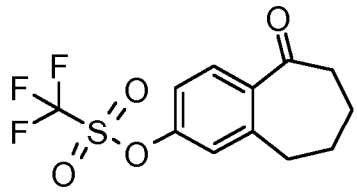
Intermediate (G). Methyl 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate



To a solution of 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulen-3-yl trifluoromethanesulfonate (**F**) (10.1 g, 19.67 mmol) in DMF (66 ml) and MeOH (33 ml), were added Pd(dppf)Cl_2 (909 mg, 1.18 mmol) and diisopropylethylamine (7.21 ml). The black suspension was carbonylated in an autoclave at 70°C under 5 bars of CO for 5 hours. The reaction mixture was filtered, then the filtrate was partially concentrated under reduced pressure. The residue was partitioned between AcOEt and water. The organic phase was washed with water (2x 100 ml), dried over $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of DCM/ MeOH from 100/0 to 95/05 to give 7.13 g (86%) of methyl 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate (**G**) as a brown gum.

LC/MS (m/z, MH^+): 424

Intermediate (A1). 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yltrifluoromethanesulfonate



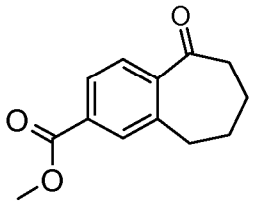
To a solution of commercially available 2-hydroxy-6,7,8,9-tetrahydro-5H-benzo[7]annulen-5-one (**A**) (18.5 g, 105 mmol) in DCM (185 ml) and lutidine (13.35 ml, 113.505 mmol), cooled at 5°C under argon, was added dropwise trifluoromethanesulfonic anhydride (20.22 ml,

123.29 mmol) while keeping temperature between 10 and 20°C. The reaction mixture was stirred for 1 hour at 5°C then at room temperature for 1 hour.

Then, ice (200 g) was added and the slurry partitioned between water and DCM. The organic phase was washed with aqueous $NaHCO_3$ solution, dried over $MgSO_4$, filtered off and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of heptane/AcOEt from 100 to 90/10 to give 28.2 g (87%) of 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yl trifluoromethanesulfonate (**A1**) as an orange oil.

LC/MS (m/z, MH^+): 309

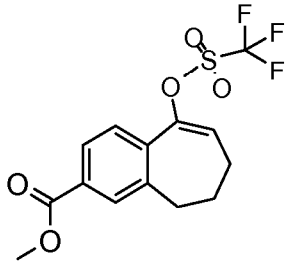
Intermediate (B1). Methyl 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulene-2-carboxylate



To a solution of 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-2-yl trifluoromethanesulfonate (**A1**) (5.03 g, 16.32 mmol) in DMF (24 ml) and MeOH (12 ml), were added $Pd(dppf)Cl_2$ (754 mg, 0.98 mmol) and diisopropylethylamine (6 ml). The black suspension was carbonylated in an autoclave at 70°C under 5 bars of CO for 2.5 hours. The reaction mixture was filtered, then the filtrate was partially concentrated under reduced pressure, and the residue, was partitioned between AcOEt and water. The organic phase was washed with water (2x 75 ml) and aqueous HCl 0.5 N, dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of heptane/AcOEt from 100/0 to 90/10 to give 3.4 g (95%) of methyl 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulene-2-carboxylate (**B1**) as a colorless oil.

LC/MS (m/z, MH^+): 219

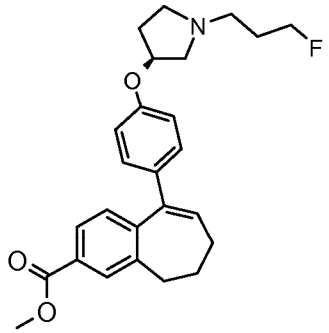
Intermediate (C1). Methyl 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate



To a solution of methyl 5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulene-2-carboxylate (**B1**) (18,19 g, 83,34 mmol) in DCM (500 ml) and anhydrous pyridine (11 ml, 130,56 mmol), cooled at 5°C under argon, was added dropwise trifluoromethanesulfonic anhydride (30 ml, 176,54 mmol). The reaction mixture, a thick suspension, was stirred at room temperature for 24 hours, then ice was added and partitioned between water and DCM. The organic phase was dried over $MgSO_4$, filtered off and concentrated under reduced pressure to give 29 g (100%) of methyl 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate (**C1**) as a yellow gum.

