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2011-033042 18 February 2011 (18.02.2011) JP(71) Applicant (for all designated States except US): **SUMITOMO CHEMICAL COMPANY, LIMITED** [JP/JP];
27-1, Shinkawa 2-chome, Chuo-ku, Tokyo, 1048260 (JP).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **HAGIYA, Koji** [JP/JP]; c/o SUMITOMO CHEMICAL COMPANY, LIMITED, 1-98, Kasugadenaka 3-chome, Konohana-ku, Osaka-shi, Osaka, 5548558 (JP).(74) Agents: **SAMEJIMA, Mutsumi** et al.; AOYAMA & PARTNERS, IMP Building, 3-7, Shiromi 1-chome, Chuo-ku, Osaka-shi, Osaka, 5400001 (JP).

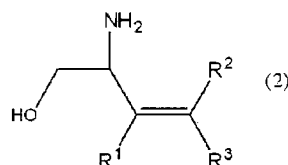
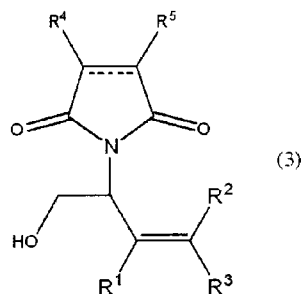
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(54) Title: PROCESS FOR PRODUCING 2 - AMINO - 3 - BUTENE - 1 - OL



(57) **Abstract:** The present invention provides a novel process for producing 2-amino-3-butene-1-ol compound. A process for producing 2-amino-3-butene-1-ol compound of the following formula (2) comprising a step of reacting an alkenylimide compound of the formula (3) with an ammonia, wherein R¹, R² and R³ each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom; R⁴ and R⁵ each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom or alternatively R⁴ and R⁵ are combined each other together with the carbon atoms to which R⁴ and R⁵ are each binded to form a cycloalkyl ring or an aromatic ring; a dashed line represents that said sites may be a double bond.

DESCRIPTION

PROCESS FOR PRODUCING 2 - AMINO - 3 - BUTENE - 1 - OL

5 TECHNICAL FIELD

The present invention relates to a process for producing 2-amino-3-butene-1-ol compound.

BACKGROUND ART

10 2-Amino-3-butene-1-ol compound is an important compound as a monomer for functional polymer, and is also an important compound as a starting material for bioactive substance such as medicine and agrochemicals.

As a process for producing 2-amino-3-butene-1-ol
15 compound, for example, Journal of the American Chemical Society, vol.79, page 4792-4796 (1950) describes a process for producing 2-amino-3-butene-1-ol by reacting 1,2-epoxybutene with aqueous ammonia.

20 DISCLOSURE of INVENTION

(PROBLEMS TO BE SOLVED BY INVENTION)

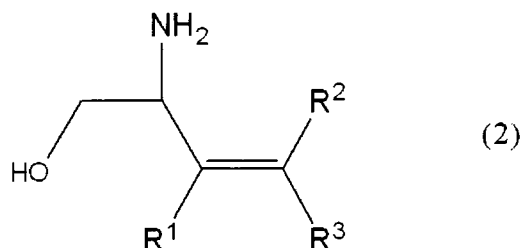
An object of the present invention is to provide a novel process for producing 2-amino-3-butene-1-ol compound.

25 (MEANS TO SOLVE PROBLEMS)

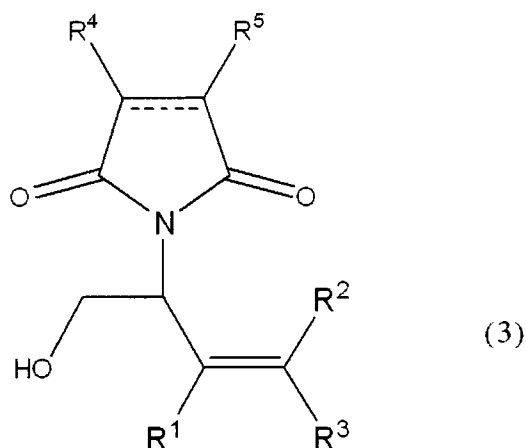
The present inventor has intensively studied, and as a result, has completed the present invention.

That is, the present invention provides:

- [1] A process for producing 2-amino-3-butene-1-ol compound
5 of the formula (2):



- wherein R^1 , R^2 and R^3 each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom,
10 comprising a step of reacting an alkenylimide compound of the formula (3):



wherein R^1 , R^2 and R^3 are each as defined above;

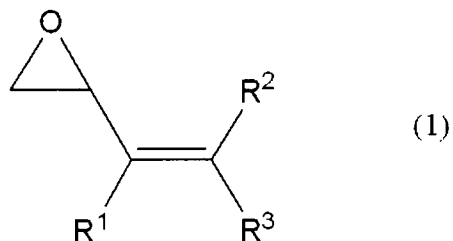
- R^4 and R^5 each independently represent an alkyl group
15 optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom or alternatively R^4

and R⁵ are combined each other together with the carbon atoms to which R⁴ and R⁵ are each binded to form a cycloalkyl ring or an aromatic ring;

a dashed line represents that said sites may be a
 5 double bond,
 with an ammonia.

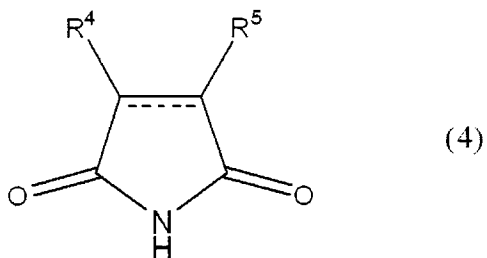
[2] The process of [1], wherein the step of reacting the alkenylimide compound of the formula (3) with an ammonia is carried out in the presence of an ammonium salt.

