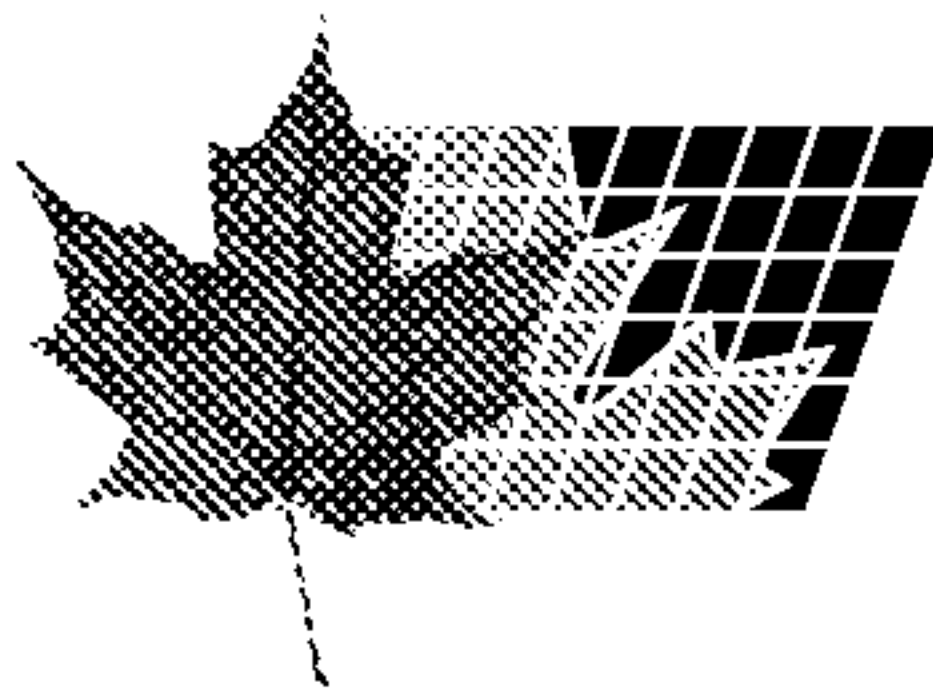




(72) AMINO, YUSUKE, JP

(72) YUZAWA, KAZUKO, JP

(72) TAKEMOTO, TADASHI, JP

(72) NAKAMURA, RYOICHIRO, JP

(71) AJINOMOTO CO., INC., JP

(51) Int.Cl.⁶ C07K 5/075, A23L 1/236

(30) 1998/09/18 (10/264252) JP

(30) 1999/06/16 (11/169419) JP

(54) **DERIVES D'ESTER N-ALKYLASPARTYLDIPEPTIDIQUE ET
EDULCORANTS**

(54) **N-ALKYLASPARTYLDIPEPTIDE ESTER DERIVATIVES AND
SWEETENERS**

(57) Novel N-alkylaspartyl dipeptide ester derivatives (involving those in the form of a salt) such as N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-henylalanine 1-methyl ester which are usable as excellent sweeteners. Because of having low caloric values and being superior in the degree of sweetness to the conventional ones, these derivatives make it possible to provide sweeteners, foods, etc. containing the same.

ABSTRACT

Novel N-alkylaspartyl dipeptide ester derivative, such as N- [N- [3- (3-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester, including that in the salt form, which can be used as an excellent sweetening agent, is provided.

The novel derivative is low in calories and moreover is more excellent particularly in a sweetening potency in comparison with conventional sweetening agents, and therefore enables furnishment of a sweetening agent, food or the like product containing the derivative.

DESCRIPTION

N-Alkylaspartyl Dipeptide Ester Derivative and Sweetening AgentTechnical Field

This invention relates to a novel N-alkylaspartyl dipeptide ester derivative, a sweetening agent or a sweetened food or the like product comprising the derivative as an effective component.

Background Art

In recent years, as eating habits have been improved to a high level, fatness caused by excessive sugar intake and diseases accompanied by fatness have been at issue. Accordingly, the development of a low-calory sweetener (sweetening agent) that replaces sugar has been in demand. As a sweetener that has been widely used at present, there is aspartame which is excellent in safety and quality of sweetness. However, this is somewhat problematic in stability. In the international Patent Publication WO 94/11391, it is stated that derivatives in which an alkyl group is introduced on a nitrogen atom of aspartic acid constituting the aspartame are markedly improved in the sweetening potency and are slightly improved in stability.

Of the compounds stated in this Publication, N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester, which has introduced 3,3-dimethylbutyl group as an alkyl group is most excellent. The sweetening potency of this compound is reported to be 10000 times that of sucrose, which is a value obtained on comparing the above compound to a 2%-, 5%- and 10%-sucrose solution. There are also stated aspartame derivatives having introduced 20 types of substituents other than 3,3-dimethylbutyl group. The sweetening potency of these aspartame derivatives is reported to be not higher than 2500 times that of sucrose. There are also stated aspartame derivatives having introduced a 3-(substituted phenyl) propyl group as an alkyl group. Among these, N-[N-(3-phenylpropyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester and N-[N-(3-(3-methoxy-4-hydroxyphenyl)propyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester, as derivatives having relatively high sweetening potency, are reported to have the sweetening potency of 1500 and 2500 times that of sucrose, respectively. However, the sweetening potency of these derivatives is much lower than that of N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester, which is 10000 times that of sucrose. Also, N-[N-[(RS)-3-phenylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methylester, having, as an alkyl group, a substituent corresponding to a 3-phenyl propyl group, to the third

position of which a methyl group is further introduced, that is a 3-phenyl butyl group, is reported to have a sweetening potency of 1200 times that of sucrose. It is slightly lowered in sweetening potency in comparison with N-[N-(3-phenylpropyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester due to the methyl group introduced at the third position. On the other hand, N-[N-[3-(3-methoxy-4-hydroxyphenyl)-(RS)-1-methylpropyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester, having a structure corresponding to N-[N-[3-(3-methoxy-4-hydroxyphenyl) propyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester, to the first position of the propyl group of which a methyl group is introduced, is reported to have a sweetening potency of 500 times that of sucrose. This derivative is lowered significantly in its sweetening potency due to the methyl group introduced at the first position of the propyl group. As an example of substituting the L-phenylalanine methyl ester moiety with another amino acid ester, there is stated N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-tyrosine 1-methyl ester. This derivative is reported to have a sweetening potency of 4000 times that of sucrose. In view of the above-described status of the art, a development of a low-calory sweetening agent having a superior sweetening potency has been requested.

Problem to be solved by Invention

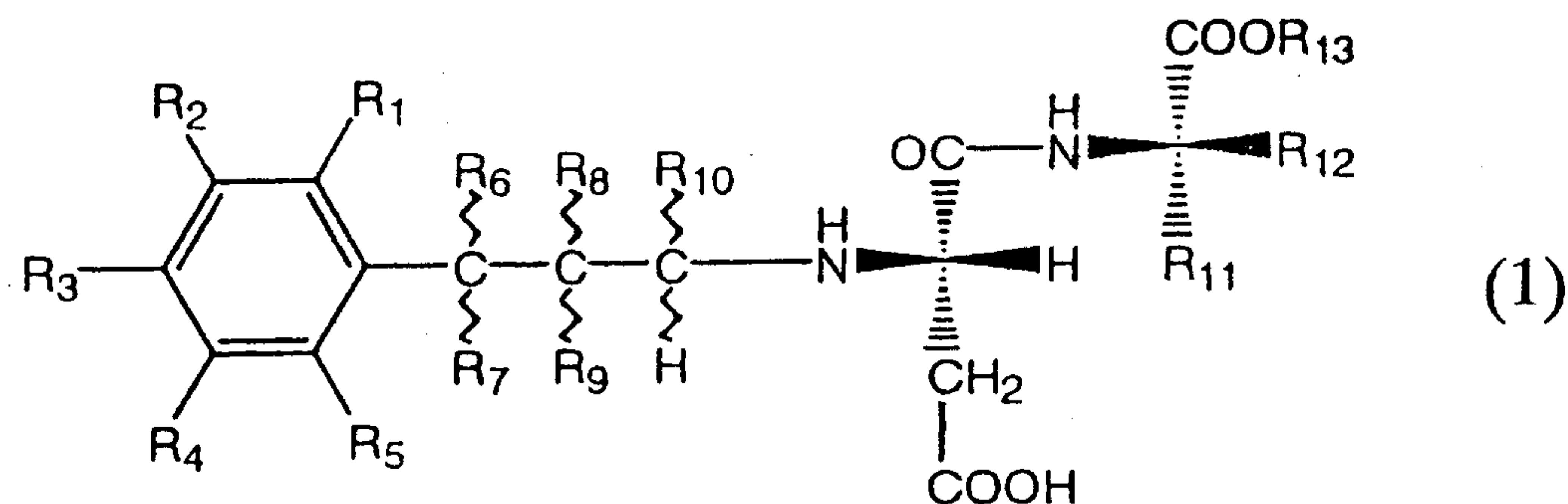
It is a problem to be solved by the present invention to provide a novel N-alkylaspartyl dipeptide ester derivative having a sweetening potency equivalent or superior to that of the above-described N-[N-[3,3-dimethylbutyl]-L- α -aspartyl]-L phenylalanine 1-methylester, and a low-calory sweetening agent comprising the derivative as an effective component (ingredient).

