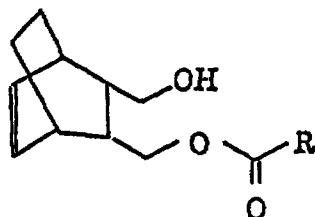


Description

The present invention relates to an optically active monoester compound of the formula (I) or (I'),

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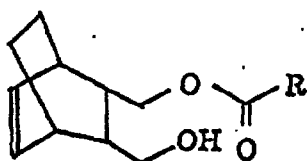


(I)

or

15

20



(I')

where R is an alkyl group of 1 to 15 carbon atoms and a process for producing said compound.

25

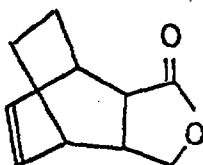
Syntheses of intermediates for pharmaceuticals and biologically active substances have recently increased. As a result, optically active starting materials for the syntheses of those materials are now in demand.

In particular, optically active analogues of bicyclo [2,2,2] oct-5-ene appear to be useful as starting materials for producing biologically active substances, but there are not so many compounds capable of being actually used therefor.

A compound of the formula,

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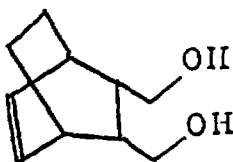
(III)

is known as a very useful compound as a starting material for biologically active substances such as a starting material for prostaglandin.

40

However, known processes for producing said compound are not practical. For example, J.B. Jones et al.: J. Am. Chem. Soc., Vol. 107, pp. 2521-6 (1985) discloses that the optically active lactone compound (III) above can be produced by converting a diol of the formula,

45



(II)

50

using a horse liver dehydrogenase.

However, this process has various drawbacks, e.g. the catalyst, horse liver dehydrogenase is expensive and, in addition, not easily available; a large amount of NAD (nicotinamide-adenine dinucleotide) is required; the reaction time is long (minimum 6 days) and the post-treatment is complicated (ether extraction for 12 hours).

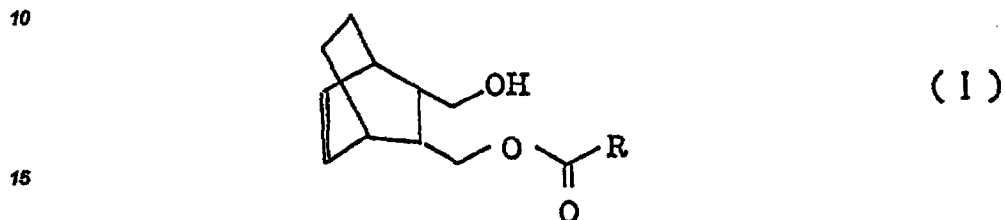
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In view of the foregoing, optically active analogues of bicyclo [2,2,2] oct-5-ene are in demand, but practically usable compounds have not yet been found. The present inventors did researches and investigated these problems. They have now completed the present invention.

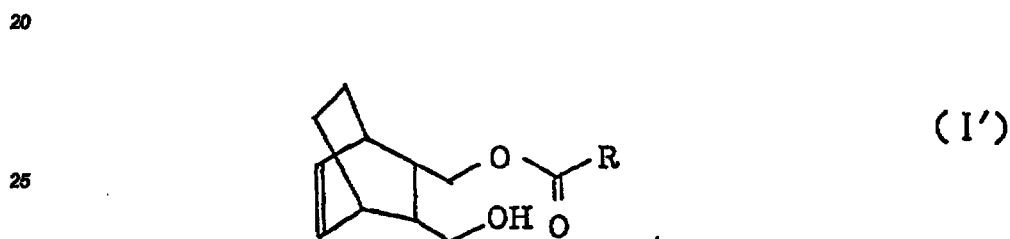
SUMMARY OF THE INVENTION

An object of the present invention is to provide a novel optically active bicyclo [2,2,2] oct-5-ene analogue.
 5 Another object of the present invention is to provide a process for producing said optically active bicyclo [2,2,2] oct-5-ene analogue.