10 [3] The process of [1] or [2], wherein the alkenylimide compound of the formula (3) is obtained via a step of reacting a compound of the formula (1):



wherein R¹, R² and R³ are each as defined as above [1],

15 with a compound of the formula (4):

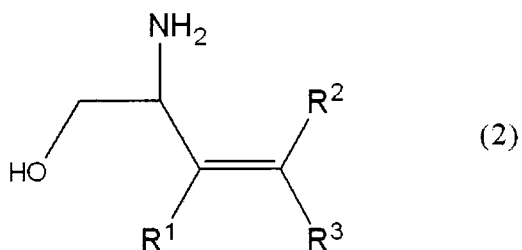


wherein R⁴, R⁵ and the dashed line are each as defined above [1],

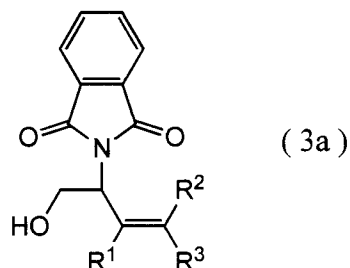
in the presence of a palladium catalyst.

[4] The process of [3], wherein the compound of the formula (4) is recovered via a step of reacting the hydroxyalkenyl imide compound of the formula (3) with an ammonia.

[5] A process for producing a compound of the formula (2):



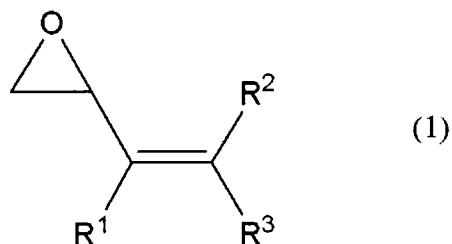
wherein R^1 , R^2 and R^3 are each as defined above [1], comprising a step of reacting an alkenylimide compound of the formula (3a):



wherein R^1 , R^2 and R^3 are each as defined above [1], with an ammonia.

[6] The process of [5], wherein the step of reacting the alkenylimide compound of the formula (3a) with an ammonia is carried out in the presence of an ammonium salt.

[7] The process of [5] or [6], wherein the alkenylimide compound of the formula (3a) is obtained via a step of reacting the compound of the formula (1):



wherein R^1 , R^2 and R^3 are each as defined above [1],
with a phthalimide in the presence of a palladium catalyst.
[8] The process of any one of [1] to [7], wherein R^1 , R^2
5 and R^3 are all hydrogen.

(EFFECT OF INVENTION)

The present invention can provide a novel process for
producing 2-amino-3-butene-1-ol. Also according to the
10 present invention, the compound of the formula (4), which
can be used as one of the starting material for producing
2-amino-3-butene-1-ol, can be obtained simultaneously with
producing the 2-amino-3-butene-1-ol and can be used
repeatedly for the production of the 2-amino-3-butene-1-ol,
15 and the process of the present invention is thus useful in
terms of production efficiency.

MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the present invention is explained in
20 detail. The present invention is characterized by
comprising a step of reacting the alkenylimide compound of
the formula (3) (hereinafter, sometimes referred to as

Compound (3)) with an ammonia. Hereinafter, the step of reacting the Compound (3) with an ammonia is sometimes referred to as the Present Reaction. The Present Reaction can convert the Compound (3) into the 2-amino-3-butene-1-ol compound of the formula (2) (hereinafter, sometimes referred to as Compound (2)).

In the formula (3), R^1 , R^2 and R^3 each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom.

An alkyl group in the alkyl group optionally having a substituent represented by each independently R^1 , R^2 and R^3 includes for example, a straight chain, branched chain or cyclic alkyl group having 1 to 20 carbon atom(s) such as methyl group, ethyl group, n-propyl group, isopropyl group, n-butyl group, isobutyl group, sec-butyl group, tert-butyl group, n-pentyl group, n-decyl group, cyclopropyl group, 2,2-dimethylcyclopropyl group, cyclopentyl group, cyclohexyl group, menthyl group and the others. Such alkyl group may have at least one substituent, for example selected from the group consisting of alkoxy group, halogen, alkoxycarbonyl group, aryl group and carboxy group. Alkoxy group includes for example, methoxy group, ethoxy group and the others, and halogen includes for example, fluorine atom, chlorine atom, bromine atom and the like, and

alkoxycarbonyl group includes for example, methoxycarbonyl group, ethoxycarbonyl group and the others, and aryl group includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group and the others. Alkyl group having a substituent includes for example, chloromethyl group, fluoromethyl group, trifluoromethyl group, methoxymethyl group, ethoxymethyl group, 1-methoxyethyl group, 2-methoxyethyl group, methoxycarbonylmethyl group, benzyl group and the others.

An aryl group in the aryl group optionally having a substituent represented by each independently R^1 , R^2 and R^3 includes for example, an aryl group having 6 to 10 carbon atoms such as phenyl group, 1-naphthyl group, 2-naphthyl group and the others. Such aryl group may have at least one substituent, for example selected from the group consisting of the above-mentioned alkoxy group, halogen atom, alkoxycarbonyl group, aryl group and carboxyl group. The aryl group optionally having a substituent represented by each independently R^1 , R^2 and R^3 includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group, 2-methylphenyl group, 4-chlorophenyl group, 4-methylphenyl group, 4-methoxyphenyl group and the others.

In the formula (3), R^4 and R^5 each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen

atom or alternatively R^4 and R^5 combine each other together with the carbon atoms to which R^4 and R^5 are each binded to form a cycloalkyl ring or an aromatic ring.