Disclosure of Invention

For resolving the above problem, the present inventors have synthesized a variety of compounds in which a variety of 3-(substituted phenyl) propyl group, such as 3,3-dialkyl-3-(substituted phenyl) propyl groups or (RS)-3-alkyl-3-(substituted phenyl) propyl groups, have been introduced on a nitrogen atom of an aspartic acid constituting an aspartame and an aspartame derivative, by reductive alkylation, using a 3-phenylpropionaldehyde derivative, a cinnamaldehyde derivative, a (2-phenylethyl) alkyl ketone derivative or the like having a variety of substituents on a phenyl group and also having 1 to 4 alkyl substituents on the main chain, and examined the sweetening potency of these derivatives. The aspartame derivative is a compound corresponding to the aspartame the L-phenylalanine methyl ester moiety of which is substituted by another amino acid ester therein. As a result of our investigations, the sweetening potency of some of the

aspartame derivatives is much higher in sweetening potency than N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-phenylalanine 1-methylester reported to have the sweetening potency of 10000 times that of sucrose, to say nothing of N-[N-[(RS)-3-phenylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methylester reported to have the sweetening potency of 1200 times that of sucrose or N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-tyrosine 1-methylester reported to have a sweetening potency equal to 4000 times that of sucrose, as disclosed in the international Patent Publication WO 94/11391, and that, in particular, the compound represented by the general formula (1) below is superior as a sweetening agent. The present invention has been brought to completion based on these findings.

That is, the present invention resides in a N-alkylasparatyl dipeptide ester derivative, inclusive of its salt form, and a sweetening agent or a sweetened food or the like product comprising the derivative, wherein the derivative is represented by the following general formula (1):



In the above formula, R_1 , R_2 , R_3 , R_4 and R_5 are reciprocally independent and denote a substituent selected from the group consisting of a hydrogen atom, a hydroxyl group, an alkoxy group having 1 to 3 carbon atoms, an alkyl group having 1 to 3 carbon atoms and a hydroxy alkyloxy group having two or three carbon atoms, or R_1 and R_2 , or R_2 and R_3 combine together and denote a methylene dioxy group.

In case that R_1 and R_2 , or R_2 and R_3 combined together denote a methylene dioxy group, R_4 and R_5 and, R_1 or R_3 which is not combined together with R_2 , are reciprocally independent and denote one of the above-mentioned substituents designated for the symbol.

R_6 , R_7 , R_8 , R_9 and R_{10} are reciprocally independent and denote a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms and optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} therein may combine together and denote an alkylene group with 1 to 5 carbon atoms.

If any optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} combined together denote an alkylene group with 1 to 5 carbon atoms, the substituents other than the selected two substituents are reciprocally independent and denote one of the above-defined substituents designated respectively for the symbol.

In the above formula, linkages denoted by wavy lines

are a single linkages, with there being no limitations on the direction of linkage.

If R_6 and R_7 , or R_8 and R_9 denote different substituents, or if R_{10} denotes a substituent other than a hydrogen atom, there is no limitation on the configuration of carbon atoms to which R_6 and R_7 are bonded, those to which R_8 and R_9 are bonded or those to which R_{10} is linked. For example, these configurations may be (R), (S) or (RS) independently of each other.

R_{11} denotes a substituent selected from the group consisting of a hydrogen atom, a benzyl group, a p-hydroxybenzyl group, a cyclohexylmethyl group, a phenyl group, a cyclohexyl group, a phenylethyl group and a cyclohexylethyl group, and R_{12} denotes a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms, and R_{13} denotes a substituent selected from the group consisting of an alkyl group with 1 to 4 carbon atoms.

However, derivatives in which R_6 , R_7 , R_8 , R_9 and R_{10} in their entirety denote a hydrogen atom at the same time, those in which R_6 denotes a methyl group, R_1 , R_2 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom at the same time and R_{11} denotes a benzyl group or a p-hydroxybenzyl group at the same time, and those in which R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_{10} denotes a methyl group, R_1 , R_4 , R_5 , R_6 , R_7 , R_8 and R_9 denote a hydrogen atom at the same time, and R_{11}

denotes a benzyl group or a p-hydroxy benzyl group, are excluded from the above-described derivatives.

Embodiments for Carrying out Invention

The novel N-alkylaspartyl dipeptide ester derivative according to the present invention includes compounds represented by the above formula (1) and also salt forms thereof. Of the amino acids constituting the above derivative, the aspartic acid is in the L-isomer. Other amino acids may be in the L- or D-isomer, as desired.

The compounds of the present invention preferably include the following compounds:

[1] The compounds represented by the above-mentioned formula (1);

provided that, in the above formula (1), R_1 , R_2 , R_3 , R_4 and R_5 are reciprocally independent and denote a substituent selected from the group consisting of a hydrogen atom (H), a hydroxyl group (OH), an alkoxy group with 1 to 3 carbon atoms (OCH_3 , OCH_2CH_3 , $\text{OCH}_2\text{CH}_2\text{CH}_3$ and so forth), an alkyl group with 1 to 3 carbon atoms (CH_3 , CH_2CH_3 , $\text{CH}_2\text{CH}_2\text{CH}_3$ and so forth), a hydroxy alkyloxy group with two or three carbon atoms ($\text{O}(\text{CH}_2)_2\text{OH}$, $\text{OCH}_2\text{CH}(\text{OH})\text{CH}_3$ and so forth), or R_1 and R_2 , or R_2 and R_3 therein combine together and denote a methylene dioxy group (OCH_2O).

It is noted that in case that R_1 and R_2 or R_2 and R_3 combined together denote a methylene dioxy group, R_4 and R_5

and R_1 or R_3 which is not combined with R_2 are reciprocally independent from each other and denote one of the above-mentioned substituents designated respectively for the symbol.

R_6 , R_7 , R_8 , R_9 and R_{10} are reciprocally independent from each other and denote a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms and optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} combine together and denote an alkylene group with 1 to 5 carbon atoms (such as CH_2 , CH_2CH_2 , $\text{CH}_2\text{CH}_2\text{CH}_2$ and so forth).

In case that optional two substituents selected from the group consisting of R_6 , R_7 , R_8 , R_9 and R_{10} combined together denote an alkylene group with 1 to 5 carbon atoms, the remaining substituents are reciprocally independent from each other and denote the respective specified or illustrated substituents designated respectively for the symbol.

In the above formula (1), a linkage denoted by wavy line are a single linkage, with there being no limitations on the direction of linkage.

In case that R_6 and R_7 or R_8 and R_9 denote respective different substituents from each other, or R_{10} is a substituent other than a hydrogen atom, there is no limitation to the configuration of the carbon atom to which R_6 and R_7 are linked, a carbon atom to which R_8 and R_9 are linked or a carbon atom to which R_{10} is linked. Thus, the

configuration may be any one of (R), (S), (RS) or the like.

R_{11} denotes a substituent selected from the group consisting of a hydrogen atom, a benzyl group ($\text{CH}_2\text{C}_6\text{H}_5$), a p-hydroxybenzyl group ($\text{CH}_2\text{C}_6\text{H}_5\text{-p-OH}$), a cyclohexylmethyl group ($\text{CH}_2\text{C}_6\text{H}_{11}$), a phenyl group (C_6H_5), a cyclohexyl group (C_6H_{11}), a phenyl ethyl group ($\text{CH}_2\text{CH}_2\text{C}_6\text{H}_5$) and a cyclohexylethyl group ($\text{CH}_2\text{CH}_2\text{C}_6\text{H}_{11}$), and R_{12} denotes a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms, and R_{13} denotes a substituent selected from the group consisting of alkyl groups with 1 to 4 carbon atoms.

However, derivatives in which R_6 , R_7 , R_8 , R_9 and R_{10} in their entirety denote a hydrogen atom at the same time, those in which R_6 denotes a methyl group, R_1 , R_2 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom at the same time and R_{11} denotes a benzyl group or a p-hydroxybenzyl group at the same time, and those in which R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_{10} denotes a methyl group, R_1 , R_4 , R_5 , R_6 , R_7 , R_8 and R_9 denote a hydrogen atom at the same time, and R_{11} denotes a benzyl group or a p-hydroxybenzyl group, are excluded from the derivatives.

[2] The compound as defined in [1] where R_6 is a methyl group.

[3] The compound as defined in [2] where R_7 is a methyl group.

[4] The compound as defined in [3] where R_8 , R_9 and R_{10} are hydrogen atoms.

[5] The compound as defined in [1] to [3] where R_{10} is a methyl

group.

[6] The compound as defined in [1] where R_6 and R_7 combine together and denote an alkylene group having 1 to 5 carbon atoms.

[7] The compound as defined in [2] except the compound where the totality of R_1 , R_2 , R_3 , R_4 and R_5 denote a hydrogen atom.

[8] The compound as defined in [1] where R_6 is a methyl group and R_1 , R_2 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 and R_{10} are all hydrogen atoms.

[9] The compound as defined in [1] where R_6 is an alkyl group having two or three carbon atoms.

[10] The compound as defined in [1] where any optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} combined together denote an alkylene group with one to five carbon atoms.

[11] The compound as defined in [1] where R_6 , R_7 , R_8 , R_9 are all hydrogen atoms, R_{10} is a methyl group, R_2 is a substituent selected from a hydrogen atom, a hydroxyl group, an alkoxy group with two or three carbon atoms, an alkyl group with one to three carbon atoms and a hydroxy alkyloxy group having two or three carbon atoms or R_2 combined with R_1 or R_3 denotes a methylene dioxy group.

[12] The compound as defined in [1] where R_6 , R_7 , R_8 and R_9 are all hydrogen atoms, R_{10} is a methyl group, R_3 is a substituent selected from a hydrogen atom, an alkoxy group with one to three carbon atoms, an alkyl group with one to three carbon atoms and a hydroxy alkyloxy group having two or three carbon

atoms, and R_2 may combine with R_1 or R_3 form a methylene dioxy group.

[13] The compound as defined in [1] where R_1 , R_4 , R_5 , R_6 , R_7 , R_8 and R_9 are all hydrogen atoms, R_{10} is a methyl group, R_2 is a methoxy group, R_3 is a hydroxyl group, and R_{11} is a substituent selected from the group selected from the group consisting of a hydrogen atom, a cyclohexyl methyl group, a phenyl group, a cyclohexyl group, a phenylethyl ($\text{CH}_2\text{CH}_2\text{C}_6\text{H}_5$) and a cyclohexylethyl group ($\text{CH}_2\text{CH}_2\text{C}_6\text{H}_{11}$).