According to one aspect of the present invention is to provide an optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene of the formula (I) or (I')

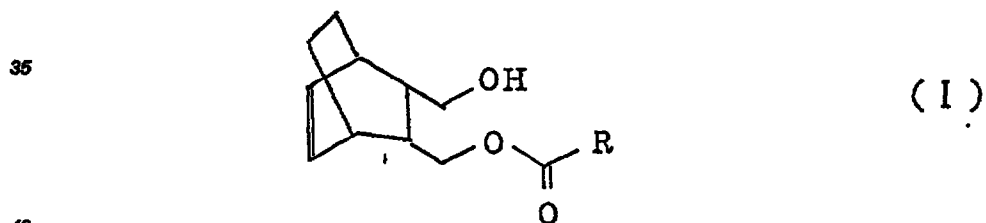


or

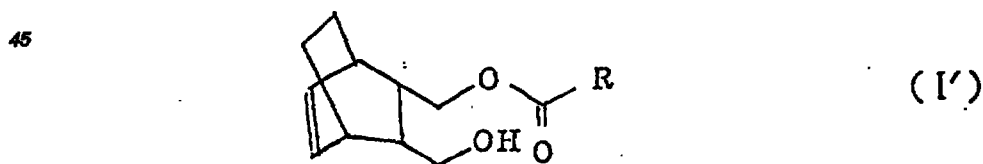


where R is an alkyl group of 1 to 15 carbon atoms.

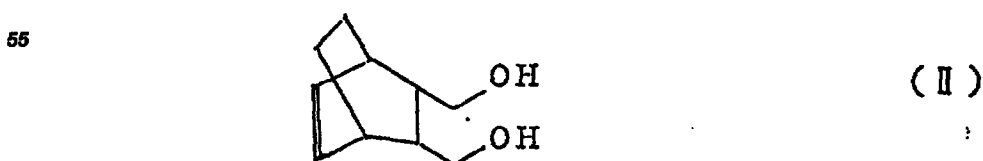
30 According to another aspect of the present invention is to provide a process for producing an optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene of the formula (I) or (I'),



or



where R is an alkyl group of 1 to 15 carbon atoms which comprises a transesterification reaction between cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol of the formula (II),



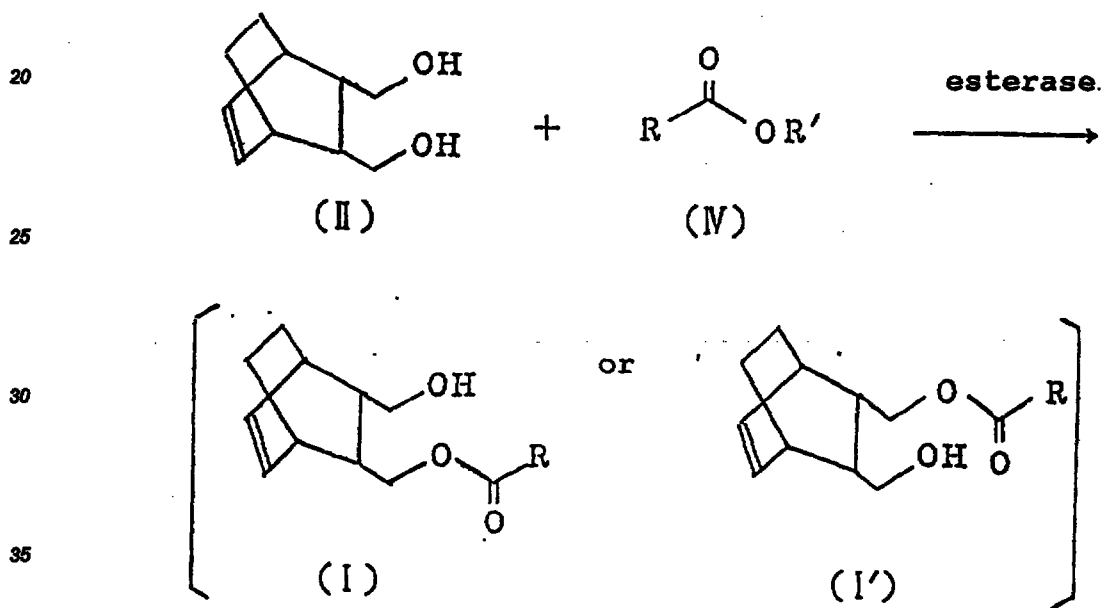
and a fatty acid alkyl ester, fatty acid vinyl ester or triglyceride by using an esterase.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

