(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 June 2017 (15.06.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/099530 A1

(51) **International Patent Classification**:
C07D 401/04 (2006.01) ***A61K 31/41*** (2006.01)
C07D 403/04 (2006.01) ***A61K 31/4439*** (2006.01)
C07D 257/04 (2006.01)

(21) **International Application Number**:
PCT/KR2016/014467

(22) **International Filing Date**:
9 December 2016 (09.12.2016)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
10-2015-0177169
11 December 2015 (11.12.2015) KR

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2017/099530 A1

(54) **Title**: PREPARATION METHOD OF INTERMEDIATE FOR OXAZOLIDINONE DERIVATIVE

(57) **Abstract**: Disclosed is a method of preparing an intermediate for an oxazolidinone derivative, which enables 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine to be produced at high yield and high purity, thus exhibiting high preparation efficiency under optimal processing conditions and making it suitable for industrial mass production.

Description

Title of Invention: PREPARATION METHOD OF INTERMEDIATE FOR OXAZOLIDINONE DERIVATIVE

Technical Field

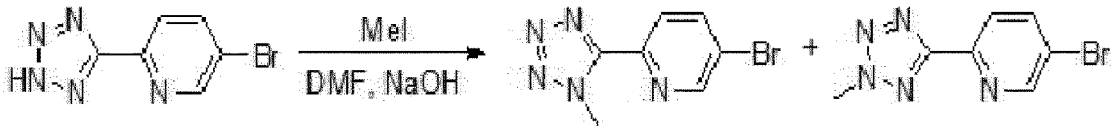
[1] The present invention relates to a method of preparing an intermediate for an oxazolidinone derivative.

Background Art

[2] Tedizolid is a compound having an oxazolidinone structure, and has the chemical name "(5R)-3-{3-fluoro-4-[6-(2-methyl-2H-tetrazol-5-yl)pyridin-3-yl]phenyl}-5-(hydroxymethyl)-1,3-oxazolidin-2-one". This tedizolid is an oxazolidinone-based derivative compound (disclosed in Korean Patent Application Publication No. 10-2005-0061271) that is useful as a disinfecting agent, and is sold in the form of an oral formulation and an injectable formulation under the trade name of SIVEXTRO, with the permission of the U.S. Food and Drug Administration.

[3] Korean Patent Application Publication No. 10-2005-0061271 discloses a method of preparing an intermediate for an oxazolidinone derivative, as shown in Scheme 1 below.

[4] [Scheme 1]

[5] 

*N*1-isomer *N*2-isomer

[6] In the preparation procedures of Scheme 1, however, the methylation of tetrazole is not selective, undesirably producing tetrazole in which the methyl group is added to a different position.

[7] This is because the NH bonding of tetrazole is present in two tautomer forms. Hence, when the methyl group is added to tetrazole, two kinds of compounds, namely 1,5-disubstituted tetrazole and 2,5-disubstituted tetrazole, are formed.

[8] The methylation of tetrazole in this way is not suitable for industrial use because of the low yield and low selectivity to desired compounds, and also suffers from high production costs.

[9] Furthermore, dimethyl sulfate, diazomethane, or trimethylsilyl diazomethane, useful for the methylation of tetrazole, is highly toxic, highly explosive, and expensive, and is thus inappropriate for industrial mass production.

Disclosure of Invention

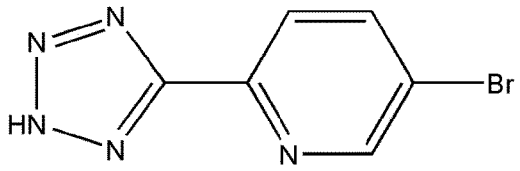
Technical Problem

[10] Accordingly, the present invention has been made keeping in mind the above problems encountered in the related art, and the present invention is intended to provide a method of preparing an intermediate for an oxazolidinone derivative, namely 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine, at high yield and high purity from 5-bromo-2-(2H-tetrazol-5-yl)pyridine.

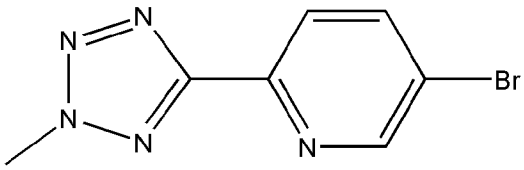
Solution to Problem

[11] The present invention provides a method of preparing the compound represented by Chemical Formula 1 below, comprising reacting the compound represented by Chemical Formula 2 below with a methylating agent in the presence of a solvent and a base, wherein the solvent is a solvent mixture of a polar aprotic solvent and a hydrocarbon chloride solvent or a polar protic solvent.