An alkyl group in the alkyl group optionally having a
5 substituent represented by each independently R^4 and R^5 includes for example, a straight chain, branched chain or cyclic alkyl group having 1 to 20 carbon atom(s) such as methyl group, ethyl group, n-propyl group, isopropyl group, n-butyl group, isobutyl group, sec-butyl group, tert-butyl
10 group, n-pentyl group, n-decyl group, cyclopropyl group, 2,2-dimethylcyclopropyl group, cyclopentyl group, cyclohexyl group, menthyl group and the others. Such alkyl group may have at least one substituent, for example selected from the group consisting of alkoxy group, halogen,
15 alkoxy carbonyl group, aryl group and carboxy group. The alkoxy group includes for example, methoxy group, ethoxy group and the others, and the halogen includes for example, fluorine atom, chlorine atom, bromine atom and the like, and the alkoxy carbonyl group includes for example,
20 methoxycarbonyl group, ethoxycarbonyl group and the others, and the aryl group includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group and the others. Alkyl group having a substituent includes for example, chloromethyl group, fluoromethyl group, trifluoromethyl
25 group, methoxymethyl group, ethoxymethyl group, 1-

methoxyethyl group, 2-methoxyethyl group, methoxycarbonylmethyl group, benzyl group and the others.

An aryl group in the aryl group optionally having a substituent represented by each independently R^4 and R^5 includes for example, an aryl group having 6 to 10 carbon atoms such as phenyl group, 1-naphthyl group, 2-naphthyl group and the others. Such aryl group may have at least one substituent, for example selected from the group consisting of the above-mentioned alkoxy group, halogen atom, alkoxycarbonyl group, aryl group and carboxyl group. The aryl group optionally having a substituent represented by each independently R^4 and R^5 includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group, 2-methylphenyl group, 4-chlorophenyl group, 4-methylphenyl group, 4-methoxyphenyl group and the others.

The cycloalkyl ring formed by combining R^4 and R^5 each other together with the carbon atoms to which R^4 and R^5 are each binded includes for example, cyclopentyl, cyclohexyl, cyclopentyl, cyclooctyl and the others.

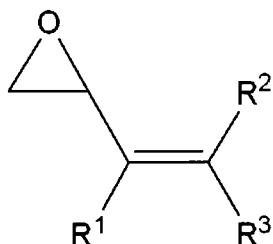
The aromatic ring formed by combining R^4 and R^5 each other together with the carbon atoms to which R^4 and R^5 are each binded includes for example, benzene ring and the others. Here the hydrogen atom that is involved in the aromatic ring such as benzene ring may be substituted by at least one group selected from the group consisting of

alkoxy group, halogen atom, alkoxycarbonyl group, aryl group and carboxy group. The alkoxy group includes for example, methoxy group, ethoxy group and the others, and the halogen atom includes for example, fluorine atom, chlorine atom, bromine atom and the like, and the alkoxycarbonyl group includes for example, methoxycarbonyl group, ethoxycarbonyl group and the others, and the aryl group includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group and the others.

In the formula (3), the dashed line represents that said sites may be a double bond.

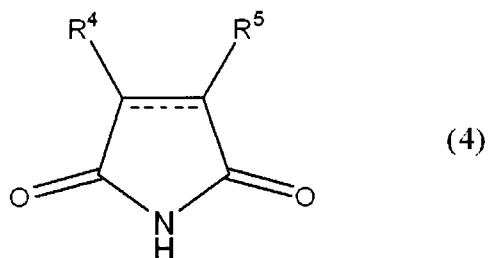
The Compound (3) includes for example, 3-butene-2-phthalimide-1-ol, 3-methyl-3-butene-2-phthalimide-1-ol, 4-phenyl-3-butene-2-phthalimide-1-ol, 3-butene-2-maleimide-1-ol, 3-methyl-3-butene-2-maleimide-1-ol, 4-phenyl-3-butene-2-maleimide-1-ol, 3-butene-2-succinimide-1-ol, 3-methyl-3-butene-2-succinimide-1-ol, 4-phenyl-3-butene-2-succinimide-1-ol and the others.

The Compound (3) is preferably produced via a step of reacting a compound of the formula (1) (hereinafter, sometimes referred to as Compound (1)):



(1)

wherein R^1 , R^2 and R^3 are each as defined above,
with a compound of the formula (4) (hereinafter, sometimes
referred to as Compound (4)):



5 wherein R^4 , R^5 and the dashed line are each as defined as
above,
in the presence of a palladium catalyst.

Hereinafter, the step of reacting the Compound (1)
with the Compound (4) in the presence of the palladium
10 catalyst is sometimes referred to as the Present Ring-
Opening Reaction.

The Compound (1) includes for example, 1,2-epoxy-3-
butene, 1,2-epoxy-3-methyl-3-butene, 1,2-epoxy-4-phenyl-3-
butene and the others.

15 The Compound (1) may be prepared by a known method
such as an oxidation method of diene compound in the
presence of a silver-containing catalyst (see for example,
WO 89/07101 pamphlet).

The Compound (4) includes for example, phthalimide,
20 4,5-dichlorophthalimide, hexahydrophthalimide, 3,4,5,6-
tetrahydrophthalimide, succinimide, 2,3-dimethylsuccinimide,

2-methylsuccinimide, 2,3-diphenylsuccinimide, 2-phenylsuccinimide, maleimide, 2,3-dimethylmaleimide, 2-methylmaleimide, 2,3-diphenylmaleimide, 2-phenylmaleimide and the others.