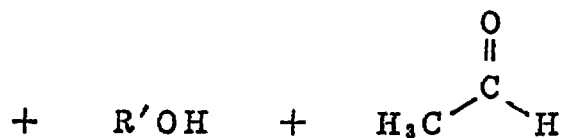
Exemplary suitable optically active monoester compounds of the formula (I) or (I') above of the present invention include

optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene,
optically active cis-endo-2-propanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene,
optically active cis-endo-2-butanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene,
optically active cis-endo-2-pentanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene,
optically active cis-endo-2-hexanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene,
optically active cis-endo-2-decanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene, and
optically active cis-endo-2-undecanoyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene.

The process for producing an optically active monoester compound may be represented by the following reaction schemes:



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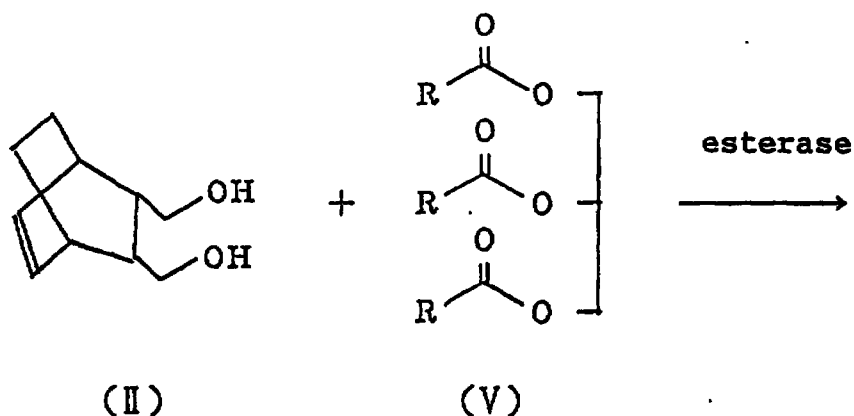
10

or

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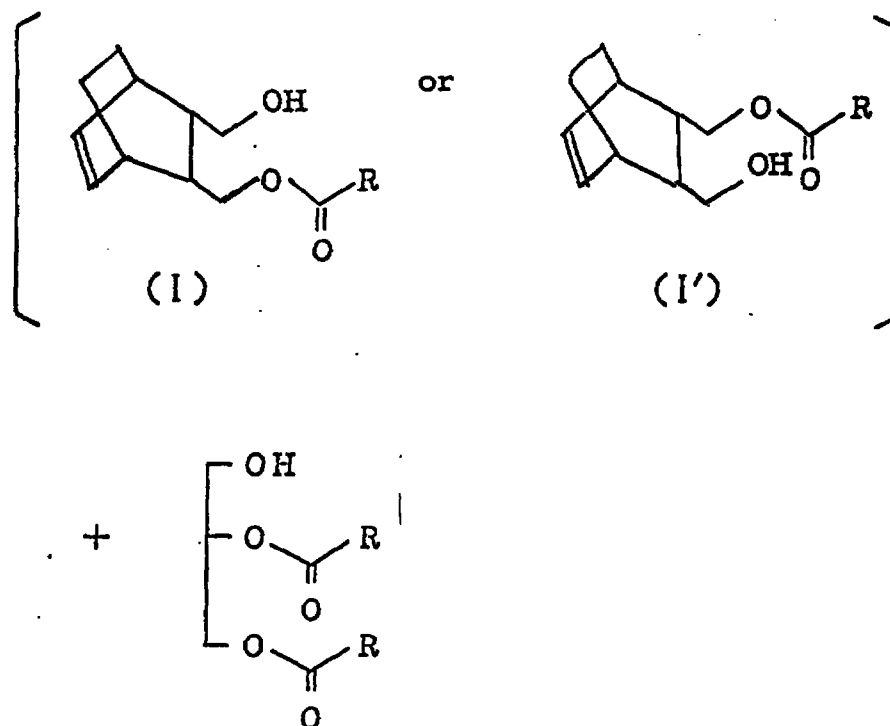
30