[14] The compound as defined in [1] where R_6 and R_7 denote hydrogen atoms and R_{10} is an alkyl group with two or three carbon atoms.

[15] The compound as defined in [1] where R_6 and R_7 denote hydrogen atoms and optional two selected from R_8 , R_9 and R_{10} combine together and denote an alkylene group with 1 to 5 carbon atoms.

[16] The compound as defined in [1] where R_6 , R_7 and R_{10} denote hydrogen atoms, at least one of R_8 and R_9 denotes an alkyl group with one to three carbon atoms or R_8 and R_9 combine together and denote an alkylene group with 1 to 5 carbon atoms.

[17] The derivative in [1] wherein R_3 denotes a methoxy group, R_1 , R_2 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote hydrogen atoms, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[18] The derivative in [1] wherein R_2 is a hydroxyl group, R_1 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom,

R_6 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

[19] The derivative in [1] wherein R_2 is a methoxy group, R_3 is a hydroxyl group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[20] The derivative in [1] wherein R_2 is a hydroxyl group, R_3 is a methoxy group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[21] The derivative in [1] wherein R_2 is a methoxy group, R_3 is a hydroxyl group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote hydrogen atoms, R_6 and R_{13} denote a methyl group and R_{11} denotes a p-hydroxybenzyl group.

[22] The derivative in [1] wherein R_2 is a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a cyclohexylmethyl group.

[23] The derivative in [1] wherein R_3 is a methoxy group, R_1 , R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

[24] The derivative in [1] wherein R_3 is a hydroxyl group, R_1 , R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[25] The derivative in [1] wherein R_2 is a methoxy group, R_3 is a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen group, R_6 , R_7 and R_{13} denote a methyl group and R_{11}

denotes a benzyl group.

[26] The derivative in [1] wherein R_2 is a hydroxyl group, R_3 is a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen group, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[27] The derivative in [1] wherein R_2 is a methyl group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[28] The derivative in [1] wherein R_2 is a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_6 , R_7 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_8 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[29] The derivative in [1] wherein R_1 is a hydroxyl group, R_2 , R_3 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[30] The derivative in [1] wherein R_1 is a hydroxyl group, R_3 is a methoxy group, R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[31] The derivative in [1] wherein R_1 is a hydroxyl group, R_3 is a methyl group, R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[32] The derivative in [1] wherein R_2 and R_3 combine together and denote a methylene dioxy group, R_1 , R_4 , R_5 , R_8 ,

R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} is a benzyl group.

[33] The derivative in [1] wherein R_2 denotes a methyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[34] The derivative in [1] wherein R_2 denotes a methyl group, R_3 is a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

[35] The derivative in [1] wherein R_2 denotes a hydroxyl group, R_3 denotes a methyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[36] The derivative in [1] wherein R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen group, R_6 and R_7 combine together and denote a tetramethylene group, R_{11} denotes a benzyl group and R_{13} denotes a methyl group.

[37] The derivative in [1] wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_7 denote a methyl group, R_{11} denotes a benzyl group and R_{13} denotes an ethyl group.

[38] The derivative in [1] wherein R_2 and R_3 denote a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl

group.

[39] The derivative in [1] wherein R_2 is a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 and R_{10} denote a hydrogen atom, R_6 , R_7 , R_{12} and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

[40] The derivative in [17] to [22] and [27] wherein the configuration of the carbon atom to which R_8 is linked in the formula is in the form of (R), (S), (RS) or the like.

[41] The derivative in [28] wherein the configuration of the carbon atom to which is R_8 linked in the formula is in the form of (R), (S), (RS) or the like.

[42] The derivative in [1] wherein the configuration of the carbon atom to which R_{10} is linked in the formula is in the form of (R), (S), (RS) or the like.

For the preferable embodiments, the following inventions are contained in the present invention.

[43] A sweetening agent or a sweetened food or the like product comprising the above-defined derivative in the present invention as an effective component, which may occasionally contain a carrier and/or a bulking agent.

[44] A method for imparting sweetness, comprising a step of: giving (mixing or adding) the above derivative to a product in need of sweetness, such as food, beverage (drinking), pharmaceuticals and oral hygiene products, and products requesting sweetness for animals other than humans.

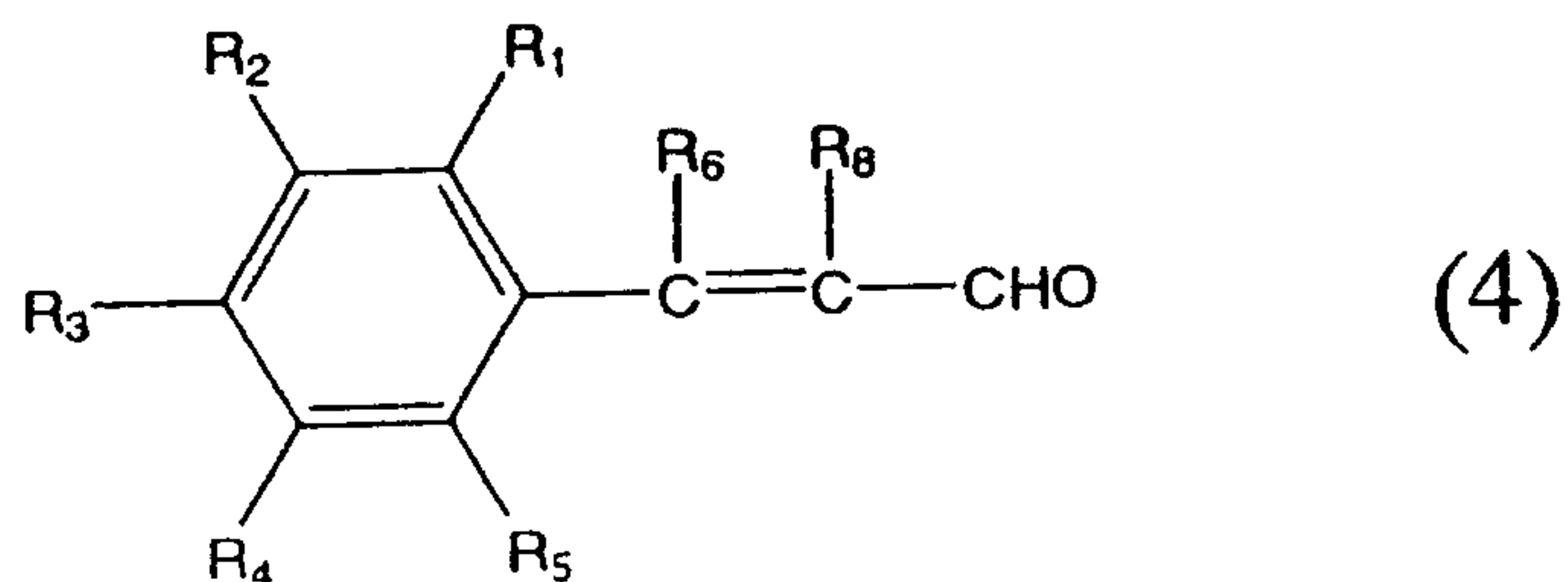
[45] A method for manufacturing a compound represented by the

$$\begin{array}{c}
 R_2 \quad R_1 \\
 \diagdown \quad \diagup \\
 \text{C}_6\text{H}_4 \\
 \diagup \quad \diagdown \\
 R_3 \quad R_4 \quad R_5
 \end{array}
 - \text{C} \begin{array}{c} \text{R}_6 \\ \text{R}_7 \end{array} - \text{C} \begin{array}{c} \text{R}_8 \\ \text{R}_9 \end{array} - \text{CHO} \quad (2)$$
$$\begin{array}{c}
 \text{COOR}_{13} \\
 | \\
 \text{H} \\
 | \\
 \text{OC} - \text{N} \begin{array}{l} \nearrow \text{R}_{12} \\ \searrow \text{R}_{11} \end{array} \\
 | \\
 \text{R}_{14}\text{HN} \begin{array}{l} \nearrow \text{H} \\ \searrow \text{CH}_2 \\ | \\ \text{COOR}_{15} \end{array}
 \end{array}
 \quad (3)$$

under a reductive alkylation condition;

wherein R_{11} , R_{12} and R_{13} in the above formula (3) have the same meaning as R_{11} , R_{12} and R_{13} , respectively in the above formula (1), R_{14} denotes a hydrogen atom or a substituent that can be converted into a hydrogen atom under the reductive alkylation condition and R_{15} denotes a hydrogen atom, a benzyl group or a substituent that may be used for protecting a carboxyl group such as a t-butyl group or the like.