5 The Compound (4) may be commercially available, or may be prepared according to a well known method.

 The palladium catalyst to be used in the Present Ring-Opening Reaction isn't limited in terms of a valence of palladium atom or a kind of ligand therefor as long as it is a palladium atom-containing compound, and preferably includes a palladium catalyst such as tetrakis(triphenylphosphine)palladium complex and the others, which consists of a palladium atom and a phosphorus atom. Such palladium catalyst may be commercially available, or may be prepared by reacting a phosphorus atom with a palladium compound. The palladium catalyst preferably consists of a zero-valent palladium(0) atom and a ligand including a phosphorus atom.

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 The palladium compound to be used in the preparation of the palladium catalyst includes for example, 1,5-diphenyl-1,4-pentadiene-3-one(palladium)complex, bis(1,5-diphenyl-1,4-pentadiene-3-one)(palladium)complex, tris(1,5-diphenyl-1,4-pentadiene-3-one)di(palladium)chloroform complex, allylpalladium chloride dimer, cyclooctadiene palladium dichloride, cyclooctadiene palladium dibromide,

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norbornadiene palladium dibromide, palladium acetate,
palladium acetyl acetone, bis(acetonitrile)
dichloropalladium, bis(benzonitrile) dichloropalladium and
the others. The palladium compound may be used alone
5 respectively or as a mixture of two or more kinds thereof.

The phosphorus compound to be used in the preparation
of the palladium catalyst may be one kind thereof or a
mixture of two or more kinds thereof. The phosphorus
compound is a compound having one or more tri-valent
10 phosphorus(III) atom in the molecule and is specifically a
phosphorus compound represented by the formula: $PR^6R^7R^8$
wherein R^6 , R^7 and R^8 each independently represent an alkyl
group optionally having a substituent, an aryl group
optionally having a substituent, an alkoxy group optionally
15 having a substituent or an aryloxy group optionally having
a substituent.

The alkyl group represented by each independently R^6 ,
 R^7 and R^8 includes for example, a straight chain, branched
chain or cyclic alkyl group having 1 to 20 carbon atom(s)
20 such as methyl group, ethyl group, n-propyl group,
isopropyl group, n-butyl group, isobutyl group, sec-butyl
group, tert-butyl group, n-pentyl group, n-decyl group,
cyclopropyl group, cyclopentyl group, cyclohexyl group,
menthyl group and the others. Such alkyl group may be
25 substituted by at least one kind of substituent for example,

selected from the group consisting of alkoxy group such as methoxy group, ethoxy group and the others; halogen atom such as fluorine atom, chlorine atom, bromine atom and the like; alkoxycarbonyl group such as methoxycarbonyl group, ethoxycarbonyl group and the others; aryl group such as phenyl group, 1-naphthyl group, 2-naphthyl group and the others; and carboxy group, and the alkyl group having these substituents includes for example, chloromethyl group, fluoromethyl group, trifluoromethyl group, methoxymethyl group, ethoxymethyl group, 2-methoxyethyl group, methoxycarbonylmethyl group, benzyl group and the others.

The aryl group represented by each independently R^6 , R^7 and R^8 includes for example, an aryl group having 6 to 10 carbon atoms such as phenyl group, 1-naphthyl group, 2-naphthyl group, ferrocenyl group and the others. Such aryl group may have the above-mentioned alkyl group, aryl group, alkoxy group, halogen atom and the others, and the aryl group optionally having a substituent includes for example, phenyl group, 1-naphthyl group, 2-naphthyl group, 2-methylphenyl group, 4-chlorophenyl group, 4-methylphenyl group, 4-methoxyphenyl group and the others.

The alkoxy group represented by each independently R^6 , R^7 and R^8 includes for example, a straight chain, branched chain or cyclic alkoxy group having 1 to 20 carbon atoms such as methoxy group, ethoxy group, n-propoxy group,

isopropoxy group, n-butoxy group, isobutoxy group, sec-butoxy group, tert-butoxy group, n-pentyloxy group, n-decyloxy group, cyclopropoxy group, cyclopentyloxy group, cyclohexyloxy group and the others. Such alkoxy group may have at least one substituent, for example selected from the group consisting of alkoxy group such as methoxy group, ethoxy group and the others; halogen atom such as fluorine atom, chlorine atom, bromine atom and the like; alkoxycarbonyl group such as methoxycarbonyl group, ethoxycarbonyl group and the others; aryl group such as phenyl group, naphthyl group and the others; and carboxy group, and the alkoxy group having these substituents includes for example, chloromethoxy group, fluoromethoxy group, trifluoromethoxy group, methoxymethoxy group, ethoxymethoxy group, 2-methoxyethoxy group, benzyloxy group and the others.

The aryloxy group represented by each independently R^6 , R^7 and R^8 includes for example, an aryloxy group having 6 to 10 carbon atoms such as phenoxy group, naphthoxy group and the others. Such aryloxy group may have at least one substituent such as the above-mentioned alkyl group, aryl group, alkoxy group, halogen atom and the others. Such aryloxy group includes for example, phenoxy group, 1-naphthoxy group, 2-naphthoxy group, 2-methylphenoxy group, 4-chlorophenoxy group, 4-methylphenoxy group, 4-

methoxyphenoxy group and the others.

The alkyl group, aryl group, alkoxy group or aryloxy group represented by each independently R^6 , R^7 and R^8 includes for example, may have a group represented by a
5 formula: $-PR^6R^7$ wherein R^6 and R^7 are each as defined above.