35

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45

50



where R is an alkyl group of 1 to 15 carbon atoms and R' is alkyl or vinyl.

55

The reaction may be carried out by mixing cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) and a fatty acid alkyl ester or fatty acid vinyl ester (IV), or triglyceride (V) with esterase in a solution so as to efficiently bring the compounds into contact with esterase, and as a result, an optically active monoester, i.e. optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene (I) or (I'), is obtained.

As reaction conditions of the process of the present invention, the reaction temperature is appropriately

about 10°C to 150°C, preferably 20°C to 45°C and the reaction time varies depending upon the type of ester of the formula (IV) or (V), but is usually 1-1000 hours.

The starting material in the process for the production, cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II), may be easily obtained by reducing commercially available cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dicarboxylic acid anhydride with lithium aluminum hydride.

Esterases used in the present invention include esterases produced by microorganism and those derived from animals. Commercially available esterases are exemplified as shown in the following table.

Table

Trade name	Origin	Seller or Maker
Lipase P	<u>Pseudomonas fluorescens</u>	Amano Pharmaceu- tical Co., Ltd
Lipase CES	<u>Pseudomonas</u> sp	"
Lipase II	<u>Porcine Pancreas</u>	Sigma Chemical Co.
Lipase VIII	<u>Geotrichum Candidum</u>	"
Lipase X	<u>Rhizopus delamar</u>	"
Lipase AP	<u>Aspergillus niger</u>	Amano Pharmaceu- tical Co., Ltd
Lipase M	<u>Mucor javanicus</u>	"
Lipase CE	<u>Humicola lanuginosa</u>	"
Lipase F-AP	<u>Rhizopus javanicus</u>	"
Lipase	<u>Chromobacterium Viscosum</u>	Toyo Jozo Co., Ltd.
Lipase A	<u>Aspergillus niger</u>	Novo Industri A/S
Lipase	<u>Rhizopus niveus</u>	Nagase Biochemi- cals, Ltd.
Lipase B	<u>Pseudomonas fragi</u>	Sapporo Beer Co.

Other than above, any esterase derived from microorganisms capable of producing esterase may be used regardless of type of the esterase.

Examples of such microorganisms include the following genres :

Pseudomonas,
Arthrobacter,
Acromobacter,

Alcaligenes,
Aspergillus,
Chromobacterium,
 5 Candida,
Mucor, and
Rhizopus.

Among them, esterase derived from Pseudomonas genus is particularly preferable.

According to the process of the present invention, exemplary suitable fatty acid alkyl esters include methyl
 10 acetate, methyl propionate, ethyl acetate, methyl propionate, ethyl propionate, methyl caproate, ethyl caproate, propyl acetate and butyl acetate; exemplary suitable fatty acid vinyl esters include vinyl acetate, vinyl propionate, vinyl caproate, and vinyl laurate; and exemplary suitable triglycerides include triacetin, tripropionin, tributyrin, and tricaproin.

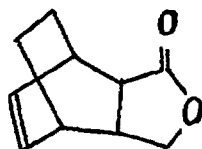
A fatty acid alkyl ester or vinyl ester, or triglyceride is usually used in an amount ranging from a large excess
 15 as compared with cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) to a molar ratio of the ester or triglyceride to the bicyclo compound (II) being 1 : 1. Preferable amounts thereof are such that both compounds can be mixed to form a uniform system.