[46] A method for manufacturing a compound represented by the above general formula (1), where R_7 , R_9 and R_{10} denote a hydrogen atom, said method comprising a step of reacting an aldehyde shown by the following general formula (4)

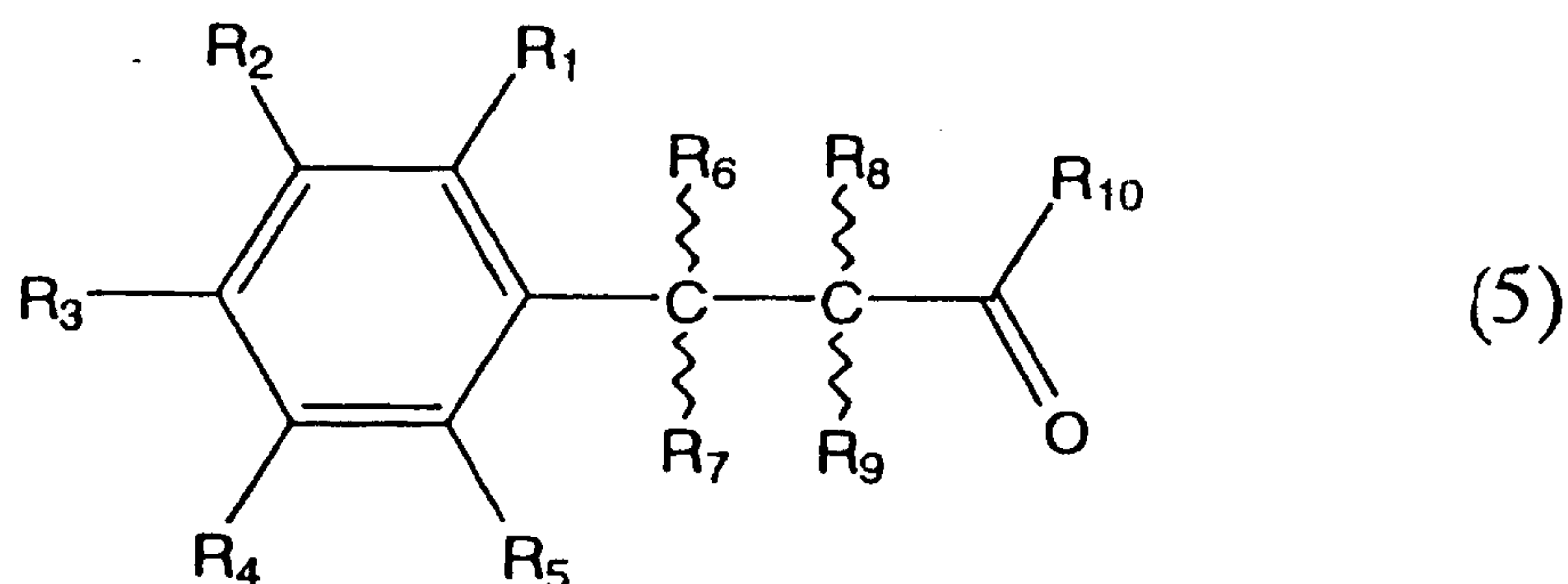


where R_1 , R_2 , R_3 , R_4 , R_5 , R_6 and R_8 have the same meaning as R_1 , R_2 , R_3 , R_4 , R_5 , R_6 and R_8 , respectively in the above formula (1);

with an aspartame derivative shown by the above-mentioned general formula (3) under a reductive alkylation condition.

[47] A method for manufacturing a compound represented by the above general formula (1), comprising a step of reacting

an aldehyde shown by the following general formula (5)



where R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , R_7 , R_8 , R_9 and R_{10} have the same meaning as R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , R_7 , R_8 , R_9 and R_{10} , respectively in the above formula (1);

it being noted that linkages denoted by wavy lines in the above formula (5) are single linkages, with there being no limitations on the direction of linkage;

it being also noted that, if R_6 and R_7 or R_8 and R_9 are not the same substituents, there is no particular limitation to the configuration of the carbon atoms to which R_6 and R_7 , or R_8 and R_9 are linked, such that it may be (R), (S), (RS) or the like whichever is desired;

with the aspartame derivative shown by the above general formula (3) under a reductive alkylation condition.

It is sufficient if the manufacturing methods given in [45] to [47] include the reacting step under the reductive alkylation condition, such that a step or steps other than the reacting step under the reductive alkylation condition may also be included in the manufacturing method. There may

also be included an optional step or steps, following the reacting step under the reductive alkylation condition, for example, de-protection in a hydroxyl group or the other functional group, a salt forming step or the like, for producing such targeted compounds.

As the substituent that can be converted into a hydrogen atom under the reductive alkylation condition, those that usually can be used for such purpose, such as benzyloxy carbonyl group or the like, may be optionally selected depending on the particular reductive alkylation condition used. As these reductive alkylation conditions, the conditions as known per se, or any suitable conditions that will be developed in future, such as a condition employing metal hydrides, may be used, as needed.

As a further preferable present embodiment of the present invention, if aldehyde shown by the general formulas (2), (4) or (5) includes hydroxyl groups, the above-described manufacturing methods of [45] to [47] employing an aldehyde the hydroxyl group of which is protected by a suitable protecting group, such as benzyl group, may also be contained in the present invention.

It is noted that salts of the compounds of the present invention, which are included in the derivatives of the present invention, may be enumerated by, for example, salts of alkali metals such as sodium and potassium, salts of alkali earth metals, such as calcium and magnesium, ammonium salt

with ammonia, salts with amino acids, such as lysine and arginine, salts with inorganic acids, such as hydrogen chloride and sulfuric acid, salts with organic acids, such as citric acid and acetic acid, and salts with sweetening agents, such as saccharin, acesulfame, cyclamic acid and glycyrrhizic acid. These salts may be included in the derivatives of the present invention, as pointed out above.

The N-alkylaspartyl dipeptide ester derivative of the present invention can be easily synthesized by reductive alkylation of aspartame or aspartame derivatives, that is compounds obtained on replacing an L-phenylalanine methylester moiety in the aspartame by another amino acid ester, using a 3-phenylpropionaldehyde derivative, a cinnamaldehyde derivative or a (2-phenylethyl) alkylketone derivative, which has different substituents on a phenyl group and also having one to four alkyl substituents on the main chain, and a reducing agent, such as a hydrogen/palladium carbon catalyst. Alternatively, the N-alkylaspartyl dipeptide ester derivative of the present invention can be produced by a method consisting in reductive alkylation of an aspartame derivative, having a protecting group in a β -position in the carboxylic acid, such as β -O-benzyl- α -L-aspartyl-L-amino acid methyl ester, using the above-described 3-phenylpropionaldehyde derivative, a cinnamaldehyde derivative or a (2-phenylethyl) alkylketone derivative, and a reducing agent, such as $\text{NaB(OAc)}_3\text{H}$, as

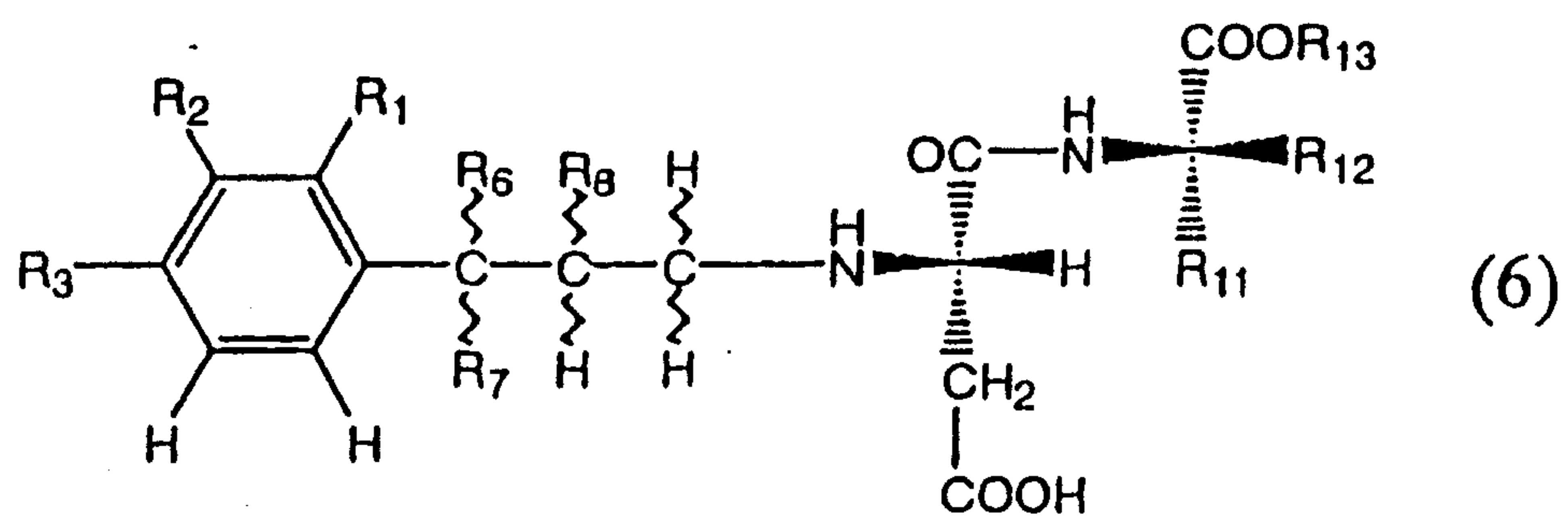
disclosed in A. F. Abdel - Magid et al., Tetrahedron letters, 31, 5595 (1990), followed by removal of protecting groups thereof, or by a method consisting in saturating unsaturated bonds with a reducing agent, as the occasion may demand. The above aspartame derivative may be obtained by a usual peptide synthesis method, as discussed in Izumiya et al., Fundamentals and Experimentation in Peptide Synthesis. Published by MARUZEN on January 20, 1985. The method for synthesis of the compounds in the present invention is, however, not limited to these methods. In place of the above-mentioned 3-phenylpropionaldehyde derivative, cinnamaldehyde derivative or the (2-phenylethyl) alkyl ketone derivative, acetal or ketal derivatives thereof may, of course, be used as the aldehyde or ketone components at the time of the reductive alkylation.

As a result of sensory evaluation, the derivative, that is the compound, and salt forms thereof, according to the present invention, have been found to have strong sweetening potency and sensory properties similar to that of sugar. For example, the sweetness of N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was approximately 70000 times that of sugar, the sweetness of N-[N-[3-(3-methyl-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was approximately 70000 times that of sugar, the sweetness of N-[N-[3-(3-hydroxy-4-

methylphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was approximately 60000 times that of sugar, and the sweetness of N-[N-[(RS)-3-(3-hydroxy-4-methoxyphenyl)butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was approximately 50000 times that of sugar. On the other hand, the half life in a buffer of pH = 3.0 at 72.0 °C of N-[N-[3-(3-methoxy-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was 34.4 hours, which was substantially equivalent to the half life of N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester (31.4 hours under the same condition). Also, the half life in a buffer with pH=3.0 at 70.0 °C of aspartame, N-[N-(3,3-dimethylbutyl)-L- α -aspartyl]-L-phenylalanine 1-methyl ester, N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester and N-[N-[3-(4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methylester, was measured, and found to be 23.5, 38.3, 44.5 and 43.6 hours, respectively.