[12] [Chemical Formula 2]

[13] 

[14] [Chemical Formula 1]

[15] 

[16] The compound represented by Chemical Formula 2 is a compound having the chemical name of 5-bromo-2-(2H-tetrazol-5-yl)pyridine, and the compound represented by Chemical Formula 1 is a compound having the chemical name of 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine, and a structural difference between these two compounds is the presence or absence of the methyl group that is substituted in the tetrazole ring.

[17] The method of the invention is a methylation reaction, in which a methyl group is added to the nitrogen at Position 2 on the tetrazole ring of the compound represented by Chemical Formula 2 in place of hydrogen.

[18] The methylation reaction of the invention is preferably carried out using a solvent mixture comprising a polar aprotic solvent and a hydrocarbon chloride solvent or a polar protic solvent.

[19] The polar aprotic solvent may include, but is not limited to, at least one selected from the group consisting of *N,N*-dimethyl formamide, tetrahydrofuran, ethyl acetate,

chloroform, 1,2-dichloroethane, 1,4-dioxane, ethyl ether, diisopropyl ether, diethylene glycol dimethyl ether, acetone, 2-butanone, cyclohexanone, dimethyl sulfoxide, *N,N*-dimethyl acetamide, and mixtures thereof.

[20] The hydrocarbon chloride solvent is preferably methylene chloride.

[21] The polar protic solvent may include, but is not limited to, at least one selected from the group consisting of water, methanol, ethanol, isopropanol, butanol, nitromethane, acetic acid, and mixtures thereof.

[22] Preferably, the solvent mixture of the invention is a solvent mixture of *N,N*-dimethyl formamide and methylene chloride, a solvent mixture of *N,N*-dimethyl formamide and methanol, or a solvent mixture of *N,N*-dimethyl formamide and ethanol.

[23] The solvent mixture of *N,N*-dimethyl formamide and methylene chloride comprises *N,N*-dimethyl formamide and methylene chloride at a volume ratio of 1:1 to 50, preferably 1:1 to 9, and more preferably 1:9.

[24] The solvent mixture of *N,N*-dimethyl formamide and methanol comprises *N,N*-dimethyl formamide and methanol at a volume ratio of 1:1 to 50, preferably 1:1 to 9, and more preferably 3:7.

[25] The solvent mixture of *N,N*-dimethyl formamide and ethanol comprises *N,N*-dimethyl formamide and ethanol at a volume ratio of 1:1 to 50, preferably 1:1 to 9, and more preferably 1:1 or 3:7.

[26] The base, which is used in the methylation reaction of the invention, may be an inorganic base or an organic base, and preferably includes, but is not limited to, at least one selected from the group consisting of lithium hydroxide (LiOH), sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3), potassium carbonate (K_2CO_3), cesium carbonate (Cs_2CO_3), calcium carbonate ($CaCO_3$), calcium hydroxide ($Ca(OH)_2$), iron hydroxide (FeO(OH)), potassium hydroxide (KOH), magnesium hydroxide ($Mg(OH)_2$), pyridine, piperidine, triethylamine, *N,N*-diisopropylethylamine (DIEA), and mixtures thereof.

[27] Preferably, the base used in the methylation reaction of the invention is calcium hydroxide ($Ca(OH)_2$).

[28] Preferably, the base is used in an amount of 0.3 to 7.0 equivalents relative to 1 equivalent of the compound represented by Chemical Formula 2, and more preferably, 0.4 to 1.2 equivalents relative to 1 equivalent of the compound represented by Chemical Formula 2, in order to attain higher selectivity and yield.

[29] The methylating agent used in the methylation reaction of the invention is preferably iodomethane.

[30] Also, the methylation reaction of the invention may be carried out at 0 to 100°C, and is preferably carried out at 20 to 40°C in order to attain higher selectivity and yield.