LC/MS (m/z, MH^+): 351

Intermediate (G). Methyl 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate

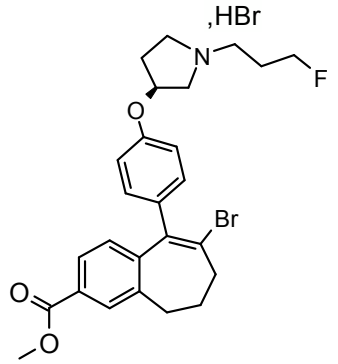


To a solution of methyl 9-(trifluoromethanesulfonyloxy)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate (**C1**) (29 g, 82.9 mmol), (3S)-1-(3-fluoropropyl)-3-[4-(tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy]pyrrolidine (**e**) (28.9 g, 82.9 mmol), in dioxane (225 ml) were added $Pd(dppf)Cl_2$ under argon, complex with DCM (3.73 g, 4.57 mmol) and Cs_2CO_3 1.5 M aqueous solution (111.12 ml, 166.68 mmol). The reaction mixture was stirred at 60°C for 1 hour.

After cooling to room temperature, the reaction mixture was poured into a mixture of water (500 ml) and AcOEt (400ml). The organic phase was washed with brine, dried over $MgSO_4$, filtered on celite and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of DCM/MeOH from 100/0 to 95/05 to give 23 g (65%) of methyl 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate (**G**) as a brown gum.

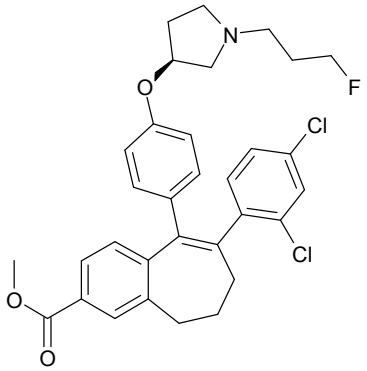
LC/MS (m/z, MH^+): 424

Intermediate (H). Methyl 8-bromo-9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate hydrobromide



To a solution of methyl 9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate (**G**) (13.93 g, 32.89 mmol), in DCM (150 ml) was added under argon pyridinium tribromide (15.78 g, 44.41 mmol). The reaction mixture was stirred for 1 hour at room temperature. Water (200 ml) was added, organic phase was then dried over $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with a gradient of DCM/MeOH from 100/0 to 95/05 to give 16.4 g (85%) of methyl 8-bromo-9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate hydrobromide (**H**) as a yellow meringue.
LC/MS (m/z, MH^+): 502

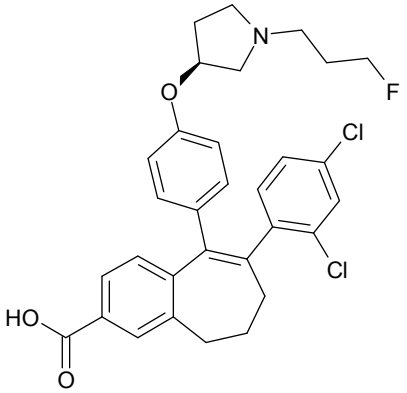
Intermediate (I). 6-(2,4-dichloro-phenyl)-5-{4-[1-(3-fluoro-propyl)-pyrrolidin-3-yloxy]-phenyl}-8,9-dihydro-7H-benzocycloheptene-2-carboxylic acid methyl ester.