Table 1 shows the structures of several synthesized N-alkyl aspartyl dipeptide ester derivatives, shown by the general formula (6), indicated below, and results of the sensory evaluation tests.

As may be seen from the results of Table 1, the novel derivatives of the present invention are particularly excellent in sweetness (sweetening potency).



Structure of N-alkylasparatyl dipeptide ester derivative and
sweetness potency

Table 1

Compound No.	R ₁	R ₂	R ₃	R ₆	R ₇	R ₈	R ₁₁	R ₁₂	R ₁₃	sweetness potency ^{*)}
1	H	H	OCH ₃	CH ₃	H	H	CH ₂ C ₆ H ₅	H	CH ₃	16000
2	H	OH	H	CH ₃	H	H	CH ₂ C ₆ H ₅	H	CH ₃	12000
3	H	OCH ₃	OH	CH ₃	H	H	CH ₂ C ₆ H ₅	H	CH ₃	30000
4	H	OH	OCH ₃	CH ₃	H	H	CH ₂ C ₆ H ₅	H	CH ₃	50000
5	H	OCH ₃	OH	CH ₃	H	H	CH ₂ C ₆ H ₄ - p - OH			
								H	CH ₃	25000
6	H	OH	OCH ₃	CH ₃	H	H	CH ₂ C ₆ H ₁₁	H	CH ₃	40000
7	H	H	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	25000
8	H	H	OH	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	25000
9	H	OCH ₃	OH	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	40000
10	H	OH	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	70000
11	H	CH ₃	OH	CH ₃	H	H	CH ₂ C ₆ H ₅	H	CH ₃	50000
12	H	OH	OCH ₃	H	H	CH ₃	CH ₂ C ₆ H ₅	H	CH ₃	5000
13	OH	H	H	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	8000
14	OH	H	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	20000
15	OH	H	CH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	25000
16	H	OCH ₂ O		CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	30000
17	H	CH ₃	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	30000
18	H	CH ₃	OH	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	70000
19	H	OH	CH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	60000
20	H	OCH ₃	OH	CH ₂ CH ₂ CH ₂ CH ₂	H		CH ₂ C ₆ H ₅	H	CH ₃	30000
21	H	OH	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₂ CH ₃	15000
22	H	OH	OCH ₃	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	CH ₃	CH ₃	40000
23	H	OH	OH	CH ₃	CH ₃	H	CH ₂ C ₆ H ₅	H	CH ₃	50000

*) values compared to sweetening potency of a 4 % aqueous solution of sucrose

Meanwhile, in case that the derivatives of the present invention (compounds of the present invention inclusive of salt forms thereof) are used as a sweetening agent, it is of course possible to use other sweetening agents in combination.

If the derivatives of the present invention are used as the sweetening agents, it is of course possible to use a carrier and/or a bulking agent, for example, a carrier or a bulking agent so far known and used.

The derivatives of the present invention can be used as a sweetening agent or a component thereof. In addition, the derivatives of the present invention can be used for products, such as foods or the like products, in need of a sweet taste, such as confectionery, chewing gums, hygiene products, toiletries, cosmetics, pharmaceuticals and various veterinary products for animals other than those for humans. Moreover, the derivatives of the present invention can be used as form of a product to be given or endowed with a sweet taste and in a sweet taste imparting method for the products (foods or the like products) in need of a sweet taste. As for the method of using the derivatives of the present invention, any suitable conventional or well-known method can be followed.

Preferred Embodiments for Carrying out Invention

The present invention will be explained in detail with

reference to Examples which, however, are merely illustrative and are not intended to limit the present invention.

The NMR spectrum and the MS spectrum were measured using Varian Gemini 300 (300 MHz) and Thermo Quest TSQ700, respectively.

(Example 1)

Synthesis of N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 10)

To 703 mg (1.45 mmol) of N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester, 10 ml of a 4N-HCl/dioxane solution were added and stirred at room temperature for one hour. The reaction solution was concentrated under reduced pressure. To the residue were added 50 ml of a 5%-aqueous solution of sodium hydrogen carbonate and extraction was made twice with 50 ml of ethyl acetate. An organic layer was washed with a saturated saline water and dried over anhydrous magnesium sulfate. Magnesium sulfate was filtered off and the liquid filtrate was concentrated under reduced pressure to yield 557 mg (1.45 mmol) of β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester, as a viscous oily substance.

557 mg (1.45 mmol) of the above β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester were dissolved in 15

ml of tetrahydrofuran (THF) to yield a solution which was maintained at 0 °C. To this solution were added 432 mg (1.45 mmol) of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde, 0.083 ml (1.45 mmol) of acetic acid and 462 mg (2.18 mmol) of NaB(OAc)₃H and stirred for one hour at 0 °C and overnight at room temperature. To the reaction solution were added 50 ml of a saturated aqueous solution of sodium hydrogen carbonate and extraction was made twice with 50 ml of ethyl acetate. An organic layer was washed with a saturated saline water and dried over anhydrous magnesium sulfate. Magnesium sulfate was filtered off and the liquid filtrate was concentrated under reduced pressure. The residue was purified with preparative thin layer chromatography (PTLC) to yield 832 mg (1.25 mmol) of N-[N-[3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl]-β-O-benzyl-L-α-aspartyl]-L-phenylalanine 1-methylester as a viscous oily substance.

The above 832 mg (1.25 mmol) of N-[N-[3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl]-β-O-benzyl-L-α-aspartyl]-L-phenylalanine 1-methyl ester were dissolved in a mixed solvent of 25 ml of methanol and 2 ml of water, and 350 mg of 10% palladium carbon (containing 50% of water) were added thereto. The resulting mixture was reduced at room temperature for three hours under a hydrogen atmosphere. The catalyst was filtered off and the filtrate was concentrated under reduced pressure. The residue was purified with PTLC to remove an odor adsorbed to yield 400 mg (0.82 mmol) of

N- [N- [3- (3-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methylester as a solid substance.

$^1\text{HMMR}$ (DMSO- d_6) δ :1.14 (s, 6H), 1.54-1.68 (m, 2H), 2.04-2.22 (m, 3H), 2.24-2.34 (dd, 1H), 2.84-2.94 (dd, 1H), 3.00-3.08 (dd, 1H), 3.31-3.36 (m, 1H), 3.59 (s, 3H), 3.71 (s, 3H), 4.46-4.55 (m, 1H), 6.60-6.65 (dd, 1H), 6.73 (s, 1H), 6.80 (d, 1H), 7.10-7.28 (m, 5H), 8.45 (d, 1H), 8.75 (brs, 1H) .

ESI(Electrospray Ionization)-MS 487.3 (MH $^+$)

Sweetness (sweetening potency), 70000 times the sweetness of sugar

(Example 2)

Synthesis of N- [N- [3- (4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester (Table 1, compound number 7)

N- [N- [3- (4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 72.2%, in the same way as in Example 1, except using 3-(4-methoxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

$^1\text{HMMR}$ (DMSO- d_6) δ :1.17 (s, 6H), 1.62-1.72 (m, 2H), 2.04-2.20 (m, 3H), 2.24- 2.34 (dd, 1H), 2.84-2.94 (dd, 1H), 2.95-3.07 (dd, 1H), 3.30-3.35 (m, 1H), 3.51 (s, 3H), 3.70 (s,

3H), 4.46-4.54 (m, 1H), 6.83 (d, 2H), 7.14-7.28 (m, 7H), 8.43 (d, 1H).

ESI-MS 471.3 (MH⁺)

Sweetness, 25000 times the sweetness of sugar

(Example 3)

Synthesis of N-[N-[3-(4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1 methyl ester (Table 1, compound number 8)

N-[N-[3-(4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 64.5%, in the same way as in Example 1, except using 3-(4-benzyloxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.15 (s, 6H), 1.58-1.72 (m, 2H), 2.04-2.20 (m, 3H), 2.24-2.34 (dd, 1H), 2.85-2.94 (dd, 1H), 3.00-3.08 (dd, 1H), 3.30-3.36 (m, 1H), 3.59 (s, 3H), 4.46-4.55 (m, 1H), 6.67 (d, 2H), 7.07 (d, 2H), 7.10-7.27 (m, 5H), 8.44 (d, 1H), 9.15 (brs, 1H).

ESI-MS 457.3 (MH⁺)

Sweetness, 25000 times the sweetness of sugar

(Example 4)

Synthesis of N-[N-[3-(3-methoxy-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1 methyl ester

(Table 1, compound number 9)

N-[N-[3-methoxy-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 62.2%, in the same way as in Example 1, except using 3-(3-methoxy-4-benzyloxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

$^1\text{HMMR}$ ($\text{DMSO}-d_6$) δ : 1.17 (s, 6H), 1.63-1.72 (m, 2H), 2.08-2.22 (m, 3H), 2.25-2.33 (dd, 1H), 2.86-2.94 (dd, 1H), 3.00-3.08 (dd, 1H), 3.33-3.38 (m, 1H), 3.59 (s, 3H), 3.75 (s, 3H), 3.47-3.55 (m, 1H), 6.67 (s, 2H), 6.81 (s, 1H), 7.14-7.27 (m, 5H), 8.46 (d, 1H), 8.70 (brs, 1H).

ESI-MS 487.3 (MH^+)

Sweetness, 40000 times the sweetness of sugar

(Example 5)

Synthesis of N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-(α -methyl) phenylalanine 1-methylester (Table 1, compound number 22)

N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-(α -methyl) phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 77.2%, in the same way as in Example 1, except using N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-(α -methyl) phenylalanine methyl ester in place of N-t-butoxy carbonyl- β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester.

¹HMMR (DMSO-d₆) δ : 1.18 (s, 6H), 1.22 (s, 3H), 1.66-1.76 (m, 2H), 2.18-2.38 (m, 4H), 3.00 (d, 1H), 3.19 (d, 1H), 3.36-3.42 (m, 1H), 3.49 (s, 3H), 3.72 (s, 3H), 6.67 (dd, 1H), 6.74 (d, 1H), 6.80 (d, 1H), 7.02-7.06 (m, 2H), 7.20-7.30 (m, 3H), 8.29 (brs, 1H), 8.75 (brs, 1H).