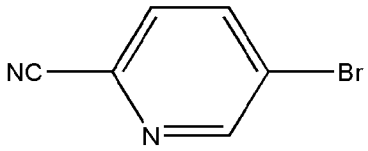
[31] In the method of the invention, the compound represented by Chemical Formula 2 may be formed into the compound represented by Chemical Formula 1 at a high yield

of 65% or more and a high purity of 99% or more through purification, with a selectivity at an *N*2/*N*1 ratio of at least 75/25, preferably at least 80/20, and more preferably at least 85/15.

[32] In the method of the invention, a methyl group may be selectively added to the nitrogen at Position 2 on the tetrazole ring of the compound represented by Chemical Formula 2, thereby preparing the compound represented by Chemical Formula 1 at high yield and high purity with very high selectivity. Thus, the method of the invention may be easily applied to industrial mass production.

[33] Also, the compound represented by Chemical Formula 2 is preferably prepared by reacting the compound represented by Chemical Formula 3 below with an alkali metal azide using a pyridine solvent in the presence of zinc chloride.

[34] [Chemical Formula 3]

[35] 

[36] The alkali metal azide may include, but is not limited to, lithium azide, sodium azide, potassium azide, or cerium azide.

[37] When the compound of Chemical Formula 2 is prepared from the compound of Chemical Formula 3 in this way, ammonium chloride, which is typically used in the process of preparing tetrazole, is not used, and thus the generation of toxic gases may be prevented, making the process of the invention environmentally friendly. The use of zinc chloride enables tetrazole, namely the compound of Chemical Formula 2, to be produced at higher yield and purity.

[38] Also, the method of preparing the compound represented by Chemical Formula 1 may further comprise crystallizing the compound of Chemical Formula 1 using a crystallization solvent.

[39] The compound of Chemical Formula 1 resulting from the methylation reaction may be purified through crystallization with the crystallization solvent.

[40] The crystallization solvent may be at least one selected from the group consisting of a polar protic solvent, a polar aprotic solvent, C_{4-11} ether, C_{4-8} alkane, C_{1-4} lower alcohol, and mixtures thereof. Preferably useful as the crystallization solvent is acetone.

Advantageous Effects of Invention

[41] According to the present invention, the method enables an intermediate for an oxazolidinone derivative, namely 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine, to be prepared at high yield and high purity from 5-bromo-2-(2H-tetrazol-5-yl)pyridine, thus exhibiting high preparation efficiency under optimal processing conditions and making

it suitable for industrial mass production.

Mode for the Invention

[42] A better understanding of the present invention may be obtained through the following examples which are set forth to illustrate, but are not to be construed as limiting the present invention.

[43] **Reference Example: Reagent and Instrument**

[44] Unless otherwise stated, the following reagents and instruments were purchased from Sigma-Aldrich Korea, HPLC was performed using a 1200 Series model available from Agilent Technologies, and ^{1}H NMR was measured using a Bruker NMR 400 MHz Spectrometer. The purity was measured based on the area% of HPLC.

[45] [HPLC Conditions]

[46]

Parameter	Conditions/Setting
HPLC system	Reverse phase
Column	Waters Sunfire C18, 3.5 μm, 4.6*150 mm
Column temperature	Room temperature
Automatic sampler temperature	Room temperature
Detection	UV at 254 nm
Mobile phase A	0.1% TFA in water
Mobile phase B	0.1% TFA in AN
Gradient	Time (min) / Mobile phase A (%) / Mobile phase B (%): 0.00 / 100 / 0; 2.0 / 100 / 0; 20.0 / 0 / 100; 21.0 / 100 / 0; 31.0 / 100 / 0
Flow rate	1.0 mL/min
Injection volume	10 μL
Data collection time	20 min

[47] **Example 1: Preparation of 5-**bromo-2-(2H-tetrazol-5-yl)pyridine

[48] Pyridine (40.0 mL, 4.0 v/w) was placed in a reactor, and zinc chloride (11.2 g, 81.9 mmol) was added dropwise at 40°C or less. Thereafter, sodium azide (8.90 g, 137 mmol) and 5-bromo-2-cyanopyridine (10.0 g, 54.6 mmol) were added into the reactor, and the reaction mixture was stirred to reflux at 120°C for 2 hr. After the termination of the reaction, the reaction product was cooled to room temperature, added with purified water (200 mL, 20.0 v/w), stirred at room temperature for 1 hr, filtered, and washed with purified water (200 mL, 20.0 v/w). The filtered solid was added with a 6 N hydrochloric acid aqueous solution (200 mL, 20.0 v/w) and then stirred at room tem-

perature for 2 hr. The reaction product was filtered, washed with purified water (200 mL, 20.0 v/w), and concentrated under reduced pressure, thus yielding a desired white compound. Yield (11.34 g, 91.8%), Purity 99.4%