To a solution of methyl 8-bromo-9-(4-{[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxy}phenyl)-6,7-dihydro-5H-benzo[7]annulene-3-carboxylate hydrobromide (**H**) (150 mg, 298.56 µmol), in dioxane (12 ml) and water (2 ml), was added 2,4-dichlorophenyl-boronic acid (62.67 mg, 328.41 µmol), Cs_2CO_3 (204.48 mg, 626.97 µmol), and $Pd(dppf)Cl_2$ (14.63 mg, 17.91 µmol). The reaction mixture was heated at 90°C for 3 hours, and partitioned between AcOEt and water. The phases were separated and the organic phase washed with brine, dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified by column

chromatography eluting with a mixture of DCM, acetonitrile and MeOH (96/2/2; V/V/V) to give 80 mg (47%) of 6-(2,4-dichloro-phenyl)-5-{4-[1-(3-fluoro-propyl)-pyrrolidin-3-yloxy]-phenyl}-8,9-dihydro-7H-benzocycloheptene-2-carboxylic acid methyl ester (**I**).
LC/MS (m/z, MH^+): 568

Compound (1). 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid



To a solution of 6-(2,4-dichloro-phenyl)-5-{4-[1-(3-fluoro-propyl)-pyrrolidin-3-yloxy]-phenyl}-8,9-dihydro-7H-benzocycloheptene-2-carboxylic acid methyl ester (**I**) (80 mg, 140.72 µmol) in MeOH (5 ml) was added a solution of NaOH (562.88 µl, 5 M) and the reaction mixture was heated at 60°C for 5 hours and the solvent removed under reduced pressure. The residue was taken up in water (10 ml) and aqueous HCl (5 M) added to pH 7. The slurry was extracted with DCM, dried over $MgSO_4$ and concentrated under reduced pressure. The solid was purified by column chromatography eluting with a mixture of DCM, acetonitrile and MeOH (90/5/5; V/V/V) to give 60 mg (77%) of 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid.
^{1}H NMR (400 MHz, DMSO-d6, δ ppm): 1.68 (m, 1 H); 1,79 (dm, J=25.3 Hz, 2 H); 2.07 to 2.23 (m, 5 H); 2.38 (m, 1 H); 2.46 (t, J=7.2 Hz, 2 H); 2.52 (m, 1 H); 2.62 (m, 1 H); 2.55 to 2.89 (m, 3 H); 4.47 (td, J=6.2 and 47.6 Hz, 2 H); 4.72 (m, 1 H); 6.63 (d, J=8.9 Hz, 2 H); 6.71 (m, 3 H); 7.18 (d, J=8.4 Hz, 1 H); 8.26 (dd, J=2.0 and 8.4 Hz, 1 H); 7.58 (d, J=2,0 Hz, 1 H); 7.63 (d, J=8.4 Hz, 1 H); 7.79 (s, 1 H); 12.3 (m, 1 H)
LC/MS (m/z, MH+): 554

2 - Evaluation of the efficacy of 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl) pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid combined with palbociclib against a subcutaneous breast cancer cell line xenograft in female nude mice

In the present study, the anti-tumor efficacy of 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid ("compound (1)"), combined with the cyclin-dependent kinase 4 (CDK4) inhibitor palbociclib, was investigated after 30 days treatment against a subcutaneous MCF7-Y537S human breast cancer cell line xenograft in female nude mice.

The treated groups included compound (1) at 5 mg/kg alone, palbociclib at 100 mg/kg alone, and the combination of compound (1) and palbociclib at the same dose and regime.

Compound (1) was orally dosed twice a day (BID) and palbociclib was orally dosed once a day (QD) for 30 days. Anti-tumor efficacy was evaluated by tumor volume measurement.

2-1: Experimental procedure

2-1-1: Animals, cell line, compounds

Female athymic nude mice were obtained from Harlan (Indianapolis, IN, USA). Animals were allowed to acclimate for at least four days before the study enrollment. Mice were 12 to 13 weeks old and weighed between 20.2 and 27.3 grams at the beginning of the treatments. These animals were housed under conditions outlined in the NIH Guide for Care and Use of Laboratory Animals in compliance with the USDA Laboratory Animal Welfare Act.