ESI-MS 501.3 (MH⁺)

Sweetness, 40000 times the sweetness of sugar

(Example 6)

Synthesis of N-[N-[3-(2-hydroxyphenyl)-3-methylbutyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 13)

N-[N-[3-(2-hydroxyphenyl)-3-methylbutyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 64.5%, in the same way as in Example 1, except using 3-(2-benzyloxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.26 (s, 6H), 1.84-2.30 (m, 6H), 2.88 (dd, 1H), 3.02 (dd, 1H), 3.32-3.38 (m, 1H), 3.59 (s, 3H), 4.45-4.54 (m, 1H), 6.68-6.78 (m, 3H), 6.96-7.06 (m, 2H), 7.12-7.30 (m, 5H), 8.50 (d, 1H), 9.30 (brs, 1H).

ESI-MS 457.4 (MH⁺)

Sweetness, 8000 times the sweetness of sugar

(Example 7)

Synthesis of N- [N- [3- (2-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester (Table 1, compound number 14)

N- [N- [3- (2-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1 methyl ester was obtained as a solid substance, with a total yield of 44.1%, in the same way as in Example 1, except using 3- (2-benzyloxy-4-methoxyphenyl) -3-methylbutyl aldehyde in place of 3- (3-benzyloxy-4-methoxy phenyl) -3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.22 (s, 6H), 1.82-2.20 (m, 5H), 2.26 (dd, 1H), 2.88 (dd, 1H), 3.01 (dd, 1H), 3.34-3.40 (m, 1H), 3.59 (s, 3H), 3.64 (s, 3H), 4.46-4.53 (m, 1H), 6.28 (dd, 1H), 6.36 (d, 1H), 6.92 (d, 1H), 7.14-7.26 (m, 5H), 8.52 (d, 1H), 9.40 (brs, 1H).

ESI-MS 487.3 (MH⁺)

Sweetness, 20000 times the sweetness of sugar

(Example 8)

Synthesis of N- [N- [3- (2-hydroxy-4-methylphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester (Table 1, compound number 15)

N- [N- [3- (2-hydroxy-4-methylphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 45.1%, in the same way as in Example 1, except using 3- (2-benzyloxy-4-methylphenyl) -3-methylbutyl aldehyde in place of 3- (3-

benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.23 (s, 6H), 1.82-2.20 (m, 5H), 2.14 (s, 3H), 2.25 (dd, 1H), 2.88 (dd, 1H), 3.01 (dd, 1H), 3.33-3.39 (m, 1H), 3.58 (s, 3H), 4.46-4.54 (m, 1H), 6.51 (d, 1H), 6.87 (s, 1H), 6.90 (d, 1H), 7.10-7.23 (m, 5H), 8.51 (d, 1H), 9.20 (brs, 1H).

ESI-MS 471.2 (MH⁺)

Sweetness, 25000 times the sweetness of sugar

(Example 9)

Synthesis of N-[N-[3-(3,4-methylenedioxyphenyl)-3-methylbutyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 16)

N-[N-[3-(3,4-methylenedioxyphenyl)-3-methylbutyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 69.7%, in the same way as in Example 1, except using 3-(3,4-methylenedioxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.16 (s, 6H), 1.60-1.70 (m, 2H), 2.05-2.20 (m, 3H), 2.27 (dd, 1H), 2.89 (dd, 1H), 3.03 (dd, 1H), 3.31-3.35 (m, 1H), 3.59 (s, 3H), 4.46-4.54 (m, 1H), 5.94 (s, 2H), 6.72 (dd, 1H), 6.79 (d, 1H), 6.88 (d, 1H), 7.15-7.28 (m, 5H), 8.44 (d, 1H).

ESI-MS 485.4 (MH⁺)

Sweetness, 30000 times the sweetness of sugar

(Example 10)

Synthesis of N-[N-[3-(3-methyl-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 17)

N-[N-[3-(3-methyl-4-methoxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 66.0%, in the same way as in Example 1, except using 3-(3-methyl-4-methoxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxy phenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.16 (s, 6H), 1.63-1.72 (m, 2H), 2.13 (s, 3H), 2.08-2.20 (m, 3H), 2.25-2.32 (dd, 1H), 2.85-2.95 (dd, 1H), 3.00-3.06 (dd, 1H), 3.31-3.36 (m, 1H), 3.59 (s, 3H), 3.73 (s, 3H), 4.47-4.55 (m, 1H), 6.79-6.82 (m, 1H), 7.03-7.06 (m, 2H), 7.15-7.27 (m, 5H), 8.44-8.47 (d, 1H).

ESI-MS 485.5 (MH⁺)

Sweetness, 30000 times the sweetness of sugar

(Example 11)

Synthesis of N-[N-[3-(3-methyl-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 18)

N-[N-[3-(3-methyl-4-hydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 63.2%, in the same

way as in Example 1, except using 3-(3-methyl-4-benzyloxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.14 (s, 6H), 1.59-1.68 (m, 2H), 2.09 (s, 3H), 2.09-2.18 (m, 3H), 2.25 (dd, 1H), 2.90 (dd, 1H), 3.02 (dd, 1H), 3.30-3.36 (m, 1H), 3.59 (s, 3H), 4.46-4.54 (m, 1H), 6.68 (d, 1H), 6.88 (dd, 1H), 6.96 (s, 1H), 6.14-6.73 (m, 5H), 8.46 (d, 1H), 9.01 (brs, 1H).

ESI-MS 471.4 (MH⁺)

Sweetness, 70000 times the sweetness of sugar

(Example 12)

Synthesis of N-[N-[2-[1-(3-methoxy-4-hydroxyphenyl) cyclopentyl] ethyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 20)

N-[N-[2-[1-(3-methoxy-4-hydroxyphenyl) cyclopentyl] ethyl]-L-α-aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance, with a total yield of 68.4%, in the same way as in Example 1, except using 2-[1-(3-methoxy-4-hydroxyphenyl) cyclopentyl] acetaldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.48-1.82 (m, 10H), 2.00-2.16 (m, 3H), 2.24 (dd, 1H), 2.90 (dd, 1H), 3.01 (dd, 1H), 3.30-3.40 (m, 1H), 3.59 (s, 3H), 3.74 (s, 3H), 4.45-4.53 (m, 1H), 6.59 (dd, 1H), 6.65 (d, 1H), 6.75 (dd, 1H), 7.14-7.28 (m, 5H), 8.44 (d, 1H), 8.70 (brs, 1H).

ESI-MS 513.4 (MH⁺)

Sweetness, 30000 times the sweetness of sugar

(Example 13)

Synthesis of N- [N- [3- (3-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1- ethyl ester (Table 1, compound number 21)

N- [N- [3- (3-hydroxy-4-methoxyphenyl) -3-methylbutyl] -L- α -aspartyl] -L-phenylalanine 1- ethyl ester was obtained as a solid substance, with a total yield of 56.1%, in the same way as in Example 1, except using N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-phenylalanine ethyl ester in place of N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester.

¹HMMR (DMSO-d₆) δ : 1.09 1.13 (m, 9H), 1.58-1.67 (m, 2H), 2.08-2.37 (m, 4H), 2.86-2.93 (dd, 1H), 2.99-3.06 (dd, 1H), 3.32-3.37 (m, 1H), 3.71 (s, 3H), 4.00-4.07 (m, 2H), 4.44-4.51 (m, 1H), 6.62-6.65 (d, 1H), 6.74-6.81 (m, 2H), 7.15-7.27 (m, 5H), 8.46 (d, 1H), 8.78 (brs, 1H).

ESI-MS 501.3 (MH⁺)

Sweetness, 15000 times the sweetness of sugar

(Example 14)

Synthesis of N- [N- [(RS) -3- (3-methoxy-4-hydroxyphenyl) butyl] -L- α -aspartyl] -L-phenylalanine 1-methyl ester (Table 1, compound number 3)

419 mg (1.09 mmol) of β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester, obtained in the same way as in Example 1, were dissolved in 10 ml of THF and the resulting solution was maintained at 0 °C. To this solution were added 308 mg (1.09 mmol) of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal, 0.062 ml (1.09 mmol) of acetic acid and 345 mg (1.63 mmol) of NaB(OAc)₃H and the resulting mixture was stirred at 0 °C for one hour and further stirred overnight at room temperature. To the reaction solution were added 30 ml of a saturated aqueous solution of sodium hydrogen carbonate and extraction was carried out twice with 30 ml of ethyl acetate. An organic layer was washed with saturated saline water and dried over anhydrous magnesium sulfate. After filtering magnesium sulfate off, the liquid filtrate was concentrated under reduced pressure. The residue was purified with preparative thin layer chromatography (PTLC) to obtain 534 mg (0.82 mmol) of N-[N-[3-(3-methoxy-4-benzyloxyphenyl)-2-butenyl]- β -O-benzyl-L- α -aspartyl]-L-phenylalanine 1-methyl ester as a viscous oily substance.

534 mg (0.82 mmol) of the above N-[N-[3-(3-methoxy-4-benzyloxyphenyl)-2-butenyl]- β -O-benzyl-L- α -aspartyl]-L-phenylalanine 1-methyl ester were dissolved in a mixed solvent of 20 ml of methanol and 1 ml of water. To the resulting mixture were added 200 mg of 10% palladium carbon (containing 50% of water). The resulting mixture was reduced at room temperature for three hours in a hydrogen

atmosphere. The catalyst was filtered off and the resulting filtrate was concentrated under reduced pressure. The residue was purified with PTLC to remove an odor adsorbed to obtain 269 mg (0.57 mmol) of N-[N-[(RS)-3-(3-methoxy-4-hydroxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester as a solid substance.