[49] 5-bromo-2-(2H-tetrazol-5-yl)pyridine:

[50] ^{1}H NMRδ (DMSO-d6, ppm) 8.95 (d,1H), 8.35 (dd,1H), 8.17 (d,1H)

[51] **Example 2: Preparation of 5-**bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine

[52] The 5-bromo-2-(2H-tetrazol-5-yl)pyridine (20.0 g, 88.4 mmol) prepared in Example 1 was added with 20.0 mL of *N,N*-dimethyl formamide and 180.0 mL of methylene chloride and then further added with calcium hydroxide (3.94 g, 53.0 mmol), after which iodomethane (33.0 mL, 530.4 mmol) was slowly added dropwise thereto at 0°C. Thereafter, the reaction solution was warmed to 40°C and stirred for 24 hr. After the termination of the reaction, the reaction solution was added with water, thus extracting an organic layer. The extracted organic layer was washed with saline and further extracted. The resulting organic layer was added with 300.0 mL of a 6 N hydrochloric acid aqueous solution to thus extract an aqueous layer, after which the separated organic layer was added with 60.0 mL of a 6 N hydrochloric acid aqueous solution, so that the aqueous layer was further extracted. Extraction was performed using HPLC until the amount of *N*1 was less than 5%. The separated aqueous layer was collected, and the pH thereof was adjusted to 10.6 at 40°C or less using a 50% sodium hydroxide aqueous solution. The produced solid was filtered, washed with water, and concentrated under reduced pressure, thus obtaining a desired compound. Yield (16.2 g, 70.5%), *N2/N1* ratio % (98/2)

[53] **Examples 3 to 14: Preparation of 5-**bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine

[54] The 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine of Examples 3 to 14 was prepared from 5-bromo-2-(2H-tetrazol-5-yl)pyridine in the same manner as in Example 2, with the exception that the methylating agent, base, solvent, warming and stirring temperature and reaction temperature were changed as shown in Table 1 below. The results of the amount (%) of the starting material (5-bromo-2-(2H-tetrazol-5-yl)pyridine) remaining after the reaction and the *N*2/*N*1 ratio are shown in Table 2 below.

[55] [Table 1]

[56]

	Methylating agent	Base	Solvent	Temp.	Reaction time
Ex.3	MeI (7.0 eq)	NaOH (3.5 eq)	DMF/EtOH (1/1, 10 v/w)	RT	30 hr
Ex.4	MeI (7.0 eq)	NaOH (3.5 eq)	DMF/MeOH (1/1, 10 v/w)	RT	30 hr
Ex.5	MeI (7.0 eq)	$Ca(OH)_2$ (3.5 eq)	DMF/MC (3/7, 10 v/w)	RT	24 hr
Ex.6	MeI (10.0 eq)	NaOH (3.5 eq)	DMF/MC (3/7, 10 v/w)	40°C	24 hr
Ex.7	MeI (10.0 eq)	NaOH (3.5 eq)	DMF/EtOH (3/7, 10 v/w)	40°C	22 hr
Ex.8	MeI (7.0 eq)	NaOH (1.0 eq)	DMF/MC (3/7, 10 v/w)	40°C	24 hr
Ex.9	MeI (7.0 eq)	NaOH (2.0 eq)	DMF/MC (3/7, 10 v/w)	40°C	23 hr
Ex.10	MeI (5.0 eq)	$Ca(OH)_2$ (0.5 eq)	DMF/MC (1/9, 10 v/w)	40°C	30 hr
Ex.11	MeI (6.0 eq)	$Ca(OH)_2$ (0.6 eq)	DMF/MC (1/9, 10 v/w)	40°C	22 hr
Ex.12	MeI (9.0 eq)	$Ca(OH)_2$ (0.6 eq)	DMF/MC (1/9, 10 v/w)	40°C	22 hr
Ex.13	MeI (10.0 eq)	$Ca(OH)_2$ (1.0 eq)	DMF/MC (1/9, 10 v/w)	40°C	24 hr
Ex.14	MeI (10.0 eq)	$Ca(OH)_2$ (3.5 eq)	DMF/MC (1/9, 10 v/w)	40°C	24 hr