Such phosphorus compound includes for example, triphenylphosphine, tris(4-chlorophenyl)phosphine, tris(4-methoxyphenyl)phosphine, bis(diphenylphosphino)ethane, bis(diphenylphosphino)propane, bis(diphenylphosphino)butane,
10 1,1'-bis(diphenylphosphino)ferrocene, 2,2'-bis(diphenylphosphino)-1,1'-binaphthalen, 2,2'-bis(diphenylphosphino)-1,1'-biphenyl, 1,1'-oxybis[2,1-phenylene bis(diphenylphosphine)], triisopropylphosphine, tri(t-butyl)phosphine, tricyclohexylphosphine,
15 triisopropylphosphite, tricyclohexylphosphite, triphenylphosphite and the others, and is preferably 1,1'-bis(diphenylphosphino)ferrocene.

The reaction of the phosphous compound and the palladium compound is carried out by mixing the phosphorus
20 compound with the palladium compound in the absence of a solvent or in the presence of the solvent to be used in the Present Ring-Opening Reaction as mentioned below. The palladium catalyst is prepared by such reaction. The amount used of the palladium compound is for example, about
25 0.000001 to about 0.1 moles, and preferably about 0.000001

to about 0.01 moles, based on 1 mole of the Compound (1).
The amount used of the phosphorus compound is for example,
about 1 to about 10 moles, and preferably about 1 to about
3 moles of phosphorus atom, based on 1 mole of a palladium
5 atom contained in the palladium compound.

The Present Ring-Opening Reaction is carried out in
the absence of a solvent or in the presence of a solvent.
The solvent to be used includes an organic solvent. The
organic solvent includes for example, ethers such as
10 diethyl ether, methyl tert-butyl ether, tetrahydrofuran and
the others; halogenated solvents such as chloroform,
chlorobenzene; alcohols such as methanol, ethanol,
isopropanol, tert-butanol and the others; and nitriles such
as acetonitrile, propionitrile and the others. The amount
15 used of the organic solvent is not particularly limited,
but is 100 times or less in weight based on the Compound
(1) for practical purposes in terms of a volumetric
efficiency.

The Present Ring-Opening Reaction is carried out by
20 firstly preparing the palladium catalyst in the absence of
the solvent or in the presence of the solvent, and to this
palladium catalyst adding for example, the Compound (1) and
the Compound (4) and then mixing the resulting solution.
The order of addition is not particularly limited, but
25 includes preferably a manner of adding the Compound (4) to

the palladium catalyst and then to the resulting mixture adding the Compound (1).

The Present Ring-Opening Reaction can be carried out either under atmospheric pressure condition or under a
5 pressured condition.

A reaction temperature for the Present Ring-Opening Reaction is selected from for example, a range of about -20°C to about 150°C, and preferably a range of about 0°C to about 100°C. When the reaction temperature is over about
10 150°C, a by-product having a high boiling point tends to increase due to a side reaction, while when the reaction temperature is below about -20°C, the reactivity tends to reduce.

The process degree of the reaction can be confirmed by
15 analytical means such as gas chromatography, high-performance liquid chromatography, thin-layer chromatography, nuclear magnetic resonance spectrum analysis, infrared absorption spectrum analysis and the others.

20 After a completion of the reaction, if necessary, the palladium catalyst is removed by a filtration treatment, and thereafter a concentration treatment, a crystallization treatment or the others enables the Compound (3) formed to separate and/or take out.

25 The Compound (3) obtained may be further purified by a

purification means such as recrystallization, column chromatography and the others.

An ammonia to be used in the Present Reaction may be gaseous or liquefied gaseous one. Alternatively, a commercial or self-made solution of ammonia dissolved in a polar solvent such as methanol. The gaseous one, liquefied gaseous one or a methanolic solution of ammonia dissolved in methanol is preferably used.

The amount used of ammonia is preferably 1 mole or more based on 1 mole of the Compound (3). The maximum amount used of ammonia is not particularly limited, but is 100 moles or less based on 1 mole of the Compound (3) for practical purposes in terms of production efficiency.

The Present Reaction is preferably carried out in the presence of a solvent. The solvent uses preferably an organic solvent. The organic solvent includes for example, ethers such as diethyl ether, methyl tert-butyl ether, tetrahydrofuran and the others; halogenated solvents such as chloroform, chlorobenzene and the others; alcohols such as methanol, ethanol, isopropanol, tert-butanol and the others; and nitriles such as acetonitrile, propionitrile and the others. The solvent is preferably alcohols, and more preferably methanol. The amount used of the solvent is not particularly limited, but is 100 times or less in weight based on the Compound (3) for practical purposes in

terms of a volumetric efficiency.

Also ammonium salt may be further added in the Present Reaction to proceed the reaction smoothly. The ammonium salt includes for example, ammonium acetate, ammonium chloride, ammonium sulfate, ammonium hydrogen sulfate and the others. The amount of ammonium salt added is preferably 0.01 to 1 mole based on 1 mole of the Compound (3).

The Present Reaction is carried out by contacting and/or mixing the Compound (3) and an ammonia if necessary, as well as a solvent and an ammonium salt. The order of mixing is not particularly limited.

The Present Reaction can be carried out either under atmospheric pressure condition or under a pressured condition. The Present Reaction is preferably carried out under a pressured condition of about 0.3 MPa to about 2 MPa.

The reaction temperature is selected from for example, a range of about 0°C to about 150°C, and preferably a range of about 40°C to about 100°C. When the reaction temperature is over about 150°C, a by-product having a high boiling point tends to increase due to a side reaction, while when the reaction temperature is below about 0°C, the reactivity tends to reduce.

The process degree of the reaction can be confirmed by analytical means such as gas chromatography, high-

performance liquid chromatography, thin-layer chromatography, nuclear magnetic resonance spectrum analysis, infrared absorption spectrum analysis and the others.