In the process of the production of the present invention, after completion of the transesterification, the
 20 esterase powder is removed by an ordinary filtration procedure and the esterase thus recovered can be used again as it is.

The resulting optically active monoester, i.e. optically active cis-endo-2-acyloxymethyl-3-hydroxymethyl-
 bicyclo [2,2,2] oct-5-ene can be isolated by subjecting the filtrate, i.e. the liquid reaction mass to a distillation under reduced pressure or column chromatography.

The optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene of the present
 25 invention has been produced for the first time by the present inventors and is a novel compound. It is useful as an intermediate for producing pharmaceuticals.

For example, after protecting the hydroxyl group of said bicyclo compound with an appropriate protecting
 group such as tetrahydropyranyl group, the thus protected bicyclo compound is subjected to ester hydrolysis, oxidation and deprotection resulting in forming the compound of the formula (III),



(III)

In addition, the compound of the present invention is very useful as a chiral synthon. That is, it can be a
 40 starting material for producing prostaglandin, alkaloids and the like which are biologically active natural products.

The production process of the present invention has the following advantages.

(i) Optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene can be very rapidly
 produced by a one-step reaction.

(ii) Since the reaction is effected under the condition that water is not substantially present, a side reaction,
 45 i.e. hydrolysis, hardly occurs.

(iii) The reaction proceeds at a relatively low temperature and therefore, any particular equipment is not
 required.

(iv) The used esterase can be easily recovered and used again.

(v) Since neither buffer solution nor solvent is necessary, the concentration of the substrate can be made
 50 high so that a large volume of a reaction vessel is not necessary.

The following examples are given by way of illustration and not limitation of the present invention.

Example 1

55 In a 100 ml. round bottom flask, 0.97 g (10 m mol) of cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) was dissolved in 35 ml. of vinyl acetate at room temperature and 3g. of Lipase P (manufactured by Amano Pharmaceutical Co., Ltd.) was added thereto followed by stirring at room temperature for 15 hours.

The reaction was confirmed by using gas chromatography. Then, the Lipase P was filtered and vinyl acetate was distilled off under reduced pressure to obtain 2.08 g. of a residue.



The resulting optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene was isolated from the residue by a silica gel column chromatography (toluene : ethyl acetate = 1 : 1), and recrystallized from n-heptane to obtain 0.80 g. (3.37 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene.

Specific rotation of this compound was

$$[\alpha]_D^{25} + 7.98^\circ (c 3.04, \text{CHCl}_3).$$

Example 2

In a 100 ml. round bottom flask, 1.68 g. (10 m mol) of cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) was dissolved in 60 ml. of ethyl acetate, and 5 g. of Lipase II (manufactured by Sigma Chemical Co.) was added thereto followed by stirring at room temperature for 48 hours.

The reaction was confirmed by using gas chromatography. Then, Lipase II was filtered off and ethyl acetate was distilled off under reduced pressure to obtain 2.06 g. of residue, from which optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene was separated by means of silica gel column chromatography (toluene : ethyl acetate = 1 : 1).

The optically active bicyclo compound thus separated was recrystallized from n-heptane to obtain 0.60 g (3.01 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene, which had a specific rotation of $[\alpha]_D^{25} + 5.38^\circ (c 1.087, \text{CHCl}_3)$.

Example 3

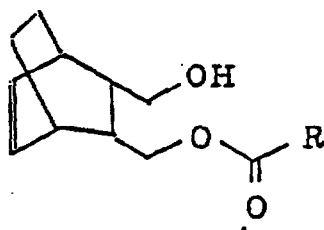
In a 100 ml. round bottom flask, 1.68 g. (10 m mol) of cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) was dissolved in 60 ml. of vinyl acetate at room temperature and 5 g. of Lipase II (Sigma Chemical Co.) was added thereto followed by stirring at room temperature for 48 hours.