Parental MCF7 cells were obtained from the American Type Culture Collection (ATCC® HTB-22™). MCF7-Y537S (ESR1) cell line was MCF7 cells expressing the ER.Y537S variant that was generated by Sanofi Biology Discovery Group. Y537S mutation was introduced in ESR1 construct (GenBank NM_000125.3) by site directed mutagenesis (Toy W. *et al.,* Cancer Discovery, 2017, 7, 277-287). The construct was transfected in MCF7 cells which were selected for their growth in absence of estradiol. MCF-Y537S is an ESR1 mutation that confers estrogen-independent activity to ERα (Estrogen Receptor alpha) and contributes to endocrine resistant disease (Robinson D.R. *et al.*, Nat Genet., 2013, 45 (12), 1446-1451). The cells were grown in Eagle's Minimum Essential Medium (EMEM) supplemented with 10% fetal bovine serum (FBS), human Insulin, in 5% CO_2 at 37°C. The cells were harvested in 0.25% Trypsin EDTA and washed by Dulbecco's Phosphate Buffered Saline (DPBS) and re-suspended in DPBS with 50% matrigel (Becton Dickinson catalog No. 356234, lot No. 32277). The cells (20×10^6 cells/per mouse) were subcutaneously (SC) implanted into the right flank of female nude mice.

When the MCF7-Y537S tumors were established, the tumors were reserved as tumor stocks for fragment implantation. The tumors were serially propagated through fragment

tissue transplantation subcutaneously. The fragment tumor tissues were subcutaneously implanted into the right flank of female nude mice. 50 mice were assigned in this experiment.

Compound (1) and palbociclib (commercially available, marketed under the tradename Ibrance®) were formulated as follows:

. Vehicle A: 20% Labrasol® (supplied from Gattefosse SAS, France);

. Vehicle B: 5% Dextrose.

Compound (1) was prepared in Vehicle A, then Solutol HS15 (purchased from Sigma) was added to the final concentration 5%, and the solution was left under stirring for an hour for complete dissolution. After that, vehicle B was added. The final pH was 5.5.

Dose volume for compound (1) administration: 10 ml/kg by oral gavage.

Doses: 5 mg/kg (dosage of compound (1) in the above volume).

Palbociclib was prepared in Vehicle A, then Solutol HS15 was added to the final concentration 5%, and the solution was left under stirring for an hour for complete dissolution. After that, vehicle B was added. The final pH was 5.5.

Dose volume: 10 ml/kg by oral gavage.

Doses: 100 mg/kg (dosage of palbociclib in the above volume).

2-1-2: Study design, end points

The animals required for experiment (plus extra) were pooled and implanted with MCF7-Y537S tumor fragment tissues on day 0. On day 21 post implantation, the mice were pooled and randomly distributed to the treatment and control groups (10 mice per group), where median tumor volumes for each group ranged from 202.5 to 211.5 mm^3. Treatments of compound (1) and palbociclib were initiated on day 22. Compound (1) was orally administered at 5 mg/kg BID (at least 5 hours apart) and palbociclib was orally administered at 100 mg/kg QD, for 30 days. Animal body weight was assessed daily.

The dosages are expressed in mg/kg and based on daily body weight per animal. Vehicle treated animals were used as controls. Mice were checked daily and adverse clinical reactions noted. Individual mice were weighed daily until the end of the experiment. Mice would be euthanized when morbid or weight loss ≥20% was observed. Tumors were measured with a caliper twice weekly until final sacrifice. When a tumor size reached approximately 2000 mm^3 or when there are animal health issues (40% area of a tumor ulcerated), animals would be euthanized and date of death recorded. Solid tumor volumes

were estimated from two dimensional tumor measurements and calculated according to the following equation:

$$Tumor\ volume\left(mm^3\right)=\frac{length\ (mm)\times width^2\ (mm^2)}{2}$$

Toxicity end points:

A dosage producing either 15% body weight loss during 3 consecutive days for an individual mouse, 20% body weight loss during 1 day, or 10% or more drug related deaths, was considered an excessively toxic dosage, unless under certain circumstances bodyweight loss or animal death can be considered non-drug related. Examples include animal handling issues such as misgavage, tumor model related issues such as tumor induced cachexia leading to body weight loss that can be observed in control or vehicle treated groups and excessive tumor ulceration. Mice that have non-drug related death or significant bodyweight loss will not be considered toxic and will be excluded from statistical analysis. Animal body weight included the tumor weight.