5 After a completion of the reaction, if necessary, excess amount used of ammonia is recovered by a degassing procedure and the resulting solution is treated by for example, any method described in the following (a) to (d) to separate and purify the Compound (2) and the Compound
10 (4) both formed:

(a) for example, to the above-mentioned resulting solution, or if necessary, the residue that is resulted by evaporating a solvent such as alcohols from the above-mentioned resulting solution, are added a water-
15 incompatible solvent and a mineral acid, and the mineral acid salt of the Compound (2) is dissolved in aqueous layer and the Compound (4) is dissolved in organic layer, and these aqueous layer and organic layer are then separated. The resulting aqueous layer is neutralized and is then
20 extracted with an organic solvent, and the extract solution is concentrated to be able to obtain the Compound (2);

(b) For example, to the above-mentioned resulting solution is added a saturated hydrocarbon solvent that is hard to dissolve the Compound (4) such as hexane and heptane, to
25 precipitate out the Compound (4), and the resulting mixture

is then filtered to be able to separate the Compound (2) and the Compound (4);

(c) For example, after evaporating a solvent from the above-mentioned resulting solution, the resulting residue
5 is distilled to be able to separate the Compound (2) and the Compound (4);

(d) For example, to the above-mentioned resulting solution is added an organic acid that is capable to form a salt with the Compound (2), and the salt formed is filtered to
10 be able to separate the Compound (2) and the Compound (4).

The compound (2) obtained may be further purified by a purification means such as distillation, column chromatography and the others.

The Compound (2) obtained in such way includes for
15 example, 3-butene-2-amino-1-ol, 3-methyl-3-butene-2-amino-1-ol, 4-phenyl-3-butene-2-amino-1-ol and the others.

The Compound (4) that is separated by filtration treatment, separation treatment, distillation treatment or the others from the reaction solution or the Compound (4)-
20 containing solution can be used directly or if necessary, after a concentration treatment in the Present Ring-Opening Reaction.

EXAMPLES

25 Next, the present invention is described in more

detail below with some examples, but the present invention should not be construed to be limited thereto.

Preparation Example 1 (Synthesis of 2-phthalimide-3-butenol)

To a 100 mL Schlenk flask equipped with a magnetic stirring bar were added bis(dibenzylideneacetone)palladium 1mg, 1,1'-bis(diphenylphosphino)ferrocene 2mg, phthalimide 295mg and tetrahydrofuran 500mg under nitrogen atmosphere and the resulting mixture was stirred at 20°C to 25°C for 15 min. To the resulting solution was added 3-butene-1,2-epoxide 140mg and the resulting mixture was stirred at 20°C to 25°C for 2 hours and at 60°C as an internal temperature for 2 hours and then was maintained. After the reaction, the reaction mixture was cooled to a room temperature and the resulting reaction mixture was analyzed by gas chromatography (GC) analysis (internal reference method) to give 2-phthalimide-3-butenol in 90% yield.

Preparation Example 2 (Synthesis of 2-phthalimide-3-butenol)

To a 100 mL Schlenk flask equipped with a magnetic stirring bar were added bis(dibenzylideneacetone)palladium 35mg, triphenylphosphine 50mg, phthalimide 295mg and tetrahydrofuran 500mg under nitrogen atmosphere and the

resulting mixture was stirred at 20°C to 25°C for 15 min.
To the resulting solution was added 3-butene-1,2-epoxide
140mg and the resulting mixture was stirred at 20°C to 25°C
for 2 hours and was then maintained. The resulting
5 reaction mixture was analyzed by gas chromatography (GC)
analysis (internal reference method) to give 2-phthalimide-
3-butenol in 86% yield.

Preparation Example 3 (Synthesis of 2-phthalimide-3-
10 butenol)

To a 100 mL Schlenk flask equipped with a magnetic
stirring bar were added bis(dibenzylideneacetone)palladium
4mg, triisopropoxyphosphine 30mg, phthalimide 295mg and
tetrahydrofuran 500mg under nitrogen atmosphere and the
15 resulting mixture was stirred at 20°C to 25°C for 15 min.
To the resulting solution was added 3-butene-1,2-epoxide
140mg and the resulting mixture was stirred at 20°C to 25°C
for 2 hours and was then maintained. The resulting
reaction mixture was analyzed by gas chromatography (GC)
20 analysis (internal reference method) to give 2-phthalimide-
3-butenol in 75% yield.

Preparation Example 4 (Synthesis of 2-phthalimide-3-
butenol)

25 To a 300 mL Schlenk flask equipped with a magnetic

stirring bar were added bis(dibenzylideneacetone)palladium 124mg, 1,1'-bis(diphenylphosphino)ferrocene 200mg, phthalimide 10.5g and tetrahydrofuran 100g under nitrogen atmosphere and the resulting mixture was stirred at 40°C as an internal temperature for 15 min. To the resulting solution was added dropwise 3-butene-1,2-epoxide 5g at 40°C over 2 hours with stirring and the resulting mixture was stirred at 60°C as an internal temperature for 2 hours and was then maintained. After the reaction, the reaction mixture was cooled to a room temperature and the resulting reaction mixture was analyzed by gas chromatography (GC) analysis (internal reference method) to give 2-phthalimide-3-butenol in 96% yield.

Tetrahydrofuran was evaporated to obtain 2-phthalimide-3-butenol 15.5g as a crystal.