The reaction was confirmed by using gas chromatography. The Lipase II was then filtered off and vinyl acetate distilled off under reduced pressure to give 2.08 g. of residue. The residue was treated by silica gel column chromatography (toluene : ethyl acetate = 1 : 1) to separate the resulting optically active cis-endo-bicyclo [2,2,2] oct-5-ene-2-acetyloxymethyl-3-hydroxymethyl.

The optically active bicyclo compound thus separated was recrystallized from n-heptane to obtain 1.26 g. (5.88 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethyl-bicyclo [2,2,2] oct-5-ene, which had a specific rotation of $[\alpha]_D^{25} + 7.10^\circ (c 1.03, \text{CHCl}_3)$.

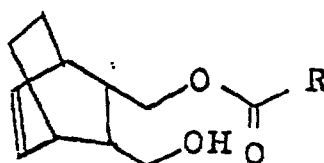
Claims

1. Optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-enes of the formulae (I) or (I')



(I)

or



(I')



The resulting optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene was isolated from the residue by a silica gel column chromatography (toluene : ethyl acetate = 1 : 1), and recrystallized from n-heptane to obtain 0.80 g. (3.37 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene.

Specific rotation of this compound was

$$[\alpha]_D^{25} + 7.98^\circ \text{ (c 3.04, CHCl}_3\text{)}.$$

Example 2

In a 100 ml. round bottom flask, 1.68 g. (10 m mol) of cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) was dissolved in 60 ml. of ethyl acetate, and 5 g. of Lipase II (manufactured by Sigma Chemical Co.) was added thereto followed by stirring at room temperature for 48 hours.

The reaction was confirmed by using gas chromatography. Then, Lipase II was filtered off and ethyl acetate was distilled off under reduced pressure to obtain 2.06 g. of residue, from which optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene was separated by means of silica gel column chromatography (toluene : ethyl acetate = 1 : 1).

The optically active bicyclo compound thus separated was recrystallized from n-heptane to obtain 0.60 g (3.01 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-ene, which had a specific rotation of $[\alpha]_D^{30} + 5.38^\circ$ (c 1.087, CHCl₃).

Example 3

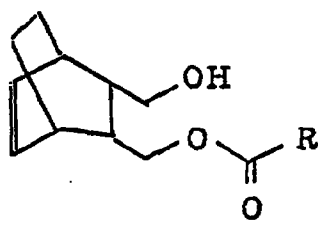
In a 100 ml. round bottom flask, 1.68 g. (10 m mol) of cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol (II) was dissolved in 60 ml. of vinyl acetate at room temperature and 5 g. of Lipase II (Sigma Chemical Co.) was added thereto followed by stirring at room temperature for 48 hours.

The reaction was confirmed by using gas chromatography. The Lipase II was then filtered off and vinyl acetate distilled off under reduced pressure to give 2.08 g. of residue. The residue was treated by silica gel column chromatography (toluene : ethyl acetate = 1 : 1) to separate the resulting optically active cis-endo-bicyclo [2,2,2] oct-5-ene-2-acetyloxymethyl-3-hydroxymethyl.

The optically active bicyclo compound thus separated was recrystallized from n-heptane to obtain 1.26 g. (5.88 m mol) of optically active cis-endo-2-acetyloxymethyl-3-hydroxymethyl-bicyclo [2,2,2] oct-5-ene, which had a specific rotation of $[\alpha]_D^{25} + 7.10^\circ$ (c 1.03, CHCl₃).

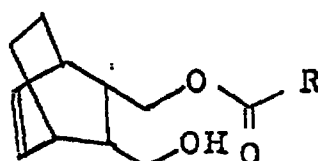
Claims

1. Optically active cis-endo-2-acetyloxymethyl-3-hydroxymethylbicyclo [2,2,2] oct-5-enes of the formulae (I) or (I')



(I)

or



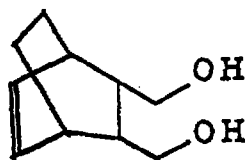
(I')



where R is an alkyl group of 1 to 15 carbon atoms.