[57] (MeI: iodomethane, NaOH: sodium hydroxide, $Ca(OH)_2$: calcium hydroxide, DMF: *N,N*-dimethyl formamide, EtOH: ethanol, MeOH: methanol, MC: methylene chloride, eq: equivalent, RT: room temperature)

[58] [Table 2]

[59]

	Starting material%	*N2*/*N1* Ratio
Ex.3	5.03	79/21
Ex.4	7.13	75/25
Ex.5	0.14	77/23
Ex.6	4.05	82/18
Ex.7	8.57	79/21
Ex.8	2.51	75/25
Ex.9	0.51	81/19
Ex.10	0.20	89/11
Ex.11	0.09	89/11
Ex.12	0.44	88/12
Ex.13	1.25	88/12
Ex.14	0.83	85/15

[60] (Starting material%: the amount (%) of 5-bromo-2-(2H-tetrazol-5-yl)pyridine remaining after methylation, *N*2/*N*1 Ratio: Ratio of compound in which methyl is added to Position 2 of tetrazole/compound in which methyl is added to Position 1 of tetrazole)

[61] **Example 15: Purification of 5-**bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine

[62] 16.2 g of the dried 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine of Example 2 was added with 48.6 mL of acetone, stirred to reflux for 1 hr, and cooled to room temperature to produce a solid, which was then filtered, washed with purified water, dewatered, and concentrated under reduced pressure. Yield (15.1 g, 65.7%, recovery efficiency 93.2%), Purity 99.3%

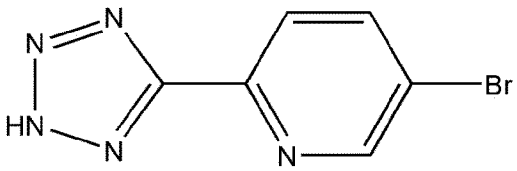
[63] 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine:

[64] ^{1}H NMRδ ($CDCl_3$, ppm) 8.82 (dd,1H), 8.14 (dd,1H), 8.00 (dd,1H), 4.45 (s,3H)

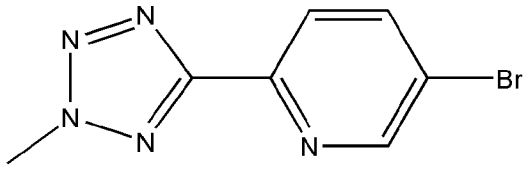
Claims

[Claim 1] A method of preparing a compound represented by Chemical Formula 1 below, comprising reacting a compound represented by Chemical Formula 2 below with a methylating agent in presence of a solvent and a base, wherein the solvent is a solvent mixture of a polar aprotic solvent and a hydrocarbon chloride solvent or a polar protic solvent:

[Chemical Formula 2]



[Chemical Formula 1]



[Claim 2] The method of claim 1, wherein the polar aprotic solvent is at least one selected from the group consisting of *N,N*-dimethyl formamide, tetrahydrofuran, ethyl acetate, chloroform, 1,2-dichloroethane, 1,4-dioxane, ethyl ether, diisopropyl ether, diethylene glycol dimethyl ether, acetone, 2-butanone, cyclohexanone, dimethyl sulfoxide, *N,N*-dimethyl acetamide, and mixtures thereof.

[Claim 3] The method of claim 1, wherein the hydrocarbon chloride solvent is methylene chloride.

[Claim 4] The method of claim 1, wherein the polar protic solvent is at least one selected from the group consisting of water, methanol, ethanol, isopropanol, butanol, nitromethane, acetic acid, and mixtures thereof.

[Claim 5] The method of claim 1, wherein the solvent mixture is a solvent mixture of *N,N*-dimethyl formamide and methylene chloride, a solvent mixture of *N,N*-dimethyl formamide and methanol, or a solvent mixture of *N,N*-dimethyl formamide and ethanol.

[Claim 6] The method of claim 5, wherein the solvent mixture of *N,N*-dimethyl formamide and methylene chloride comprises *N,N*-dimethyl formamide and methylene chloride at a volume ratio of 1:1 to 50, the solvent mixture of *N,N*-dimethyl formamide and methanol comprises *N,N*-dimethyl formamide and methanol at a volume ratio of 1:1 to 50, or the solvent mixture of *N,N*-dimethyl formamide and ethanol comprises *N,N*

-dimethyl formamide and ethanol at a volume ratio of 1:1 to 50.