Example 1 (Synthesis of 2-amino-3-butenol)

To a 100 mL stainless reaction tube equipped with a magnetic stirring bar were 2-phthalimide-3-butenol 1g that was obtained in the Preparation Example 4 and 15 weight% ammonia/methanol solution 10g, and the resulting mixture was stirred at 80°C as an internal temperature for 6 hours. After the reaction, the resulting solution was cooled to a room temperature and was concentrated to obtain an oil. To the oil were added ethyl acetate 10g and 10 weight% aqueous

hydrochloric acid, and the resulting mixture was separated in a separating funnel and the aqueous layer was then concentrated to obtain a pale yellow crystal 420mg. This pale yellow crystal was confirmed as 2-amino-3-butenol hydrochloride salt by ^1H -NMR analysis. The ^1H -NMR analysis (internal reference method) showed 80% purity. Yield 59%.

The ethyl acetate layer that was obtained by the above separation treatment was analyzed by gas chromatography (GC) analysis (internal reference method) to give 2-phthalimide-3-butenol in 35% yield and phthalimide in 60% yield.

Preparation Example 5 (Synthesis of 2-phthalimide-3-butenol)

To a 300 mL Schlenk flask equipped with a magnetic stirring bar were added bis(dibenzylideneacetone)palladium 124mg, 1,1'-bis(diphenylphosphino)ferrocene 200mg, phthalimide 10.5g and tetrahydrofuran 100g under nitrogen atmosphere and the resulting mixture was stirred at 40°C as an internal temperature for 15 min. To the resulting solution was added dropwise 3-butene-1,2-epoxide 5g at 40°C over 2 hours with stirring and the resulting mixture was stirred at 60°C as an internal temperature for 2 hours and was then maintained. The reaction mixture was cooled to a room temperature and the resulting reaction mixture was

analyzed by gas chromatography (GC) analysis (internal reference method) to give 2-phthalimide-3-butenol in 80% yield.

Tetrahydrofuran was evaporated and the crystal
5 precipitated out was filtered to obtain 2-phthalimide-3-butenol 11.5g as a crystal.

Example 2 (Synthesis of 2-amino-3-butenol)

To a 100 mL stainless reaction tube equipped with a
10 magnetic stirring bar were 2-phthalimide-3-butenol 10.5g that was obtained in the Preparation Example 5, 15 weight% ammonia/methanol solution 66g and ammonium acetate 370mg, and the resulting mixture was stirred at 90°C as an internal temperature for 18 hours. The resulting mixture
15 was cooled to a room temperature and was then filtered. The filtrate was concentrated and was then filtered again. The crystal that was obtained by twice filtration treatments was washed with some ethyl acetate to obtain phthalimide. The filtrate as well as the wash liquid at
20 filtering were combined to obtain an oil. To the oil were added ethyl acetate 20g and 8 weight% hydrochloric acid 26g, and the resulting mixture was separated in a separating funnel to give an aqueous layer. To the aqueous layer was added sodium hydroxide until the aqueous layer was
25 alkalified and was then added tetrahydrofuran, and the

resulting mixture was separated in a separating funnel. The oil layer was concentrated to obtain a pale yellow oil. The oil was evaporated under reduced pressure to obtain 2-amino-3-butenol as a component at 60°C to 63°C of column
5 top temperature under 0.67 kPa of pressure in 2.0 g. A gas chromatography (GC) analysis (internal reference method) showed 95% purity. Yield 47%.

Preparation Example 6 (Synthesis of 2-phthalimide-3-
10 butenol)

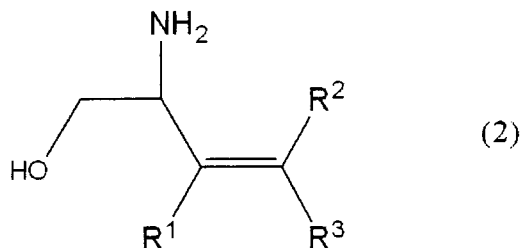
To a 100 mL Schlenk flask equipped with a magnetic stirring bar were added bis(dibenzylideneacetone)palladium 80mg, 1,1'-bis(diphenylphosphino)ferrocene 150mg, phthalimide 1.9g and tetrahydrofuran 10g under nitrogen
15 atmosphere, and the resulting mixture was stirred at 40°C as an internal temperature for 15 min. To the resulting solution was added dropwise 3-butene-1,2-epoxide 500mg at 40°C over 10 min. with stirring. The resulting mixture was stirred at 40°C as an internal temperature for 2 hours and
20 was then maintained. The reaction mixture was cooled to a room temperature and was then analyzed by gas chromatography (GC) analysis (internal reference method) to obtain 2-phthalimide-3-butenol in 8% yield.

25 INDUSTRIAL APPLICABILITY

2-Amino-3-butene-1-ol compound is an important compound for a monomer for functional polymer, and is also an important compound as a starting material for bioactive substance such as medicine and agrochemicals. The present
5 invention is industrially applicable as a process for producing 2-amino-3-butene-1-ol compound.

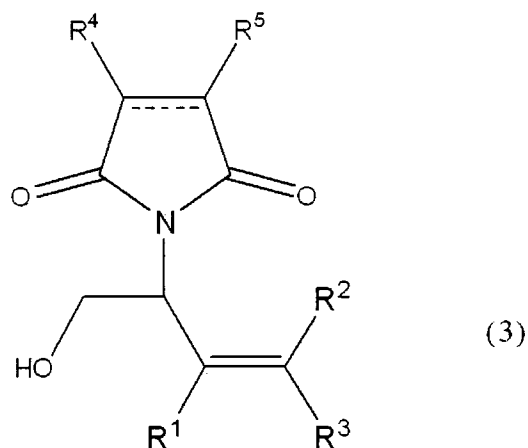
CLAIMS

1. A process for producing 2-amino-3-butene-1-ol compound of the formula (2):



wherein R^1 , R^2 and R^3 each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom, comprising a step of reacting an alkenylimide compound of the formula (3):