$^1\text{HMMR}$ (DMSO- d_6) δ : 1.10 (2d, 3H), 1.50-1.60 (m, 2H), 2.10-2.40 (m, 4H), 2.55-2.65 (m, 1H), 2.85-2.95 (m, 1H), 3.03-3.09 (dd, 1H), 3.34-3.40 (m, 1H), 3.60 (s, 1.5H), 3.61 (s, 1.5H), 3.74 (s, 1.5H), 3.75 (s, 1.5H), 4.50-4.60 (m, 1H), 6.55 (d, 1H), 6.67 (d, 1H), 6.72 (s, 1H), 7.15-7.30 (m, 5H), 8.50 (brd, 1H), 8.70 (brs, 1H).

ESI-MS 473.3 (MH $^+$)

Sweetness, 30000 times the sweetness of sugar

(Example 15)

Synthesis of N-[N-[(RS)-3-(4-methoxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 1)

N-[N-[(RS)-3-(4-methoxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 37.3% in the same way as in Example 14 except using 3-(4-methoxyphenyl)-2-butenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

$^1\text{HMMR}$ (DMSO- d_6) δ : 1.09 (d, 1.5H), 1.11 (d, 1.5H), 1.54 (m, 2H), 2.17-2.23 (m, 3H), 2.28-2.38 (m, 1H), 2.64 (m, 1H), 2.85-

2.95 (m, 1H), 3.02-3.10 (dd, 1H), 3.60 (s, 1.5H), 3.61 (s, 1.5H), 3.70 (s, 1H), 4.54 (m, 1H), 6.83 (d, 2H), 7.07 (d, 2H), 7.18-7.28 (m, 5H).

ESI-MS 457.3 (MH⁺)

Sweetness, 16000 times the sweetness of sugar

(Example 16)

Synthesis of N-[N-[(RS)-3-(3-hydroxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1 methyl ester (Table 1, compound number 2)

N-[N-[(RS)-3-(3-hydroxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 31.1% in the same way as in Example 14 except using 3-(3-benzyloxyphenyl)-2-butenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

¹HMMR (DMSO-d₆) δ : 1.09 (m, 3H), 1.55 (m, 2H), 2.10-2.24 (m, 3H), 2.26-2.34 (dd, 1H), 2.58 (m, 1H), 2.85-2.98 (m, 1H), 3.01-3.10 (dd, 1H), 3.60 (s, 1.5H), 3.61 (s, 1.5H), 4.53 (m, 1H), 6.55-6.62 (m, 3H), 7.05 (t, 1H), 7.16-7.30 (m, 5H), 8.47 (m, 1H), 8.75 (brs, 1H).

ESI-MS 443.2 (MH⁺)

Sweetness, 12000 times the sweetness of sugar

(Example 17)

Synthesis of N-[N-[(RS)-3-(3-hydroxy-4-methoxyphenyl)

butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester
(Table 1, compound number 4)

N-[N-[(RS)-3-(3-hydroxy-4-methoxyphenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 38.8% in the same way as in Example 14 except using 3-(3-benzyloxy-4-methoxyphenyl)-2-butenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

$^1\text{HMMR}$ (DMSO- d_6) δ : 1.08 (m, 3H), 1.53 (m, 2H), 2.13-2.21 (m, 3H), 2.28 (dd, 1H), 2.56 (m, 1H), 2.86-3.00 (m, 1H), 3.02-3.12 (dd, 1H), 3.29-3.40 (m, 1H), 3.60 (s, 1.5H), 3.61 (s, 1.5H), 3.71 (s, 3H), 4.53 (m, 1H), 6.53 (d, 1H), 6.60 (d, 1H), 6.79 (d, 1H), 7.15-7.26 (m, 5H), 8.46 (m, 1H), 8.75 (brs, 1H).

ESI-MS 473.3 (MH^+)

Sweetness, 50000 times the sweetness of sugar

(Example 18)

Synthesis of N-[N-[3-((RS)-3-hydroxy-4-methoxyphenyl) butyl]-L- α -aspartyl]-3-cyclohexyl-L-alanine 1-methyl ester (Table 1, compound number 6)

N-[N-[(RS)-3-(3-hydroxy-4-methoxyphenyl) butyl]-L- α -aspartyl]-3-cyclohexyl-L-alanine 1-methyl ester was obtained as a solid substance with a total yield of 41.7% in the same way as in Example 14 except using N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-3-cyclohexyl-L-alanine methyl ester in place of N-t-butoxycarbonyl- β -O-

benzyl- α -L-aspartyl-L-phenylalanine methyl ester and also except using 3-(3-benzyloxy-4-methoxyphenyl)-2-butenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

$^1\text{HMMR}$ (DMSO- d_6) δ : 0.75-1.34 (m, 5H), 1.11 (d, 3H), 1.50-1.70 (m, 10H), 2.18-2.28 (m, 2H), 2.35-2.45 (m, 2H), 2.58-2.65 (m, 1H), 3.27-3.36 (m, 1H), 3.60 (m, 3H), 3.71 (s, 3H), 4.35 (m, 1H), 6.53-6.60 (m, 1H), 6.61 (d, 1H), 6.79 (d, 1H), 8.44 (m, 1H), 8.80 (brs, 1H).

ESI-MS 479.4 (MH^+)

Sweetness, 40000 times the sweetness of sugar

(Example 19)

Synthesis of N-[N-[(RS)-3-(3-methoxy-4-hydroxyphenyl)butyl]-L- α -aspartyl]-L-tyrosine 1-methyl ester (Table 1, compound number 5)

N-[N-[(RS)-3-(3-methoxy-4-hydroxyphenyl)-butyl]-L- α -aspartyl]-L-tyrosine 1-methyl ester was obtained as a solid substance with a total yield of 37.5% in the same way as in Example 14 except using N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-tyrosine methyl ester in place of N-t-butoxycarbonyl- β -O-benzyl- α -L-aspartyl-L-phenylalanine methyl ester.

$^1\text{HMMR}$ (DMSO- d_6) δ : 1.10 (d, 3H), 1.55 (m, 2H), 2.16-2.41 (m, 4H), 2.58 (m, 1H), 2.70-2.82 (m, 1H), 2.85-2.95 (dd, 1H), 3.58 (s, 3H), 3.78 (s, 3H), 4.43 (m, 1H), 6.53-6.75 (m, 5H), 6.96 (d, 2H), 8.49 (brd, 1H), 8.75 (brs, 1H), 9.80 (brs, 1H)

ESI-MS 489.3 (MH⁺)

Sweetness, 25000 times the sweetness of sugar

(Example 20)

Synthesis of N-[N-[(RS)-3-(3-methyl-4-hydroxyphenyl)butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 11)

N-[N-[(RS)-3-(3-methyl-4-hydroxy phenyl) butyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 19.7% in the same way as in Example 14 except using 3-(3-methyl-4-benzyloxyphenyl)-2-butenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

¹HMMR (DMSO-d₆) δ : 1.06-1.09 (m, 3H), 1.49-1.54 (m, 2H), 2.08 (m, 3H), 2.11-2.20 (m, 3H), 2.17-2.33 (m, 1H), 2.85- 2.95 (m, 2H), 3.05-3.09 (m, 1H), 3.33-3.37 (m, 1H), 3.61 (s, 3H), 4.50-4.55 (m, 1H), 6.65 (m, 1H), 6.76 (m, 1H), 6.84 (s, 1H), 7.16-7.28 (m, 5H), 8.47-8.50 (m, 1H), 9.02 (brs, 1H)

ESI-MS 457.2 (MH⁺).

Sweetness, 50000 times the sweetness of sugar

(Example 21)

Synthesis of N-[N-[3-(3-hydroxy-4-methoxyphenyl)-(RS)-2-methylpropyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 12)

N-[N-[3-(3-hydroxy-4-methoxyphenyl)-(RS)-2-

methylpropyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 45.6% in the same way as in Example 14 except using 3-(3-benzyloxy-4-methoxyphenyl)-2-methyl-2-propenal in place of 3-(3-methoxy-4-benzyloxyphenyl)-2-butenal.

$^1\text{HMMR}$ ($\text{DMSO}-d_6$) δ : 0.68-0.85 (m, 3H), 1.65-1.82 (m, 1H), 2.08- 2.37 (m, 2H), 2.27-2.30 (d, 4H), 2.94-3.10 (m, 2H), 3.43-3.45 (m, 1H), 3.62 (s, 3H), 3.72 (s, 3H), 4.48-4.59 (m, 1H), 6.49-6.59 (m, 2H), 6.77-6.80 (m, 1H), 7.20-7.29 (m, 5H), 8.57-8.58 (m, 1H), 8.92 (brs, 1H).

ESI-MS 473.4 (MH^+)

Sweetness, 5000 times the sweetness of sugar

(Example 22)

Synthesis of N-[N-[3-(3-hydroxy-4-methylphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 19)

274 mg (0.97 mmol) of 3-[(3-benzyloxy-4-methyl)phenyl]-3-methylbutyl aldehyde, 353 mg (1.2 mmol) of aspartame and 100 mg of 10% palladium carbon (containing 50% of water) were added to 7 ml of methanol and stirred at room temperature for four hours in a hydrogen atmosphere. The catalyst was filtered off and the resulting filtrate was concentrated under reduced pressure. The residue was purified by preparative thin layer chromatography (PTLC) to produce 299 mg (0.64 mmol, 65.5%) of N-[N-[3-(3-hydroxy-4-

methylphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester as a solid substance.

¹HMMR (DMSO-d₆) δ : 1.14 (s, 6H), 1.58-1.70 (m, 2H), 2.05 (s, 3H), 2.07-2.42 (m, 4H), 2.89 (dd, 1H), 3.03 (dd, 1H), 3.30-3.40 (m, 1H), 3.59 (s, 3H), 4.46-4.54 (m, 1H), 6.60 (d, 1H), 6.73 (s, 1H), 6.94 (d, 1H), 7.15-7.30 (m, 5H), 8.46 (brs, 1H) 9.08 (brs, 1H).