[Claim 7] The method of claim 5, wherein the solvent mixture of *N,N*-dimethyl formamide and methylene chloride comprises *N,N*-dimethyl formamide and methylene chloride at a volume ratio of 1:1 to 9, the solvent mixture of *N,N*-dimethyl formamide and methanol comprises *N,N*-dimethyl formamide and methanol at a volume ratio of 1:1 to 9, or the solvent mixture of *N,N*-dimethyl formamide and ethanol comprises *N,N*-dimethyl formamide and ethanol at a volume ratio of 1:1 to 9.

[Claim 8] The method of claim 1, wherein the base is at least one selected from the group consisting of lithium hydroxide (LiOH), sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3), potassium carbonate (K_2CO_3), cesium carbonate (Cs_2CO_3), calcium carbonate ($CaCO_3$), calcium hydroxide ($Ca(OH)_2$), iron hydroxide (FeO(OH)), potassium hydroxide (KOH), magnesium hydroxide ($Mg(OH)_2$), pyridine, piperidine, triethylamine, *N,N*-diisopropylethylamine (DIEA), and mixtures thereof.

[Claim 9] The method of claim 1, wherein the base is calcium hydroxide ($Ca(OH)_2$).

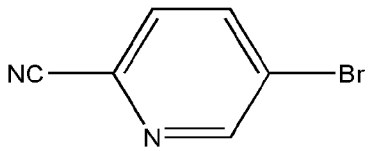
[Claim 10] The method of claim 1, wherein the base is used in an amount of 0.3 to 7.0 equivalents relative to 1 equivalent of the compound represented by Chemical Formula 2.

[Claim 11] The method of claim 1, wherein the methylating agent is iodomethane.

[Claim 12] The method of claim 1, wherein the reacting is carried out at 0 to 100℃.

[Claim 13] The method of claim 1, wherein the compound represented by Chemical Formula 2 is prepared by reacting a compound represented by Chemical Formula 3 below with an alkali metal azide using a pyridine solvent in presence of zinc chloride:

[Chemical Formula 3]



[Claim 14] The method of claim 13, wherein the alkali metal azide is lithium azide, sodium azide, potassium azide, or cerium azide.

[Claim 15] The method of any one of claims 1 to 14, further comprising crystallizing the compound of Chemical Formula 1 using a crystallization solvent.

[Claim 16] The method of claim 15, wherein the crystallization solvent is at least

one selected from the group consisting of a polar protic solvent, a polar aprotic solvent, C_{4-11} ether, C_{4-8} alkane, C_{1-4} lower alcohol, and mixtures thereof.

[Claim 17] The method of claim 16, wherein the crystallization solvent is acetone.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/014467

A. CLASSIFICATION OF SUBJECT MATTER

C07D 401/04(2006.01)i, C07D 403/04(2006.01)i, C07D 257/04(2006.01)i, A61K 31/41(2006.01)i, A61K 31/4439(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)
C07D 401/04; A61K 31/422; C07D 263/22; C07D 413/14; C07D 403/04; C07D 257/04; A61K 31/41; A61K 31/4439

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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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: 5-bromo-2-(2-methyl-2H-tetrazol-5-yl)pyridine, oxazolidinone, intermediate, methylating agent, preparation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JO, Y. W. et al., "Synthesis and antibacterial activity of oxazolidinones containing pyridine substituted with heteroaromatic ring", Bioorganic & Medicinal Chemistry, 2004, Vol. 12, No. 22, pages 5909-5915. See pages 5910-5914; schemes 1-2.	1-17
A	IM, W. B. et al., "Discovery of torezolid as a novel 5-hydroxymethyl-oxazolidinone antibacterial agent", European Journal of Medicinal Chemistry, 2011, Vol. 46, No. 4, pages 1027-1039. See the whole document.	1-17
A	KR 10-2011-0071107 A (TRIUS THERAPEUTICS) 28 June 2011 See the whole document.	1-17
A	WO 2006-038100 A1 (RANBAXY LABORATORIES LIMITED) 13 April 2006 See the whole document.	1-17
A	KR 10-2005-0061271 A (DONG-A PHARM. CO., LTD.) 22 June 2005 See the whole document.	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2017 (17.03.2017)	**17 March 2017 (17.03.2017)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2016/014467

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