Efficacy end points:

The primary efficacy end points include tumor volume changes from baseline summarized by the ratio of medians of tumor volume changes from baseline between the treated and control groups (ΔT/ΔC). Changes in tumor volume for each treated (T) and control (C) group are calculated for each animal on each day by subtracting the tumor volume on the day of first treatment (staging day) from the tumor volume on the specified observation day. The median ΔT is calculated for the treated group and the median ΔC is calculated for the control group. The ratio ΔT/ΔC is calculated and expressed as percentage:

$$\Delta T\ /\ \Delta C=\left(\frac{Median\ deltaT}{Median\ deltaC}\right)\times 100$$

ΔT/ΔC ≤ 40% is considered as therapeutically active, ΔT/ΔC = 0% is considered as tumor stasis, and ΔT/ΔC < 0% is considered as tumor regression (very active). ΔT/ΔC > 40% is considered as therapeutically inactive.

Percent tumor regression is defined as % (percentage) of tumor volume decrease in the treated group on a specified observation day compared to its volume when the study was initiated. At a specific time point (t) and for each animal, the regression percentage is calculated using the following formula:

$$\%\ regression\ \ (at\ t)=\left(\frac{volume_{t0}-volume_t}{volume_{t0}}\right)\times 100$$

The median percent regression for a group on a given day is then calculated by taking the median of individual % regression values calculated for each animal in the group. The day of calculation is determined by the day when ΔT/ΔC is calculated, excepted if median percent regression is not representative of the activity of the group. In this case, the day is determined by the first day when the median percent regression is maximal.

2-1-3: Statistical analysis

A two-way Anova-Type analysis with factors treatment and day (repeated) is performed on tumor volume changes from baseline. It is followed by contrast analyses with Bonferroni-Holm correction for multiplicity to compare all treated groups to the control group and to compare the combination *versus* each single agent at the dose involved in the combination at each day from day 27 to 51.

In the figures, the medians and Median Absolute Deviation (MAD) of each group are represented for each day of measurement.

In the tables, the medians and Normalized MAD (nMAD = 1.4826*MAD) of each group are reported for each day of measurement.

Tumor volume changes from baseline are calculated for each animal and each day by subtracting the tumor volume on the day of first treatment (day 21) from the tumor volume on the specified observation day.

All statistical analyses were performed using SAS version 9.2 software. A probability of less than 5% ($p<0.05$) was considered as significant.

2-2: Results

Compound (1) at 5 mg/kg BID, palbociclib 100 mg/kg QD and the combination of compound (1) and palbociclib at the doses and regime for 30 days were well tolerated in this study showing average body weight change in % per group at nadir (the lowest of body weight drop in the group) of -1.7% (day 22), -2.0% (day 22) and -6.4% (day 26), respectively (Table 1).

Compound (1) at a dose of 5 mg/kg BID for 30 days had minimal effect on tumor growth with ΔT/ΔC value of 59% ($p = 0.4113$) on day 51. Palbociclib at a dose of 100 mg/kg QD for 30 days achieved anti-tumor efficacy with ΔT/ΔC value of 27% ($p<0.0001$) on day 51. When compound (1) at 5 mg/kg combined with palbociclib 100 mg/kg with the same dose regime as BID for compound (1) and QD for palbociclib, the combination treatment demonstrated strong anti-tumor efficacy with ΔT/ΔC value less than 0 ($p < 0.0001$) and

induced tumor regression (median tumor regression 32%) on day 51. The statistical analysis indicated the combination effect was significantly different when compared to either compound (1) alone or palbociclib alone on day 51 ($p < 0.0001$). Detailed results are shown in Tables 1, 2 and 3 below, as well as in Figures 2 and 3:

- Figure 2: Antitumor activity of compound (1) combined with palbociclib against subcutaneous human breast cancer cell line MCF7-Y537S xenograft in nude mice: tumor volume evolution. The curves represent medians + or – MAD (Median Absolute Deviation) at each day for each group;
- Figure 3: Antitumor activity of compound (1) combined with palbociclib against subcutaneous human breast cancer cell line MCF7-Y537S xenograft in nude mice: tumor volume changes from baseline on day 51. Points represent individual tumor volume changes from baseline on day 51, bars correspond to medians.