10



wherein R^1 , R^2 and R^3 are each as defined above;

R^4 and R^5 each independently represent an alkyl group optionally having a substituent, an aryl group optionally having a substituent or a hydrogen atom or alternatively R^4 and R^5 are combined each other together with the carbon

15

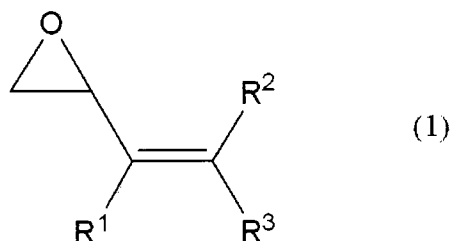
atoms to which R^4 and R^5 are each binded to form a cycloalkyl ring or an aromatic ring;

a dashed line represents that said sites may be a double bond,

5 with an ammonia.

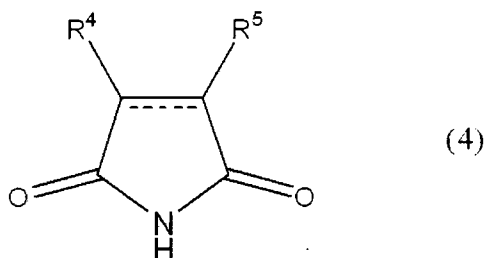
2. The process according to claim 1, wherein the step of reacting the alkenylimide compound of the formula (3) with an ammonia is carried out in the presence of an ammonium salt.

10 3. The process according to claim 1 or claim 2, wherein the alkenylimide compound of the formula (3) is obtained via a step of reacting a compound of the formula (1):



wherein R^1 , R^2 and R^3 are each as defined as above claim 1,

15 with a compound of the formula (4):

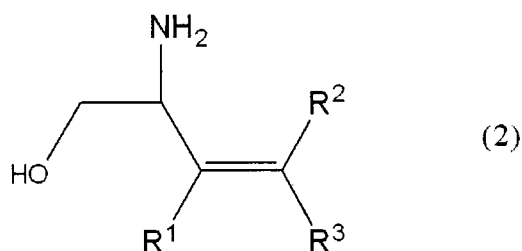


wherein R^4 , R^5 and the dashed line are each as defined above claim 1,

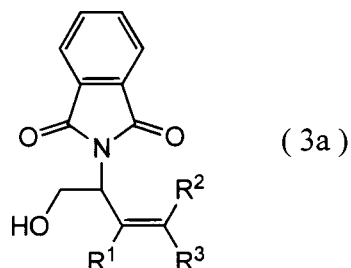
in the presence of a palladium catalyst.

4. The process according to claim 3, wherein the compound of the formula (4) is recovered via a step of reacting the hydroxyalkenyl imide compound of the formula (3) with an ammonia.

5. A process for producing a compound of the formula (2):



wherein R^1 , R^2 and R^3 are each as defined above claim 1, comprising a step of reacting an alkenylimide compound of the formula (3a):

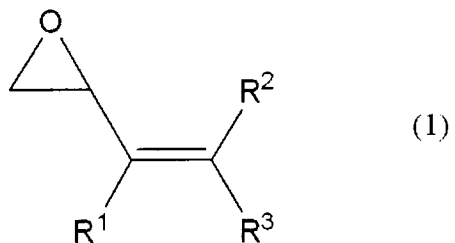


wherein R^1 , R^2 and R^3 are each as defined above claim 1, with an ammonia.

6. The process according to claim 5, wherein the step of reacting the alkenylimide compound of the formula (3a) with an ammonia is carried out in the presence of an ammonium salt.

7. The process according to claim 5 or claim 6, wherein the alkenylimide compound of the formula (3a) is obtained

via a step of reacting the compound of the formula (1):



wherein R¹, R² and R³ are each as defined above claim 1,
with a phthalimide in the presence of a palladium catalyst.

- 5 8. The process of any one of claims 1 to 7, wherein R¹,
R² and R³ are all hydrogen.

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2012/054489

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C07C213/08
 ADD.

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)
 C07C

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

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

EPO-Internal, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BARRY M. TROST ET AL: "Palladium-Catalyzed DYKAT of Butadiene Monoepoxide: Enantioselective Total Synthesis of (+)-DMDP, (-)-Bulgecinine, and (+)-Broussonetine G", CHEMISTRY - A EUROPEAN JOURNAL, vol. 12, no. 25, 25 August 2006 (2006-08-25), pages 6607-6620, XP55026149, ISSN: 0947-6539, DOI: 10.1002/chem.200600202 scheme 2compounds 4,5,7 ----- -/--	1-8



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

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"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

4 May 2012

Date of mailing of the international search report

14/05/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Scheid, Günther

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2012/054489

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BARRY M. TROST ET AL: "Dynamic Kinetic Asymmetric Transformation of Diene Monoepoxides: A Practical Asymmetric Synthesis of Vinylglycinol, Vigabatrin, and Ethambutol", JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, vol. 122, no. 25, 1 June 2000 (2000-06-01), pages 5968-5976, XP55026148, ISSN: 0002-7863, DOI: 10.1021/ja000547d compounds 8,12,19 -----	1-8
X,P	BARRY M. TROST ET AL: "Development of a Flexible Strategy towards FR900482 and the Mitomycins", CHEMISTRY - A EUROPEAN JOURNAL, vol. 17, no. 28, 4 July 2011 (2011-07-04), pages 7890-7903, XP55026146, ISSN: 0947-6539, DOI: 10.1002/chem.201003489 scheme 6 compounds 47,48 -----	1-8