2. Compounds as claimed in claim 1 in which R is an alkyl group of 1 to 11 carbon atoms.

3. A process for producing optically active cis-endo-2-acyloxymethyl-3-hydroxymethylbicyclo [2,2,2]-oct-5-enes as claimed in claim 1 which comprises transesterifying cis-endo-bicyclo [2,2,2] oct-5-ene-2,3-dimethanol of the formula

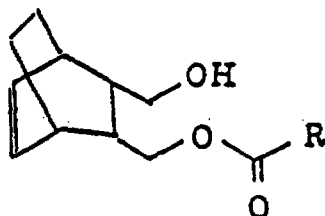


(II)

with a fatty acid alkyl ester, fatty acid vinyl ester or triglyceride by using an esterase.

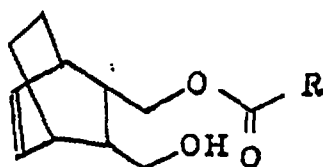
Patentansprüche

1. Optisch aktive cis-endo-2-Acyloxymethyl-3-hydroxymethylbicyclo-[2,2,2]-oct-5-ene der Formel (I) oder (I'):



(I)

oder

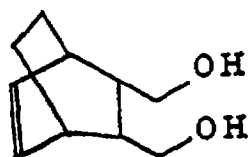


(I')

worin R eine Alkylgruppe mit 1 bis 15 Kohlenstoffatomen ist.

2. Verbindungen nach Anspruch 1, bei welchen R eine Alkylgruppe mit 1 bis 11 Kohlenstoffatomen ist.

3. Verfahren zur Herstellung optisch aktiver cis-endo-2-Acyloxymethyl-3-hydroxymethylbicyclo-[2,2,2]-oct-5-ene nach Anspruch 1, welches den Schritt der Umesterung eines cis-endo-Bicyclo-[2,2,2]-oct-5-en-2,3-dimethanol der Formel



(II)



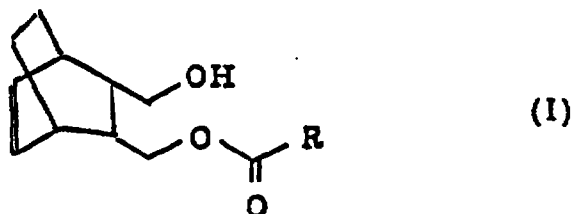
mit einem Fettsäurealkylester, einem Fettsäurevinylester oder einem Triglycerid unter Verwendung einer Esterase beinhaltet.

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Revendications

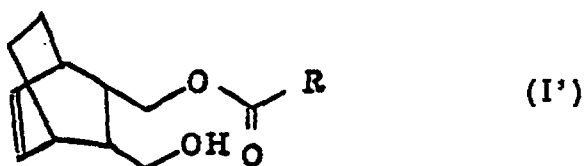
1. Cis-endo-2-acyloxyméthyl-3-hydroxyméthylbicyclo [2,2,2] oct-5-ènes optiquement actifs des formules (I) ou (I')

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20 ou



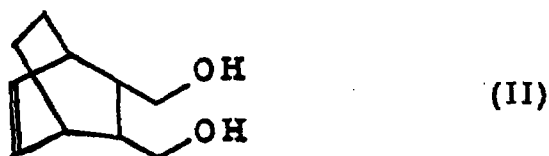
25

où R est un groupement alkyle de 1 à 15 atomes de carbone.

30

2. Composés tels que revendiqués dans la revendication 1, dans lesquels R est un groupement alkyle de 1 à 11 atomes de carbone.
3. Procédé de production de cis-endo-2-acyloxyméthyl-3-hydroxyméthylbicyclo [2,2,2] oct-5-ènes tel que revendiqué dans la revendication 1, qui comprend la transestérification d'un cis-endo-bicyclo [2,2,2] oct-5-ène-2,3-diméthanol de la formule

35



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avec un ester alkylque d'un acide gras, un ester vinylique d'un acide gras ou un triglycéride par utilisation d'une estérase.

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