From this experiment, we conclude that the compound (1) at 5 mg/kg twice a day combined with the CDK4 inhibitor palbociclib at 100 mg/kg once a day induced significant anti-tumor efficacy and tumor regression in MCF7-Y537S human breast cancer cell line xenograft model in nude mice that was superior to single agents alone.

Table 1: Efficacy of compound (1) combined with palbociclib against subcutaneous MCF7-Y537S human breast cancer xenograft in nude mice.

Agent	Route/ Dosage (in mL/kg per injection)	Dosage in mg/kg per injection (total dose)	Schedule in days (total of 30 days)	*Unscheduled death (Day of death)	Average body weight change in % per group at nadir (day of nadir)	△T/△C in % at day 51	Median % of regressions on day 51	Regressions		p-value on day 47 #	Biological Interpretation
								Partial	Complete		
Vehicle	PO, BID (10)	-	-	0/10	-2.2 (22)	100	-	0/10	0/10	-	-
Compound (1)	PO, BID (10)	5 (295) N.B.	22 to 51	2/10	-1.7 (22)	59	NR	0/8	0/8	p = 0.4113	Inactive
Palbociclib	PO, QD (10)	100 (3000)	22 to 51	0/10	-2.0 (22)	27	NR	0/10	0/10	p < 0.0001	Active
Compound (1) + Palbociclib	PO, BID (10) PO, QD (10)	5 (295) N.B. + 100 (3000)	22 to 51	1/10	-2.3 (26)	<0	32	2/9	0/9	p < 0.0001	Very active

PO: *per os*

N.B.: animals accepted one dose in the starting date.

NR: no regression (0% regression).

Statistical analysis: Comparison of each single agent and combination *versus* the control group. The p-values were obtained using a contrast analysis to compare each treated group *versus* control at each day using Bonferroni-Holm adjustment for multiplicity after a two-way Anova-Type with repeated measures on tumor volume changes from baseline. A probability less than 5% ($p<0.05$) was considered as significant.

*3 mice were excluded from statistical analysis because those mice corresponded to non-drug related death or terminations during the study.

Table 2: Efficacy of compound (1) combined with palbociclib against subcutaneous human breast cancer cell line MCF7-Y537S xenograft model in nude mice. Comparison of each group to the control group at each day.

Tumor volume changes from baseline mm³ : Median (nMAD)*, n and p-value#									
Treatment Group	Global	Day 27	Day 30	Day 34	Day 37	Day 41	Day 44	Day 49	Day 51
Control	-	111.5 (44.48) n=10	181.0 (78.58) n=10	296.0 (133.43) n=10	392.0 (235.73) n=10	663.0 (363.24) n=10	867.0 (456.64) n=10	1140.0 (615.28) n=10	1322.0 (633.07) n=10
Compound (1) 5 mg/kg	-	114.0 (19.27) n=8	171.5 (31.13) n=8	270.5 (112.68) n=8	336.0 (112.68) n=8	440.0 (39.29) n=8	498.5 (91.18) n=8	727.5 (160.86) n=8	782.0 (112.68) n=8
	0.3975	0.6333	0.3909	0.7343	0.5990	0.2495	0.1950	0.3770	0.4113
Palbociclib 100 mg/kg	-	68.5 (31.88) n=10	98.0 (25.20) n=10	121.5 (34.10) n=10	132.0 (31.88) n=10	193.5 (52.63) n=10	249.5 (43.74) n=10	298.5 (97.11) n=10	363.5 (108.23) n=10
	<0.0001	0.1164	0.0009	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Compound (1) 5 mg/kg + Palbociclib 100 mg/kg	-	-8.0 (63.75) n=9	-17.0 (97.85) n=9	-35.0 (74.13) n=9	-30.0 (57.82) n=9	-43.0 (60.79) n=9	-63.0 (45.96) n=9	-53.0 (72.65) n=9	-52.0 (72.65) n=9
	<0.0001	0.0077	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

p-values obtained with a contrast analysis *versus* control at each day with Bonferroni-Holm adjustment for multiplicity after a two-way Anova-Type on tumor volume changes from baseline.
* MAD= Median Absolute Deviation; nMAD= normalized MAD; nMAD= 1.4826*MAD.