ESI-MS 471.3 (MH⁺)

Sweetness, 60000 times the sweetness of sugar

(Example 23)

Synthesis of N-[N-[3-(3,4-dihydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester (Table 1, compound number 23)

N-[N-[3-(3,4-dihydroxyphenyl)-3-methylbutyl]-L- α -aspartyl]-L-phenylalanine 1-methyl ester was obtained as a solid substance with a total yield of 76.5% in the same way as in Example 1 except using 3-(3,4-dibenzyloxyphenyl)-3-methylbutyl aldehyde in place of 3-(3-benzyloxy-4-methoxyphenyl)-3-methylbutyl aldehyde.

¹HMMR (DMSO-d₆) δ : 1.14 (s, 6H), 1.76-1.93 (m, 2H), 2.40-2.50 (m, 2H), 2.73-2.80 (m, 2H), 2.91 (dd, 1H), 3.06 (dd, 1H), 3.59 (s, 3H), 3.95-4.05 (m, 1H) 4.45-4.55 (m, 1H), 6.52 (d, 1H), 6.64-6.70 (m, 2H), 6.94 (d, 1H), 7.15-7.30 (m, 5H), 8.73 (brs, 1H), 8.80 (brs, 1H), 9.09 (brs, 1H).

ESI-MS 473.3 (MH⁺)

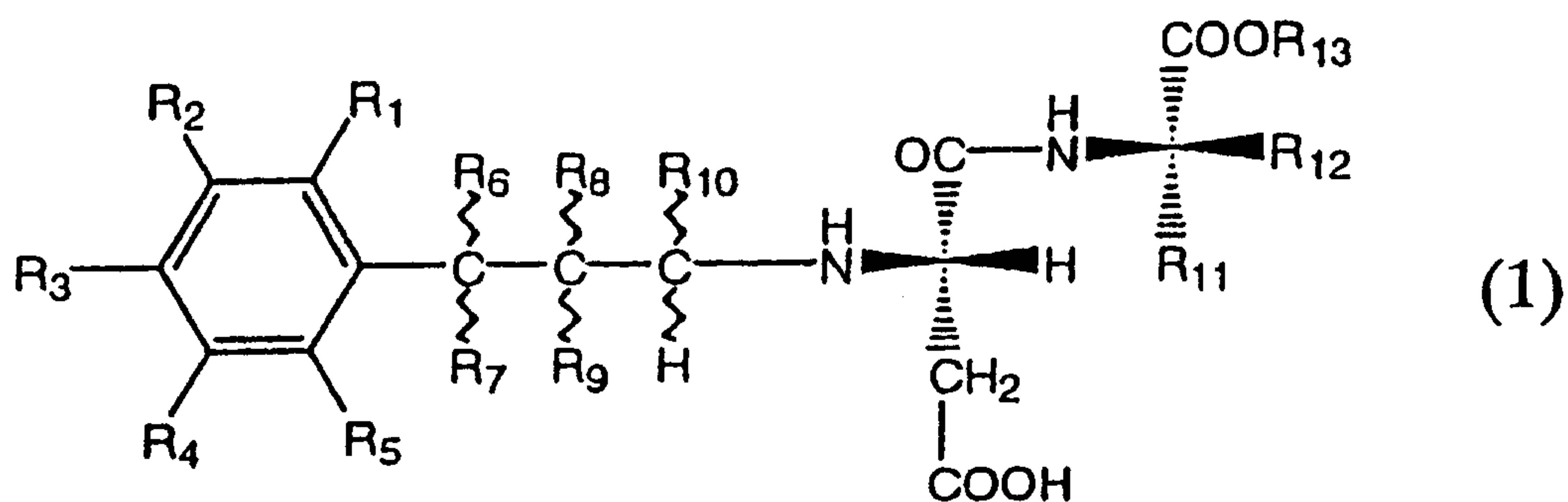
Sweetness, 50000 times the sweetness of sugar

Effect of Invention

The novel N-alkylaspartyl dipeptide ester derivative according to the present invention is low in calories and exhibits a sweetening potency which is particularly superior, in comparison with conventional sweetening agents. In the present invention, a novel chemical substance which has superior properties as a sweetening agent can be provided. The novel derivative can be used not only for a sweetening agent but also for the affording of sweetness to foods or the like products, such as beverages (drinks) and foods, requiring sweet taste.

CLAIMS

1. An N-alkylaspartyl dipeptide ester derivative, including its salt form, represented by the following general formula (1):



where R_1 , R_2 , R_3 , R_4 and R_5 are reciprocally independent and denote a substituent selected from the group consisting of a hydrogen atom, a hydroxyl group, an alkoxy group having 1 to 3 carbon atoms, an alkyl group having 1 to 3 carbon atoms and a hydroxy alkyloxy group having two or three carbon atoms, or R_1 and R_2 , or R_2 and R_3 combine together and denote a methylene dioxy group,

provided that in case that R_1 and R_2 , or R_2 and R_3 combined together denote a methylene dioxy group, R_4 and R_5 , and R_1 or R_3 which is not combined with R_2 together, are reciprocally independent and denote one of the above-mentioned substituents designated for the symbol;

where R_6 , R_7 , R_8 , R_9 and R_{10} are reciprocally independent

and denote a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms and optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} therein may combine together and denote an alkylene group with 1 to 5 carbon atoms;

provided that, if any optional two substituents selected from R_6 , R_7 , R_8 , R_9 and R_{10} combine together and denote an alkylene group with 1 to 5 carbon atoms, the substituents other than the selected two are reciprocally independent and denote one of said substituents designated for the symbol;

wherein R_{11} denotes a substituent selected from the group consisting of a hydrogen atom, a benzyl group, a p-hydroxy benzyl group, a cyclohexyl methyl group, a phenyl group, a cyclohexyl group, a phenyl ethyl group and a cyclohexyl ethyl group, and R_{12} denotes a substituent selected from the group consisting of a hydrogen atom and an alkyl group with 1 to 3 carbon atoms, and R_{13} denotes a substituent selected from the group consisting of alkyl groups with 1 to 4 carbon atoms;

provided that derivatives in which R_6 , R_7 , R_8 , R_9 and R_{10} in their entirety denote a hydrogen atom at the same time, those in which R_6 denotes a methyl group, and R_1 , R_2 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom at the same time and R_{11} denotes a benzyl group or a p-hydroxy benzyl group, at the same time, and those in which R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_{10} denotes a methyl group, R_1 ,

R_4 , R_5 , R_6 , R_7 , R_8 and R_9 denote a hydrogen atom at the same time, and R_{11} denotes a benzyl group or a p-hydroxy benzyl group, are excluded.

2. The derivative as defined in claim 1 wherein R_3 denotes a methoxy group, R_1 , R_2 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

3. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_1 , R_3 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

4. The derivative as defined in claim 1 wherein R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

5. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a benzyl group.

6. The derivative as defined in claim 1 wherein R_2 denotes a methoxyl group, R_3 denotes a hydroxy group, R_1 , R_4 ,

R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a p-hydroxy benzyl group.

7. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group and R_{11} denotes a cyclohexyl methyl group.

8. The derivative as defined in claim 1 wherein R_3 denotes a methoxy group, R_1 , R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

9. The derivative as defined in claim 1 wherein R_3 denotes a hydroxyl group, R_1 , R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

10. The derivative as defined in claim 1 wherein R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

11. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 ,

R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

12. The derivative as defined in claim 1 wherein R_2 denotes a methyl group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_7 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

13. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_6 , R_7 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_8 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

14. The derivative as defined in claim 1 wherein R_1 denotes a hydroxyl group, R_2 , R_3 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

15. The derivative as defined in claim 1 wherein R_1 denotes a hydroxyl group, R_3 denotes a methoxy group, R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

16. The derivative as defined in claim 1 wherein R_1 denotes a hydroxyl group, R_3 denotes a methyl group, R_2 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13}

denote a methyl group, and R_{11} denotes a benzyl group.

17. The derivative as defined in claim 1 wherein R_2 and R_3 combine together and denote a methylene dioxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

18. The derivative as defined in claim 1 wherein R_2 denotes a methyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

19. The derivative as defined in claim 1 wherein R_2 denotes a methyl group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

20. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

21. The derivative as defined in claim 1 wherein R_2 denotes a methoxy group, R_3 denotes a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_7 combine together and denote a tetramethylene group, R_{11} denotes a

benzyl group, and R_{13} denotes a methyl group.

22. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 and R_7 denote a methyl group, R_{11} denotes a benzyl group, and R_{13} denotes an ethyl group.

23. The derivative as defined in claim 1 wherein R_2 denotes a hydroxyl group, R_3 denotes a methoxy group, R_1 , R_4 , R_5 , R_8 , R_9 and R_{10} denote a hydrogen atom, R_6 , R_7 , R_{12} and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

24. The derivative as defined in claim 1 wherein R_2 and R_3 denote a hydroxyl group, R_1 , R_4 , R_5 , R_8 , R_9 , R_{10} and R_{12} denote a hydrogen atom, R_6 , R_7 , and R_{13} denote a methyl group, and R_{11} denotes a benzyl group.

25. The derivative as defined in anyone claim of claims 1 to 7 and 12 wherein, if the substituents R_6 and R_7 differ from each other, the configuration of the carbon atom to which R_6 is linked in said formula is in the state of (R), (S) or (RS).

26. The derivative as defined in claim 1 or 13 wherein, if the substituents R_8 and R_9 differ from each other, the

configuration of the carbon atom to which R_8 is linked in said formula is in the state of (R), (S) or (RS).

27. The derivative as defined in claim 1 wherein, if R_{10} denotes a substituent other than a hydrogen atom, the configuration of the carbon atom to which R_{10} is linked in said formula is in the state of (R), (S) or (RS).

28. A sweetening agent, or a sweetened food or the like product comprising the derivative as defined in claim 1 as an effective component, which may optionally contain a carrier or a bulking agent for the sweetening agents.