For palbociclib at 100 mg/kg, the effect on tumor volume changes from baseline is significant compared to the control group from day 30 to day 51.

For the combination compound (1) at 5 mg/kg + palbociclib at 100 mg/kg, the effect on tumor volume changes from baseline is significant compared to the control group from day 27 to day 51.

n = number of animals. 3 mice were excluded from statistical analysis because those mice corresponded to non-drug related death or terminations during the study.

Table 3: Efficacy of compound (1) combined with palbociclib against subcutaneous human breast cancer cell line MCF7-Y537S xenograft model in nude mice. Comparison of compound (1) 5 mg/kg and palbociclib 100 mg/kg as single agents *versus* the combination at each day.

Tumor volume changes from baseline mm³ : Median (nMAD)*, n and p-value#									
Treatment Group	Global	Day 27	Day 30	Day 34	Day 37	Day 41	Day 44	Day 49	Day 51
Compound (1) 5 mg/kg + Palbociclib 100 mg/kg	-	-8.0 (63.75) n=9	-17.0 (97.85) n=9	-35.0 (74.13) n=9	-30.0 (57.82) n=9	-43.0 (60.79) n=9	-63.0 (45.96) n=9	-53.0 (72.65) n=9	-52.0 (72.65) n=9
Palbociclib 100 mg/kg	-	68.5 (31.88) n=10	98.0 (25.20) n=10	121.5 (34.10) n=10	132.0 (31.88) n=10	193.5 (52.63) n=10	249.5 (43.74) n=10	298.5 (97.11) n=10	363.5 (108.23) n=10
	<0.0001	0.2417	0.0736	0.0026	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Compound (1) 5 mg/kg	-	114.0 (19.27) n=8	171.5 (31.13) n=8	270.5 (112.68) n=8	336.0 (112.68) n=8	440.0 (39.29) n=8	498.5 (91.18) n=8	727.5 (160.86) n=8	782.0 (112.68) n=8
	<0.0001	0.0342	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

p-values obtained with a contrast analysis to compare the combinations of compound (1) and palbociclib *versus* each single agent at the dose involved in the combination at each day with Bonferroni-Holm adjustment for multiplicity after a two-way Anova-Type on tumor volume changes from baseline.
* MAD= Median Absolute Deviation; nMAD= normalized MAD ; nMAD= 1.4826*MAD

The effect of the combination of compound (1) at 5 mg/kg + palbociclib at 100 mg/kg is significantly greater than the effect of palbociclib at 100 mg/kg alone on day 34 to day 51.

The effect of the combination of compound (1) at 5 mg/kg + palbociclib at 100 mg/kg is significantly greater than the effect of compound (1) at 5 mg/kg alone on day 27 to day 51.

n = number of animals. 3 mice were excluded from statistical analysis because those mice corresponded to non-drug related death or terminations during the study.

CLAIMS

1. Use of a combination comprising 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid, or a pharmaceutically acceptable salt thereof, and palbociclib, in the manufacture of a medicament for treating cancer.

2. The use according to claim 1, wherein the combination shows therapeutic synergy.

3. The use according to claim 1, wherein 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid, or a pharmaceutically acceptable salt thereof, and palbociclib are to be administered simultaneously, separately, or spaced out over a period of time.

4. The use according to claim 1 or claim 2, wherein the cancer is breast cancer.

5. A pharmaceutical composition comprising 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid, or a pharmaceutically acceptable salt thereof, and palbociclib, and at least one pharmaceutically acceptable excipient.

6. The pharmaceutical composition according to claim 5, for use in the treatment of cancer.

7. The pharmaceutical composition according to claim 6, wherein the cancer is breast cancer.

8. Use of a compound 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for treating cancer, by co-administration with palbociclib.

9. Use of palbociclib in the manufacture of a medicament for treating cancer, by co-administration with compound 6-(2,4-dichlorophenyl)-5-[4-[(3S)-1-(3-fluoropropyl)pyrrolidin-3-yl]oxyphenyl]-8,9-dihydro-7H-benzo[7]annulene-2-carboxylic acid or a pharmaceutically acceptable salt thereof.